CITY OF NORTH MIAMI
PUBLIC WORKS UTILITIES

CONTRACT DOCUMENTS FOR

WINSON WATER TREATMENT PLANT
BID PACKAGE 1: FILTER REHAB

VOLUME 1: TECHNICAL SPECIFICATIONS

BID SET
DECEMBER 2016
SECTION 01010 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Work to be performed under this Contract shall consist of furnishing and installation of all tools, equipment, materials, supplies, manufactured articles, transportation and services, including fuel, power, water, and essential communications, for the performance of all labor, work, and/or other operations as required for the fulfillment of the Contract in strict accordance with the Contract Documents. The Work shall be complete, and all work, materials, and services not expressly shown or called for in the Contract Documents which may be necessary for the complete and proper construction of the Work in good faith shall be performed, furnished, and installed by the Contractor as though originally so specified or shown, at no increase in cost to the Owner.

B. Wherever the Contract Documents address a third party, i.e., subcontractor, manufacturer, etc., it is to be considered as the Contractor through the third party.

C. Wherever a reference to number of days is noted, it shall be construed to mean calendar days.

D. The project is located at the Winson Water Treatment Plant 12098 NW 11\(^{th}\) Avenue, North Miami, Florida, 33168. The Contractor shall note that the project area is on property owned by the City of North Miami. The Contractor shall confine its construction activities to the locations shown in the Drawings.

E. The Contractor is advised that the work is to be performed in a fully operational water treatment facility, which is the principal source of potable water supply to the City of North Miami. The Contractor shall be fully responsible for all precautionary measures together with all remediation, cleanup, disinfection, regulatory agency fines and all other labor, materials, and costs associated with any contamination of the water supply caused directly or indirectly by the activities of the Contractor in the performance of the work.

F. Notwithstanding other indemnification requirements of the Contract Documents, the Contractor shall also indemnify, defend, and hold harmless the Owner, the Engineer and the Owner's agents from any and all legal action that may arise from contamination of the water supply caused directly or indirectly by the Contractor in the performance of the work.

1.02 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of the Contract at the Winson Treatment Plant is comprised of the replacement of the filter media, surface wash agitator system, underdrains and filter pipe gallery for existing Filters No. 1 through No. 4, including internal wall waterproofing for leak suppression, with all auxiliary accessories as detailed in the Contract Documents

B. The Work set forth within these bid documents includes the furnishing of all labor, materials, equipment, services and incidental, including all associated piping, electrical work, control systems, and all appurtenant work, complete, tested and ready for operation, all in conformance with Contract Document requirements.
1.03 WORK BY OTHERS

A. The Contractor's attention is directed to the fact that Work may be conducted at the site by other Contractors during the performance of the Work under this Contract. The Contractor shall conduct its operations so as to cause a minimum of interference with the Work of such other Contractors, and shall cooperate fully with such Contractors to provide continued safe access to their respective portions of the site, as required to perform their respective contracts.

B. The contract drawings illustrate the approximate limits of Contractor's staging area. For additional sequencing restrictions reference Article 1.04 of this Section.

C. When two or more contracts are being executed at one time on the same or adjacent land in such manner that work on one contract may interfere with that on another, the Owner shall determine the sequence and order of the Work. When the territory of one contract is the necessary or convenient means of access for the execution of another contract, such privilege of access or any other reasonable privilege may be granted by the Owner to the Contractor so desiring, to the extent, amount, in the manner, and at the times permitted. No such decision as to the method or time of conducting the Work or the use or territory shall be made the basis of any claim of delay or damage.

D. Interference with Work on Utilities: The Contractor shall cooperate fully with all utility forces of the Owner or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the Work, and shall schedule the Work so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.04 SEQUENCE OF CONSTRUCTION

A. General: Work under the Contract shall be scheduled and performed in such a manner as to result in the least possible disruption to the operation of the existing treatment facilities. Process control modifications shall not be made without first obtaining written permission from the Owner or from the Engineer.

B. Critical events in the sequence of construction are specified herein. The outlined sequence of construction does not include all items necessary to complete the work, but is intended to identify the sequence of critical events necessary to minimize disruption to the on-going plant operations and to ensure compliance with regulatory requirements. It shall be understood by the Contractor that the critical events identified are not all inclusive and that additional items of work not shown may be required. The sequence of construction is a precedence requirement and does not attempt to schedule the Contractor's work. It is intended only to indicate which activities must precede other activities in order to minimize interferences and disruptions.

C. At no time shall the Contractor undertake to close off any pipelines, or open valves, or take any other action that would affect the operation of the existing system, until authorization is granted by the Owner or Engineer and after proper notification.

D. The work to be performed by the Contractor involves additions, temporary facilities, and modifications to major operational systems within the treatment plant and other minor sub-processes. The Contractor will be required to "interface" with these active facilities and should ensure that these systems remain operational during all construction activities.
Specific constraints to be placed on the work to be performed are summarized below. Note that this listing is subject to revision based on actual conditions.

E. General constraints on the sequence of construction are as follows:

1. Following the Notice to Proceed with the Work, Contractor shall notify Owner and Engineer in writing at least seven (7) days before it is ready to start actual construction and prior to removing a filter basin from service.

2. FILTER PIPE GALLERY REPLACEMENT

   a. The Contractor shall mobilize and prepare the staging area as shown on the drawings, including the demolition of the existing northeast wall of the filter gallery.

   b. The Contractor shall work closely with the Owner and Engineer for scheduling the work required under this Contract.

   c. The Owner will take the entire filter operation out of service for one consecutive fourteen (14) calendar day period – a total of 336 consecutive hour period – commencing at approximately 10 am on a specific date as mutually agreed to by the Contractor and Owner. The Owner will drain the filters and have them ready for Contractor to commence work accordingly.

   d. The Contractor shall meet with the Engineer and Owner at least fourteen (14) days prior to the planned shutdown to review its proposed demolition and construction sequence, to reach agreement with the Owner as to access requirements and a subsequent testing, disinfection and startup schedule.

   e. This shutdown is intended to provide the Contractor full, uninterrupted access to the filter gallery for demolition and construction work without need of having to maintain operations.

   f. The Contractor shall proceed with Work continuously, (24 hours/day) start to finish, until the Work noted herein is completed and normal plant operation is restored.

   g. During this shutdown period the Owner will purchase water from other utilities for distribution to residents. The Owner shall pay for water for up to fourteen (14) calendar days.

   h. During this one shutdown period, the filter facility will be off-line and the Contractor shall have access to the filter gallery for the continuous 24-hour per day, 14 day period as noted.

   i. The Contractor shall install the proposed air compressor unit with ancillary piping and electrical work as necessary to result in a functioning system acceptable to the Owner prior to commencing any demolition work.

   j. The Contractor shall demolish existing and install new filter gallery mechanical, structural, electrical and instrumentation work as shown on the drawings.
k. For purposes of existing filter gallery structure refurbishment required by the contract documents, the Contactor shall coordinate its activities to ensure that all such work is completed prior to the conclusion of this one shutdown period.

l. As demolition and construction activity within the pipe gallery will be limited to the noted 14 consecutive day period, the Contactor shall coordinate it activities to ensure that all requisite existing dimensions and connections have been verified, required submittals / shop drawings have been approved by the Engineer, proposed piping and equipment has been procured, delivered and field assembled to extent necessary, and all new stainless steel piping has been fabricated to match dimensional requirements of the proposed installation.

m. The Contractor shall remove the wall at the northeast end of the filter gallery to facilitate access. Reference the structural drawings for removal and reconstruction requirements.

n. As the existing filter gallery can also be accessed through the southwestern end, and that area includes critical process monitoring equipment, the Contactor shall exercise due caution and utilize requisite methods of its choosing to transport materials and equipment required for the demolition installation work as necessary to not impact plant operations. It is suggested that the Contactor thoroughly familiarize itself with existing work area access and restrictions, as all costs for such shall be included in the base bid.

o. The Contractor shall make all necessary provision to have access to requisite trades and equipment as may be necessary to implement field adjustments during the shutdown need to address existing conditions. In this effort, the Contactor shall also ensure that it will have uninterrupted power (emergency generators), lights, equipment and materials as necessary to complete the work.

p. Properly dispose of all replaced materials, piping, and other debris from the water treatment plant on a daily basis. Storage of demolition materials on site shall not be acceptable.

q. If the Contractor fails to complete the requisite work during the noted 14-day shut-down period, it shall be responsible for payment to the City a penalty in the amount of $10,000 per day for the duration after the initial 14 day period until the work is completed. This payment shall be deducted from the Contractors pay request accordingly.

r. The Contractor shall pressure test and disinfect all new filter pipe gallery improvements in accordance with the requirements noted in the Section entitled “Pipeline Testing and Disinfection”.

3. FILTER BASIN UPGRADES

   a. After the filter pipe gallery replacement work has been completed, the Contractor may commence the filter basin upgrades.

   b. The Contractor shall meet with the Engineer and Owner at least fourteen (14) days prior to commencing filter basin upgrades to review its proposed demolition and construction sequence, to reach agreement with the Owner as to access requirements and a subsequent testing, disinfection and startup schedule.
c. The existing filters are covered with screen enclosures that shall remain in place at all times during construction, with the exception of the filter that is being refurbished. The Contractor may, with City approval, remove the screen over the filter that is being refurbished. If it chooses to do so, the Contractor shall store and protect the screen and reinstall it at the completion of the work for the filter unit. Any damage to the screen or support structure resulting from Contractor activities shall be corrected, to the satisfaction of the Owner, at no additional cost.

d. The Owner may take up to two filters out of service and empty the liquid contents. Under normal conditions, all filter basins are in operation at all times. No more than two (2) filter may be out of service at any one time for rehabilitation.

e. The Contractor shall be required to restrict its construction activities to two filters at a time. To avoid impacts to adjacent functioning filters, the Contractor shall install a wooden partition between out of service and functioning filters if applicable. The partition shall be supported by the screen superstructure, and the design of such partition shall be by the Contractor, subject to Owner acceptance.

f. Filters shall be rehabilitated in the following sequence:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Filter No. 2 and Filter No. 4</th>
<th>Filter No. 1 and Filter No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Out of Service</td>
<td>In-Service</td>
</tr>
<tr>
<td>2</td>
<td>In-Service</td>
<td>Out of Service</td>
</tr>
</tbody>
</table>

g. During each filter shutdown period the Owner will purchase water from other utilities for distribution to residents.

h. The Owner shall pay for water purchases during these individual filter shutdown periods.

i. It is anticipated that the media in the existing filters and underdrains is either wholly or partially “cemented” and will require use of jackhammers, or other such equipment to remove. The Contractor shall include all such costs to demolish, remove and dispose of existing filter internals in its base bid.

j. Reference the Sections entitled “Filter Underdrains”, “Filter Basin Interior Waterproofing”, “Filter Media and Gravel” and “Surface Wash Agitator System” for additional requirements related to filter equipment.


l. A maximum of two (2) filters may be taken off–line at any time. Total downtime for each filter basin, including testing, disinfection and acceptance by the Engineer shall not exceed 100 calendar days. For a total of four filters, the cumulative filter downtime shall not exceed 200 calendar days.
m. If the Contractor fails to complete the requisite filter basin upgrade work during
the noted 200 cumulative calendar day period, it shall be responsible for payment
of City a penalty in the amount of $5,000 for any additional days beyond the 200
cumulative day filter shutdown period allowed by the contract until the work is
completed. This payment shall be deducted from the Contractors pay request
accordingly.

n. Note that the filter media cannot be placed until after a minimum mandatory
waterproofing cure time of 14 days.

o. In addition, the Contractor shall not install filter media until onsite media testing
has been accepted by Owner. Contractor shall retain the services of an
independent testing laboratory to test the filter media immediately upon delivery
and prior to installation.

p. The Contractor shall notify the Owner in writing at least seven (7) days prior to
filter media washing and scraping operations and surface scour and underdrain
system hydraulic testing.

q. Each individual filter basin surface scour test and underdrain system hydraulic
test shall not be conducted until the hydrostatic test has been successfully
completed and accepted by the Owner.

r. The Contractor shall notify water plant operations personnel when the filter media
is ready for washing and scraping / scouring operations. All operations shall be
conducted by the water plant staff.

s. The Contractor shall hydraulically test each existing filter basin in accordance
with the requirements noted in the Section entitled “Hydraulic Testing of
Structures”.

t. The Contractor shall disinfect each refurbished filter in accordance with the
requirements noted in the Section entitled “Disinfection and Bacteriological
Testing”.

u. The Contractor shall work closely with the Owner and Engineer for scheduling the
work required under this Contract.

v. The Contractor shall coordinate with materials and equipment manufacturers to
ensure that requisite personnel are on-site for trouble shooting and training
purposes during testing, checkout, disinfection and startup.

w. Properly dispose of all replaced materials, piping, and other debris from the water
treatment plant on a daily basis. Storage of demolition materials on site shall not
be acceptable.

E. Substantial Completion: See the Section titled “COMPLETION TIME TERM OF
CONTRACT” in the Special Conditions.

F. Final Completion: See the Section titled “COMPLETION TIME TERM OF CONTRACT” in
the Special Conditions.

1.05 CONTRACTOR USE OF PROJECT SITE
A. The Contractor's use of the project site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities, and field offices, as noted in the Contract Drawings.

B. **Disposal of Debris:** All debris, materials, piping, and miscellaneous waste products from the Work described in this Section shall be removed from the project daily. Such materials shall be disposed of in accordance with applicable federal, state, and local regulations. The Contractor is responsible for determining these regulations and shall bear all costs or retain any profit associated with disposal of these items.

C. The Contractor shall provide a security badge identification system for its employees and subcontractors working in and around the WTP facilities as described in the Section entitled “Site Access and Storage”.

1.06 **OWNER USE OF THE PROJECT SITE**

A. The Owner may utilize all or part of the facilities during the entire period of construction for the conduct of the Owner’s normal operations. The Contractor shall cooperate with the Owner to minimize interference with the Contractor's operations and to facilitate the Owner's operations.

1.07 **PROJECT MEETINGS**

A. **Preconstruction Conference:** Prior to the commencement of Work at the site, a preconstruction conference will be held at a mutually agreed time and place which shall be attended by the Contractor, its superintendent, and its subcontractors as appropriate. Other attendees will be:

1. Representatives of the Owner.
2. Governmental representatives as appropriate.
3. Others as requested by Contractor, Owner, or Engineer.

B. Unless previously submitted to the Engineer, the Contractor shall bring to the conference one copy each of the following:

1. Preliminary schedule.
2. Preliminary procurement schedule of major equipment and materials and items requiring long lead time.
3. Preliminary Shop Drawing/Sample/Substitute or "Or Equal" submittal schedule.
4. Schedule of Payment Items (lump sum price breakdown) for progress payment purposes.

C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda will include:

1. Contractor's tentative schedules.
2. Transmittal, review, and distribution of Contractor's submittals.

3. Processing applications for payment.


5. Critical work sequencing.

6. Field decisions and Change Orders.

7. Use of project site, office and storage areas, security, housekeeping, the Owner's needs.

8. Major equipment deliveries and priorities.

D. The Engineer will preside at the preconstruction conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

E. Progress Meetings: The Engineer will schedule and hold regular on-site progress meetings at least weekly and at other times as requested by Engineer. The Owner, Contractor, Engineer, and all subcontractors active on the site shall be represented at each meeting. Contractor may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.

F. The Engineer will preside at the meetings and provide for keeping and distribution of the minutes. The purpose of the meetings will be to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.

G. The Contractor shall attend meetings held to coordinate work between other contracts that may be on-going on the project site. The General Superintendent, Job Superintendent, and/or other key representatives of each prime Contractor shall attend these meetings, at the Owner's request.

1.08 PERMITS

A. It shall be the Contractor's responsibility to secure all permits of every description required to initiate and complete the work under this contract, except permits obtained by the Owner.

B. Permits that have been obtained by the Owner include the following:

<table>
<thead>
<tr>
<th>Agency</th>
<th>Permit</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida Department of Health</td>
<td>No permit required</td>
<td>See Attachment 1</td>
</tr>
<tr>
<td>Miami-Dade Department of Environmental</td>
<td>Approval Letter issued March 19, 2013</td>
<td>See Attachment 2</td>
</tr>
<tr>
<td>Resources Management (DERM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miami-Dade Building Department</td>
<td>Processing No. M2016016055</td>
<td></td>
</tr>
<tr>
<td>City of North Miami Building</td>
<td>Permit No. BBC00-2016-00104</td>
<td>The Owner will provide copies of</td>
</tr>
</tbody>
</table>
C. Measurement and Payment for Contractor acquired permit requirements. The Engineer will furnish signed and sealed sets of Contract Documents for permit use as required.

D. The Contractor shall furnish to the Engineer copies of all permits prior to commencement of Work requiring permits.

1.09 FIELD ENGINEERING

A. Provide Field Engineering Services: Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

B. Submit a copy of registered site drawing and certificate signed by the Land Surveyor that the elevations and locations of the Work are in conformance with the Contract Documents.

C. The Contractor shall provide sketches for Engineer's review of all field routed piping (generally 2-inch and smaller), instrument locations and conduit stub-ups at equipment.

D. If dimensions of equipment or piping locations are not shown on the Drawings, the Contractor shall coordinate such accordingly with the Engineer.

1.10 SITE CONDITIONS

A. The Contractor acknowledges that it has investigated prior to bidding and satisfied itself as to the conditions affecting the Work, including but not restricted to those bearing upon transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads and uncertainties of weather, river stages, tides, water tables or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during execution of the Work. The Contractor further acknowledges that it has satisfied itself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, or any contiguous site, as well as from information presented by the Drawings and Specifications made a part of this Contract, or any other information made available to it prior to receipt of Bids. Any failure by the Contractor to acquaint itself with the available information will not relieve him from responsibility for estimating properly the difficulty or cost of successfully performing the Work. The Owner assumes no responsibility for any conclusions or interpretations made by the Contractor on the basis of the information made available by the Owner.

1.11 DIMENSIONS OF EXISTING FACILITIES

A. Where the dimensions and locations of existing improvements are of critical importance in the installation or connection of new work, the Contractor shall verify such dimensions and locations in the field prior to the fabrication and/or installation of materials or equipment which are dependent on the correctness of such information.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)
Permit Determination from MD Health Dept.  
North Miami WTP Filter Rehab

Determination: No Permit is Required

August 18, 2016
From: Pierre-Louis, Wisler [mailto:PWisler@northmiamifl.gov]
Sent: Thursday, August 18, 2016 10:25 AM
To: Brown, George A. <gbrown@hazenandsawyer.com>; Carney, Patricia A <pcarney@hazenandsawyer.com>; Mena, Freddy J <fmena@hazenandsawyer.com>
Cc: Vida, Paul <PVida@northmiamifl.gov>; Rizvi, Hasan <hrizvi@northmiamifl.gov>; Okereke, Chuks <cokereke@northmiamifl.gov>
Subject: Fwd: North Miami Winson Water Treatment Plant Filter Rehabilitation

FYI

Sent from my iPhone

Begin forwarded message:

From: "Caballero, Reinaldo" <Reinaldo.Caballero@flhealth.gov>
Date: August 18, 2016 at 10:00:15 AM EDT
To: "Pierre-Louis, Wisler" <PWisler@northmiamifl.gov>, "Rojas, Richard M" <Richard.Rojas@flhealth.gov>
Subject: North Miami Winson Water Treatment Plant Filter Rehabilitation

Good morning Mr. Wisler,

Based on the description of the project and its purpose this project does not require permit from The Health Department.

According to Chapter 62-555.520(1)(c)(1) F.A.C. "No construction permit is required for replacement of any existing drinking water pumping, storage, or treatment facilities, including chemical application facilities and residuals handling facilities, with new facilities of the same design and capacity, and the same general location, as the existing facilities"

However, suppliers of water shall submit written notification to the Department before beginning such work or alterations. Each notification shall include a description of the scope, purpose, and location of the work or alterations, and the assurance that the work or alterations will comply with applicable requirements.

When constructing or altering treatment or storage facilities, or water mains, for which a public water system construction permit is not required per subsection 62-555.520 (1), F.A.C., the facilities may be placed into, or returned to, operation without the Department’s approval after disinfection and satisfactory completion of as bacteriological evaluation (two consecutive days) . The results of the bacteriological evaluation shall be submitted to the County Health Department within ten days after the end of the month during which the bacteriological evaluation was completed.

No Permit Required projects require a DOH “NO PERMIT REQUIRED” stamp. The fee for that stamp is $72.10 and we stamp up to seven sets for that fee.

If you have any question, please do not hesitate to contact me anytime.
Reinaldo Caballero
Florida Department of Health in Miami-Dade County
Environmental Specialist III
Email: Reinaldo.Caballero@flhealth.gov
Phone: (305) 623-3500 x 22022
Mailing Address: 1725 NW 167 STREET, Floor: 01 Room: 119
MIAMI, FL 33056

Our Mission is to protect, promote & improve the health of all people in Florida through integrated state, county, & community efforts.

Please note: Florida has very broad public records law. Most written communication to or from state officials regarding state business are public records available to the public and media upon request. Your e-mail communications may therefore be subject to public disclosure.

The City of North Miami is a public entity subject to Chapter 119 of the Florida Statutes concerning public records. E-mail messages are covered under such laws and thus subject to disclosure. All E-mail sent and received is captured by our servers and kept as a public record.
Attachment 2

Section 01010

Miami-Dade

Department of Environmental Resources Management
March 12, 2013

Mr. Wisler Pierre-Louis
North Miami City Engineer
1815 NE 150 St.
North Miami, FL 33181

RE: City of North Miami - Winson Water Treatment Plant – Filter Rehabilitation
12098 Northwest 11th Avenue. North Miami, FL 33168
Folio #: 0621260167320
RER Operating Permit: PWO-14

APPROVAL LETTER

Project Description: Replacement of the filter media, surface wash agitator system, underdrains and filter pipe gallery for existing filters No. 1 through No. 4 at the Winson Water Treatment Plant.

Dear Mr. Pierre-Louis:

This letter shall serve as a notification that as of March 12, 2013 the plans and supporting documentation for the above described project have been approved under Section 24-15 of the Miami-Dade County Code. This approval is intended for the water supply facilities as they pertain to Section 24-43 of the Miami-Dade County Code. Any modification in your plans should be submitted for review, as changes may result in approvals or permits being required. This letter does not relieve you from the need to obtain any other approvals or permits (local, state or federal), which may be required. This determination has been done on the basis of the following information presented by the applicant:


Within thirty (30) days of completion of construction (COC), the engineer of record shall submit as-built plans and a letter of certification verifying that the facility has been constructed in compliance with the approved plans. After receipt of the COC, an inspection and approval of the certified facility by RER staff is required.

Failure to adhere to the items and timeframes stipulated above may result in the referral of this case for enforcement action.

If we may be of any further assistance, please contact me or Mr. Galo Pacheco of this office at (305)372-6584 or via e-mail at pacheg@miamidade.gov.

Sincerely,

[Signature]

Rashid Atambouli, P.E., Chief
Pollution Regulation Division

Cc: Johnny Vega, Galo Pacheco – RER
RER No. PWO-14
SECTION 01011 – SPECIAL BUILDING INSPECTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall provide a Special Building Inspector, in accordance with the requirements of the Florida Building Code, to perform all special inspections required by the Building Department with jurisdiction.

B. The Special Inspector shall be a Professional Engineer licensed in the State of Florida.

C. It is recognized that the scope of services associated with providing the special inspector cannot be quantified until the CONTRACTOR meets with the Building Department with jurisdiction and the Building Department defines the scope of special inspections.

D. For the purposes of bidding, assume an allowance of 100 hours of professional engineering services on a time and material basis for special inspections.

E. Special Inspector Allowance: The allowance amount for this bid item is to pay for all labor, equipment and materials for all work necessary and required for a licensed Professional Engineer to perform special inspections of the Work. This item includes, but is not limited to performing all special inspections as required by the Florida Building Code and all discretionary special inspections as required by the Building Department with jurisdiction, completion of all inspection reports, and completion/submittal of the Certification of Compliance. The allowance shown on the bid schedule is an estimate of services required. Payment will be based on the actual fee paid directly to the Special Inspector, documented by paid receipts, specifically excluding any labor, mark-up, overhead and profit, administration or other costs involved in obtaining licenses or paying fees. Any portion of this allowance that remains after all authorized payments have been made will be withheld from contract payments and will remain with the Owner.

1.02 SPECIAL BUILDING INSPECTOR FORM

A. Prepare and submit the form for “Special Building Inspector” as required by the Building Department with jurisdiction. The form shall be executed by the Professional Engineer licensed in the state of Florida.

B. Provide a copy of the form that is submitted to the Building Department to the ENGINEER for informational purposes.

1.03 INSPECTION REPORTS

A. Prepare a log of all progress reports and inspections related to the Special Inspections required by the Building Official. The log shall be maintained at the job site.

B. On a weekly basis submit signed and sealed progress reports and inspection reports to the Building Official as required by the Florida Building Code.
C. Provide copies of the reports that are submitted to the Building Department to the ENGINEER and the OWNER for informational purposes.

1.04 CERTIFICATION

A. The Special Inspector shall submit a Certificate of Compliance prior to scheduling the final building inspection in accordance with the Florida Building Code.

B. The Certificate of Compliance shall state that the work performed by the CONTRACTOR was done in accordance with the applicable portion of the permitted construction documents as delineated in the special building inspection plan.

C. Furnish a copy of the Certificate of Compliance to the OWNER and the ENGINEER.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -
SECTION 01025 - MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Payment for the various items in the Schedule of Payment items, as further specified herein, shall include all compensation to be received by the Contractor for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, taxes, materials, commissions, transportation and handling, bonds, permit fees, insurance, overhead and profit, and incidentals appurtenant to the items of Work being described, as necessary to complete the various items of the Work all in accordance with the requirements of the Contract Documents, including all appurtenances thereto, and including all costs of compliance with the regulations of public agencies having jurisdiction, including Safety and Health Requirements of the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA). Such compensation shall also include payment for any loss or damages arising directly or indirectly from the Work.

B. The Contractor's attention is called to the fact that the quotations for the various items of Work are intended to establish a total price for completing the Work in its entirety. Should the Contractor feel that the cost for any item of Work has not been established by the Schedule of Payment items or this Section, it shall include the cost for that Work in some other applicable bid item, so that its proposal for the project does reflect its total price for completing the Work in its entirety.

1.02 SCHEDULE OF VALUES BIDS

A. **Item No. 1 - Mobilization**: For performing preparatory work and operations in mobilizing for beginning the work of the Project shall include, but not be limited to:

- Movement of personnel, equipment, supplies and incidentals to the Project site for the establishment of temporary offices, safety equipment, first aid supplies, staging area, sanitary and other temporary facilities.

- The cost of bonds, required insurance, preparation of the schedule, submittal of shop drawings for long-lead materials and equipment that need to be ordered as soon as possible; together with ordering said materials and equipment in a timely fashion.

- All other preconstruction expenses.

- This item excludes the actual cost of permit fees, which are paid under a separate dedicated allowance account and excludes the cost of materials that are paid under another bid item.

- No actual construction or physical preparatory work for the other bid items under this project may be performed at the project site until the contractor has completed its mobilization activities.

The total payment for mobilization shall not exceed five (5) percent of the original Bid Price for Bid Item No. 2.
Partial payment for the mobilization item shall be made in accordance with the following payment schedule:

<table>
<thead>
<tr>
<th>Percent of Original Bid Item No. 2 Amount Earned</th>
<th>Allowable Percent of Lump Sum Price for the Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>25</td>
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<td>90</td>
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B. Item No. 2 – Filter System Rehabilitation: Included in this item are the complete furnishing and installation of all general, structural, architectural, mechanical, instrumentation, and electrical and appurtenant work required for a complete and operable installation in accordance with the Contract Documents along with all other items necessary to complete the Work that are not specifically included in other bid items.

C. Item No. 3 - Permit Fee Allowance: Payment for permit fees will be based upon the actual permit fees required by the Contractor from the various agencies having jurisdiction for construction of the project, in accordance with the Contract Documents. The allowance amount shown on the bid schedule is an estimate of permit fees required for the project and is a cost pass through item and no mark-ups will be added to this item. The Contractor shall produce documentation upon request verifying actual cost. Only permit fees substantiated by the Contractor and approved by the Engineer will be paid as part of this bid item. Any portion of this allowance that remains after all authorized payments have been made will be withheld from contract payments and will remain with the Owner.

1.03 SCHEDULE OF PAYMENT VALUES

A. The Contractor shall submit a Schedule of Payment Values for review with the return of the executed Agreement to the Owner. The schedule shall contain the installed value of the component parts of Work for the purpose of making progress payments during the construction period.

B. The schedule shall be given in sufficient detail for proper identification of Work accomplished. The Schedule of Payment Values shall directly correlate to each activity outlined in the construction progress schedule and the construction network analysis (specified in the Section entitled “Submittals” to accurately relate construction progress to the requested payment. Each item shall include its proportional share of all costs including the Contractor’s overhead, contingencies and profit. The sum of all scheduled items shall equal the total value of the Contract.

C. If the Contractor anticipates the need for payment for materials stored on the project site or off-site in bonded warehouse, it shall also submit a separate list covering the cost of materials, delivered and unloaded with taxes paid. This list shall also include the installed value of the item with coded reference to the Work items in the Schedule of Payment Values. Similar procedures shall be employed for undelivered specifically manufactured equipment and materials as specified herein.

1.04 NON-PAYMENT FOR REJECTED OR UNUSED PRODUCTS
A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Defective Work not accepted by Owner.
6. Material remaining on hand after completion of Work.

1.05 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings or preliminary operation and maintenance manuals are acceptable to Engineer.

B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

1.06 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.

B. Use detailed Application for Payment Form provided by the Owner.

C. Include accepted schedule of values for each portion of Work and the unit price breakdown for the Work to be paid on unit price basis, and a listing of Owner-selected equipment, if applicable, and allowances, as appropriate.

D. Preparation:

1. Round values to nearest dollar.
2. List each Change Order and Written Amendment executed prior to date of submission as separate line item. Totals to equal those shown on the Transmittal Summary Form.
3. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form, a listing of materials on hand as applicable, and such supporting data as may be requested by the Engineer or Owner.

- END OF SECTION -
SECTION 01070 - ABBREVIATIONS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Wherever in these specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of these specifications, the following acronyms or abbreviations which may appear in these specifications shall have the meanings indicated herein.

1.02 ABBREVIATIONS AND ACRONYMS

AAMA  Architectural Aluminum Manufacturer's Association
AASHTO  American Association of the State Highway and Transportation Officials
ACI  American Concrete Institute
ACOE  Army Corps of Engineers
ACPA  American Concrete Pipe Association
AFBMA  Anti-Friction Bearing Manufacturer's Association, Inc
AGMA  American Gear Manufacturer's Association
AHGDA  American Hot Dip Galvanizers Association
AI  The Asphalt Institute
AIA  American Institute of Architects
AISC  American Institute of Steel Construction
AISI  American Iron and Steel Institute
AITC  American Institute of Timber Construction
AMCA  Air Moving and Conditioning Association
ANSI  American National Standards Institute, Inc.
APA  American Plywood Association
API  American Petroleum Institute
APHA  American Public Health Association
APWA  American Public Works Association
ASA  Acoustical Society of America
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Name</th>
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<tbody>
<tr>
<td>ASAE</td>
<td>American Society of Agriculture Engineers</td>
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<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
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<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating, and Air-Conditioning Engineers</td>
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<tr>
<td>ASLE</td>
<td>American Society of Lubricating Engineers</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>ASMM</td>
<td>Architectural Sheet Metal Manual</td>
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<tr>
<td>ASSE</td>
<td>American Society of Sanitary Engineers</td>
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<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<tr>
<td>AWPA</td>
<td>American Wood Preservers Association</td>
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<tr>
<td>AWPI</td>
<td>American Wood Preservers Institute</td>
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<tr>
<td>AWS</td>
<td>American Welding Society</td>
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<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
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<tr>
<td>BHMA</td>
<td>Builders Hardware Manufacturer's Association</td>
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<tr>
<td>CMA</td>
<td>Concrete Masonry Association</td>
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<tr>
<td>CRSI</td>
<td>Concrete Reinforcing Steel Institute</td>
</tr>
<tr>
<td>DIPRA</td>
<td>Ductile Iron Pipe Research Association</td>
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<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>ETL</td>
<td>Electrical Test Laboratories</td>
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<tr>
<td>FBC</td>
<td>Florida Building Code</td>
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<tr>
<td>FDA</td>
<td>Food and Drug Administration</td>
</tr>
<tr>
<td>FDEP</td>
<td>Florida Department of Environmental Protection</td>
</tr>
<tr>
<td>FDOT</td>
<td>Florida Department of Transportation</td>
</tr>
<tr>
<td>FS</td>
<td>Federal Specifications</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IES</td>
<td>Illuminating Engineering Society</td>
</tr>
<tr>
<td>IPCEA</td>
<td>Insulated Power Cable Engineers Association</td>
</tr>
</tbody>
</table>
ISA  Instrument Society of America
ISO  International Organization for Standardization
MBMA Metal Building Manufacturer's Association
MTI  Marine Testing Institute
NAAM National Association of Architectural Metal Manufacturer's
NACE National Association of Corrosion Engineers
NBS  National Bureau of Standards
NEC  National Electrical Code
NEMA National Electrical Manufacturer's Association
NFPA National Fire Protection Association
NIOSH National Institute of Occupational Safety and Health
NRCA National Roofing Contractors Association
NSF  National Science Foundation
OSHA Occupational Safety and Health Administration
PCA Portland Cement Association
SMACCNA Sheet Metal and Air Conditioning Contractors National Association
SSPC Steel Structures Painting Council
SSPWC Standard Specifications for Public Works Construction
SFWMD South Florida Water Management District
UL  Underwriters Laboratories, Inc.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

- END OF SECTION -
SECTION 01090 - REFERENCE STANDARDS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Titles of Sections and Paragraphs: Captions accompanying specification sections and paragraphs are for convenience of reference only, and do not form a part of the Specifications.

B. Applicable Publications: Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date of the opening of bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

C. Specialists, Assignments: In certain instances, Specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such assignments shall be recognized as special requirements over which the Contractor has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the Work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of contract requirements remains with the Contractor.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the specifications, all work specified herein shall conform to or exceed the requirements of all applicable codes.

B. References herein to "Building Code" shall mean the Florida Building Code (FBC). The latest edition of the code as approved and used by the local agency as of the date of the Notice to Proceed, as adopted by the agency having jurisdiction, shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, Drawings and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to ordering or providing any materials or labor. The Contractor shall follow the most stringent requirements.

D. Applicable Standard Specifications: The Contractor shall construct the Work specified herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards, and Specifications listed herein.

E. References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
F. References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not used)

- END OF SECTION -
SECTION 01300 - SUBMITTALS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. This section specifies the means of all submittals. All submittals, whether their final destination is to the Owner, Engineer, or other representatives of the Owner, shall be directed through the Engineer. A general summary of the types of submittals and the number of copies required is as follows:

<table>
<thead>
<tr>
<th>Copies to Engineer</th>
<th>Type of Submittal</th>
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<tbody>
<tr>
<td>6</td>
<td>Progress Schedule</td>
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<tr>
<td>6</td>
<td>Construction Schedule</td>
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<td>6</td>
<td>Schedule of Payment Items</td>
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<tr>
<td>6</td>
<td>Operations and Maintenance (O&amp;M) Manuals</td>
</tr>
<tr>
<td>6</td>
<td>Progress Estimates</td>
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<tr>
<td>10</td>
<td>Shop Drawings</td>
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<td>2</td>
<td>Certificates of Compliance</td>
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<td>2</td>
<td>Warranties</td>
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<tr>
<td>2*</td>
<td>Product Samples</td>
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* Unless otherwise required in the specific Section where requested.

1.02 SUBMITTAL PROCEDURES

A. Transmit each submittal with a form acceptable to the Engineer, clearly identifying the project Contractor, the enclosed material and other pertinent information specified in other parts of this section. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

B. Revise and resubmit submittals as required, identify all changes made since previous submittals. Resubmittals shall be noted as such.

C. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.03 CONSTRUCTION PROGRESS SCHEDULE

A. The Contractor shall have the capability of preparing and utilizing the specified construction progress scheduling techniques. A statement of capability shall be submitted in writing to the Engineer with the return of the executed Agreement to the Owner and will verify that either the Contractor's organization has in-house capability qualified to use the technique or that the Contractor employs a consultant who is so qualified. Capability shall be verified by description of the construction projects to which the Contractor or its consultant has successfully applied the scheduling technique and which were controlled throughout the duration of the project by means of systematic use and updating of the construction progress schedule, the network analysis and associated reports. The submittal shall include the name of the individual on the Contractor's staff who will be responsible for the construction progress schedule and associated reports and for providing the required updating information of same. The Contractor shall submit its proposed progress schedule to the Engineer for review and comment within ten days of the Notice to Award.
B. The computer generated construction progress schedule and associated report shall include the following tabulations: a list of activities in numerical order, a list of activity precedence, schedules sequenced by Early Start Date, Total Float, and Late Start Date. All schedules shall be in color; black and white schedules will not be accepted. Each schedule and report shall include the following minimum items.

1. Activity Numbers
2. Estimated Duration
3. Activity Description
4. Early Start Date (Calendar Dated)
5. Early Finish Date (Calendar Dated)
6. Latest Allowable Start Date (Calendar Dated)
7. Latest Allowable Finish Date (Calendar Dated)
8. Status (whether critical)
9. Estimated Cost of the Activity
10. Total Float and Free Float

C. In addition, each construction progress schedule, network analysis and report shall be prefaced with the following summary data:

1. Contract Name and Number
2. Contractor's Name
3. Contract Duration and Float
4. Contract Schedule
5. The Effective or Starting Date of The Schedule (the date indicated in the Notice-to-Proceed)

D. The work day to calendar date correlation shall be based on an 8-hour day and 40-hour week with adequate allowance for holidays, adverse weather and all other special requirements of the Work. Normal work hours are Monday through Friday, 8:00 am to 5:00 pm. Exceptions for construction sequencing requirements shall be as noted in the Section entitled “Summary of Work”.

E. If the Contractor desires to make changes in its method of operating which affect the construction progress schedule and related items, it shall notify the Engineer in writing stating what changes are proposed and the reason for the change. If the Engineer accepts these changes, in writing, the Contractor shall revise and submit, without additional cost to the Owner, all of the affected portions of the construction progress schedule, and associated reports. The construction progress schedule and related items shall be adjusted by the Contractor only after prior acceptance, in writing by the Engineer. Adjustments may consist of changing portions of the activity sequence, activity durations, division of activities, or
other adjustments as may be required. The addition of extraneous, nonworking activities and activities which add restraints to the construction progress schedule shall not be accepted.

F. Except where earlier completions are specified, schedule dates which show completion of all Work prior to the contract completion date shall, in no event, be the basis for claim for delay against the Owner by the Contractor.

G. Construction progress schedules and related items which contain activities showing negative float or which extend beyond the contract completion date will be accepted only upon the condition that the Contractor will comply with recovery schedule requirements as specified in paragraph H. below.

H. Whenever it becomes apparent from the current construction progress schedule and associated reports that delays to the critical path have resulted and the contract completion date will not be met, or when so directed by the Engineer, the Contractor shall take some or all of the following actions at no additional cost to the Owner. They shall submit to the Engineer for approval, a written statement of the steps they intend to take to remove or arrest the delay to the critical path in the current construction progress schedule.

1. Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work.

2. Increase the number of working hours per shift, shifts per day, working days per week, the amount of construction equipment, or any combination of the foregoing, sufficiently to substantially eliminate the backlog of work.

3. Reschedule activities to achieve maximum practical concurrence of accomplishment of activities, and comply with the revised schedule.

I. If when so requested by the Engineer, the Contractor should fail to submit a written statement of the steps they intend to take or should fail to take such steps as reviewed and accepted in writing by the Engineer, the Engineer may direct the Contractor to increase the level of effort in manpower (trades), equipment and work schedule (overtime, weekend and holiday work, etc.) to be employed by the Contractor in order to remove or arrest the delay to the critical path in the current construction progress schedule, and the Contractor shall promptly provide such level of effort at no additional cost to the Owner.

J. If the completion of any activity, whether or not critical, falls more than 100 percent behind its previously scheduled and accepted duration, the Contractor shall submit for approval a schedule adjustment showing each such activity divided into two activities reflecting completed versus uncompleted work.

K. Shop drawings which are not approved on the first submittal or within the time scheduled, and equipment which does not pass the specified tests and certifications shall be immediately rescheduled.

L. The contract time will be adjusted only in accordance with the General Requirements and other portions of the Contract Documents as may be applicable. If the Engineer finds that the Contractor is entitled to any extension of the contract completion date, the Engineer's determination as to the total number of days extension shall be based upon the current construction progress schedule and on all data relevant to the extension. Such data shall be included in the next updating of the schedule and related items. Actual delays in
activities which, according to the construction progress schedule, do not affect any contract completion date will not be the basis for a change therein.

M. From time to time it may be necessary for the contract schedule of completion time to be adjusted by the Owner in accordance with the General Requirements and other portions of the Contract Documents as may be applicable. Under such conditions, the Engineer will direct the Contractor to reschedule the Work or contract completion time to reflect the changed conditions, and the Contractor shall revise the construction progress schedule and related items accordingly, at no additional cost to the Owner.

N. Available float time may be used by the Owner through the Owner's Engineer.

O. The Owner controls the float time and, therefore, without obligation to extend either the overall completion date or any intermediate completion dates, the Owner may initiate changes that absorb float time only. Owner initiated changes that affect the critical path on the network diagram shall be the sole grounds for extending the completion dates. Contractor initiated changes that encroach on the float time may be accomplished only with the Owner's concurrence. Such changes, however, shall give way to Owner initiated changes competing for the same float time.

P. To the extent that the construction project schedule, or associated report or any revision thereof shows anything not jointly agreed upon or fails to show anything jointly agreed upon, it shall not be deemed to have been accepted by the Engineer. Failure to include on a schedule any element of Work required for the performance of this Contract shall not excuse the Contractor from completing all Work required within any applicable completion date, notwithstanding the review of the schedule by the Engineer.

Q. Review and acceptance of the construction progress schedule, and related reports, by the Engineer is advisory only and shall not relieve the Contractor of the responsibility for accomplishing the Work within the contract completion date. Omissions and errors in the construction progress schedule, and related reports shall not excuse performance less than that required by the Contract and in no way make the Engineer an insurer of the Contractor's success or liable for time or cost overruns flowing from any shortcomings in the construction progress schedule, and related reports.

R. The Contractor shall present and discuss the proposed schedule at the preconstruction conference.

S. The construction progress schedule shall be based upon the precedence diagramming method of scheduling and shall be prepared in the form of a horizontal bar chart showing in detail the proposed sequence of the Work and identifying all construction activities included but not limited to yard piping, all structures and treatment units and all related Work specified herein to be performed under the Contract. The schedule shall be time scaled, identifying the first day of each week, with the estimated date of starting and completion of each stage of the Work in order to complete the project within the contract time. The project critical path shall be clearly identified.

T. The progress schedule shall be plotted on 22-inch by 34-inch and 11-inch by 17-inch paper and shall be revised and updated monthly, depicting progress through the last day of the current month and scheduled progress through completion. Six up to date copies of the schedule shall be submitted along with the application for monthly progress payments for the same period.
U. The construction progress schedule shall be developed and maintained using MS-Project, Suretrak or equivalent software.
1.04 SCHEDULE OF PAYMENT ITEMS

A. The Contractor shall submit a Schedule of Payment Items for review within two weeks after receiving the Notice to Proceed. The schedule shall contain the installed value of the component parts of Work for the purpose of making progress payments during the construction period and shall directly correlate on an item by item basis (unless otherwise accepted by the Engineer) to each individual activity detailed in the construction progress schedule. The sum of all scheduled items shall equal the total value of the Contract. Reference the Section entitled “Measurement and Payment” for further details.

B. If the Contractor anticipates the need for payment for materials stored on the project site, it shall also submit a separate list covering the cost of materials, delivered and unloaded with taxes paid. This list shall also include the installed value of the item with coded reference to the Work items in the Schedule of Payment Items.

C. The Contractor shall expand or modify the above schedule and materials listing as required by the Engineer’s initial or subsequent reviews.

1.05 PROGRESS PAYMENT APPLICATIONS

1. Applications for payments shall be made to the Engineer for review in accordance with the Section entitled “Measurement and Payment”.

1.06 SHOP DRAWINGS

A. The Contractor shall submit for review shop drawings for concrete reinforcement, structural details, piping layout and appurtenances, wiring, color selection charts, materials and equipment fabricated especially for this Contract, and materials and equipment for which such Drawings are specified or specifically requested by the Engineer.

B. Shop drawings shall show the principal dimensions, weight, structural and operating features, space required, clearances, type and/or brand of finish or shop coat, grease fittings, etc., depending on the subject of the Drawings.

C. When so specified, or if considered by the Engineer to be acceptable, the manufacturer's specifications, catalog data, descriptive matter, illustrations, etc. may be submitted for review in place of shop drawings. In such case, the requirements shall be as specified for shop drawings, insofar as applicable.

D. The Contractor shall be responsible for the prompt submittal of all shop drawings so that there shall be no delay to the Work due to the absence of such Drawings. The Engineer will review the shop drawings within 21 calendar days of receipt of such Drawings. Reviewed shop drawings will be returned to the Contractor by regular mail, posted no later than 21 days after receipt.

E. Time delays caused by rejection of submittals are not cause for extra charges to the Owner or time extensions.

F. Requirements: All shop drawings shall be submitted to the Engineer through the Contractor. The Contractor is responsible for obtaining shop drawings from its subcontractors and returning reviewed Drawings to them. All shop drawings shall be prepared on standard size, 22-inch by 34-inch sheets. All Drawings shall be clearly marked with the name of the project, Owner, Contractor, and building, equipment, or structure to
which the drawing applies. Drawings shall be suitably numbered and stamped by the Contractor. Each shipment of Drawings shall be accompanied by a letter of transmittal giving a list of the drawing numbers and the names mentioned above.

G. **Product Data:** Where manufacturer's publications in the form of catalogs, brochures, illustrations, or other data sheets are submitted in lieu of prepared shop drawings, such submission shall specifically indicate the particular item offered. Identification of such items and relative pertinent information shall be made with indelible ink. Submissions showing only general information will not be accepted.

H. Product data shall include materials of construction, dimensions, performance characteristics, capacities, wiring diagrams, piping and controls, etc.

I. **Warranties:** When warranties are called for, a sample of the warranty shall be submitted with the shop drawings. The sample warranty shall be the same form that will be used for the actual warranty. Actual warranties shall be originals and notarized.

J. **Work Prior to Review:** No material or equipment shall be purchased, fabricated especially for this Contract, or delivered to the project site until the required shop drawings have been submitted, processed and marked either "FURNISH AS SUBMITTED" or "FURNISH AS CORRECTED". All materials and Work involved in the construction shall be as represented by said Drawings.

K. The Contractor shall not proceed with any portion of the Work (such as the construction of foundations) for which the design and details are dependent upon the design and details of equipment for which submittal review has not been completed.

L. **Contractor's Review:** Only submittals which have been checked and corrected should be submitted to the Contractor by its subcontractors and vendors. Prior to submitting shop drawings to the Engineer, the Contractor shall check thoroughly all such Drawings to satisfy itself that the subject matter thereof conforms to the Drawings and Specifications in all respects. Drawings which are correct shall be marked with the date, checker's name and indications of the Contractor's approval, and then shall be submitted to the Engineer. Other Drawings submitted to the Engineer will be returned to the Contractor unreviewed.

M. **Contractor's Responsibility:** The Engineer's review of shop drawings will be general and shall not relieve the Contractor of the responsibility for details of design, dimensions, etc., necessary for proper fitting and construction of the Work required by the Contract and for achieving the specified performance.

N. **Contractor's Modifications:** For submissions containing departures from the Contract Documents, the Contractor shall include proper explanation in its letter of transmittal. Should the Contractor submit for review equipment that requires modifications to the structures, piping, layout, etc. detailed on the Drawings, it shall also submit for review details of the proposed modifications. If such equipment and modifications are accepted, the Contractor, at no additional cost to the Owner, shall do all Work necessary to make such modifications.

O. **Substitutions:** Whenever a particular brand or make of material, equipment, or other item is specified, or is indicated on the Drawings, it is for the purpose of establishing a standard of quality, design, and type desired and to supplement the detailed specifications. Any other brand or make which is equivalent to that specified or indicated may be offered as a substitute subject to the following provisions:
1. The Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature, and performance data together with samples of the materials, where feasible, to enable the Engineer to determine if the proposed substitution is equal, in all respects including, but not limited to, quality, performance, ease of maintenance, availability of spare parts, and experience record.

2. The Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.

3. A list of installations where the proposed substitution is equal. Such listing shall cover a minimum of the previous five years and will furnish project names and contact phone numbers.

4. Where the acceptance of a substitution requires excessive review by the Engineer, revision or redesign of any part of the Work, all such additional review costs, revisions and redesign, and all new Drawings and details required therefore, shall be at Contractor expense.

5. In all cases the Engineer shall be the sole judge as to whether a proposed substitution is to be accepted. The Contractor shall abide by the Engineer's decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item as specified. No substitute items shall be used in the Work without written acceptance of the Engineer.

6. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

7. Owner may require, at Contractor's expense, a special performance guarantee or other surety with respect to any substitute.

P. Complete Submittals: Each submittal shall be complete in all aspects incorporating all information and data required to evaluate the products' compliance with the Contract Documents. Partial or incomplete submissions shall be returned to the Contractor without review.

Q. Shop Drawing Distribution: The Contractor shall submit a minimum of 10 copies of all shop drawings to the Engineer for review. Shop drawings will be reviewed, stamped and distributed with the appropriate box checked either "FURNISH AS SUBMITTED", "FURNISH AS CORRECTED" or "REVISE AND RESUBMIT". The distribution of processed shop drawings will be as follows:

1. Drawings Marked "FURNISH AS SUBMITTED" or "FURNISH AS CORRECTED"
   - 3 copies returned to the Contractor
   - 3 copies transmitted to the Owner
   - 2 copies remain at the Engineer's office
   - 1 copy remains with the shop drawing reviewer
   - 1 copy for the Engineer's field personnel

2. Drawings Marked "REVISE AND RESUBMIT"
   - 2 copies returned to the Contractor
   - 2 copies remain at the Engineer's office
1 copy remains with the shop drawing reviewer
5 copies will be discarded

R. If the Contractor requires additional copies of returned shop drawings, it shall include extra Drawings in its original submittal. The Engineer will process the Drawings and return them to the Contractor.

1.07 WARRANTIES

A. Warranties called for in the Contract Documents shall be originals and submitted to the Owner through the Engineer. When warranties are required they shall be submitted prior to request for payment.

B. When advance copies of warranties are requested, they shall be submitted with, and considered as shop drawings.

1.08 CERTIFICATES

A. Four copies of certificates of compliance and test reports shall be submitted for requested items to the Engineer prior to request for payment.

1.09 PRODUCT SAMPLES

A. Contractor shall furnish for review all product samples as required by the Contract Documents or requested by the Engineer to determine compliance with the specifications.

B. Samples shall be of sufficient size or quantity to clearly illustrate the quality, type, range of color, finish or texture and shall be properly labeled to show complete project identification, the nature of the material, trade name of manufacturer and location of the Work where the material represented by the sample will be used.

C. Samples shall be checked by the Contractor for conformance to the Contract Documents before being submitted to the Engineer and shall bear the Contractor's stamp certifying that they have been so checked. Transportation charges on samples submitted to the Engineer shall be prepaid by the Contractor.

D. Engineer's review will be for compliance with the Contract Documents, and its comments will be transmitted to the Contractor with reasonable promptness.

E. Acceptable samples will establish the standards by which the completed Work will be judged.

1.10 OPERATION AND MAINTENANCE MANUALS

A. General: The Contractor shall furnish and deliver to the Engineer three (3) complete Operation and Maintenance (O&M) Manuals for the substantial, complete systems including instructions, technical bulletins, and any other printed matter such as diagrams, prints or drawings, containing full information required for the proper operations, maintenance, and repair of all Contractor furnished equipment. Also included shall be a spare parts diagram and complete spare parts list. These requirements are a prerequisite to the operation and acceptance of equipment. Each O&M Manual shall be bound together in appropriate three-ring hard cover binders. A detailed table of contents shall be provided for each Manual. Provide an appropriate label on the binder edge. Provide tabs and separate sections for operation, maintenance, spare parts, etc.
B. Written operations and maintenance instructions are required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item. Extensive pictorial cuts of equipment are required for operator reference in servicing.

C. Information not applicable to the specific piece of equipment installed on this project shall be struck from the Manual by the Contractor. Information provided shall include a source of replacement parts and names of service representatives, including addresses and telephone numbers.

D. When written instructions include shop drawings and other information previously reviewed by the Engineer, only those editions which were accepted by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the O&M Manual.

E. Maintenance and Lubrication Schedules: The Contractor shall include in the O&M Manual, for all Contractor furnished mechanical and electrical equipment including switchgear and motor control centers, instrumentation, valves, gates, etc., complete maintenance and lubrication schedules. Separate forms will be submitted for each piece of equipment.

F. The Contractor shall include in the O&M Manual, for all Contractor furnished pumps and motors, complete data sheets. Separate forms shall be submitted for each different type and size of pump and motor. Sample forms are included at the end of this section.

G. All Final O&M Manuals shall also be submitted in whole in electronic format on compact disk. Electronic O&M manuals shall contain information in standard formats (Adobe, PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible through the use of standard, “off-the-shelf” software such as an Internet browser. Hypertext links shall be embedded throughout the text for ease of navigation between references.

1.11 RECORD DRAWINGS

A. The Contractor shall keep and maintain, at the job site, one record set of Drawings. On these, it shall mark all project conditions, locations, configurations, and any other changes or deviations which may vary from the details represented on the original Contract Drawings, including buried or concealed construction and utility features which are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Drawings. Said record drawings shall be supplemented by detailed sketches as necessary or directed to indicate, fully, the Work as actually constructed. These master record drawings of the Contractor's representation of as-built conditions, including all revisions made necessary by addenda and change orders shall be maintained up-to-date during the progress of the Work.

B. At a minimum the record drawings shall be reviewed on the 20th working day of every third month after the month in which the final Notice-to-Proceed is given as well as on completion of Work. Failure to maintain the record drawings up-to-date shall be grounds for withholding monthly progress payments until such time as the record drawings are brought up-to-date.

C. Record drawings shall be accessible to the Engineer at all times during the construction period.

D. Final payment will not be acted upon until the Contractor-prepared record drawings have been delivered to the Engineer. Said up-to-date record drawings shall be in the form of a set of prints with carefully plotted information overlaid in pencil.
E. Upon substantial completion of the Work and prior to final acceptance, the Contractor shall finalize and deliver a complete set of record drawings to the Engineer for transmittal to the Owner, conforming to the construction records of the Contractor. This set of drawings shall consist of corrected drawings showing the reported location of the Work. The information submitted by the Contractor and incorporated in the Record Drawings will be assumed to be correct, and the Engineer will not be responsible for the accuracy of such information, and for any errors or omissions which may appear on the Record Drawings as a result.

1.12 SUPPLEMENTS

A. The supplements listed below following “END OF SECTION” are part of this Specification.

1. Forms: Transmittal of Contractor’s submittal.

PART 2 - PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -
TRANSMITTAL OF CONTRACTOR’S SUBMITTAL
(Attach to Each Submittal)  DATE:__________________________

TO: __________________________  Submittal No.__________________________

________________________________________  □ New Submittal  □ Resubmittal

________________________________________  Previous Submittal No.:__________________________

________________________________________  Project: No.__________________________

________________________________________  Project No.:__________________________

________________________________________  Specification Section No.:__________________________

FROM: __________________________  (Cover only one section with each transmittal)
  Contractor  Schedule Date of Submittal


________________________________________

________________________________________

________________________________________

________________________________________

SUBMITTAL TYPE:  □ Shop Drawing  □ Quality Control  □ Contract Closeout  □ “Or-Equal”/Substitute
□ Sample

The following items are hereby submitted:

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Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: ________________  Contractor (Authorized Signature)
SECTION 01400 - QUALITY CONTROL

PART 1 - GENERAL

1.01 SAMPLING AND TESTING

A. Unless otherwise specified, all sampling and testing shall be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered; however, the Owner reserves the right to use any generally accepted system of sampling and testing which, in the opinion of the Engineer will insure the Owner that the quality of the workmanship is in full accord with the Contract Documents.

B. Any waiver by the Owner of any specific testing or other quality assurance measures, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the specified testing or other quality assurance requirements as originally specified, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial Work, shall not be construed as a waiver of any requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, the Engineer reserves the right to make independent investigations and tests and failure of any portion of the Work to meet any of the requirements of the Contract Documents, shall be reasonable cause for the Engineer to require the removal or correction and reconstruction of any such Work in accordance with the General Conditions.

1.02 SITE INVESTIGATION AND CONTROL

A. The Contractor shall verify all dimensions in the field and shall check field conditions continuously during construction. The Contractor shall be solely responsible for any inaccuracies built into the Work due to its failure to comply with this requirement.

B. The Contractor shall inspect related and appurtenant Work and shall report in writing to the Engineer any conditions which will prevent proper completion of the Work. Failure to report any such conditions shall constitute acceptance of all site conditions, and any required removal, repair, or replacement caused by unsuitable conditions shall be performed by the Contractor within the scope of the Project.

1.03 OBSERVATION AND TESTING

A. The Owner will employ and pay for the services of an independent testing laboratory for testing as specified by the Engineer unless otherwise specified in these documents.

B. The work or actions of the testing laboratory shall in no way relieve the Contractor of its obligations under the Contract. The laboratory testing work will include such observations and testing required by the Contract Documents, existing laws, codes, ordinances, etc. The testing laboratory will have no authority to change the requirements of the Contract Documents, nor perform, accept or approve any of the Contractor's Work.

C. The Contractor shall allow the Engineer ample time and opportunity for field observation and testing materials and equipment to be used in the Work. The Contractor shall advise the Engineer promptly upon placing orders for materials and equipment so that arrangements may be made, if desired, for observation before shipment from the place of manufacture.
The Contractor shall at all times furnish the Engineer and its representatives, facilities including labor, and allow proper time for inspecting and testing materials, equipment, and workmanship. The Contractor must anticipate that possible delays may occur in the execution of its work due to the necessity of materials and equipment being inspected and accepted for use. The Contractor shall furnish, at its own expense, all samples of materials required by the Engineer for testing, and shall make its own arrangements for providing water, electric power, or fuel for the various observations and tests of structures and equipment.

D. The Owner will bear the cost of all tests, observations, or investigations undertaken by the order of the Engineer for the purpose of determining conformance with the Contract Documents if such tests, observations, or investigations are not specifically required by the Contract Documents, and if conformance is ascertained thereby. Whenever nonconformance is determined by the Engineer as a result of such tests, observations, or investigations, the Contractor shall bear the full cost of any additional tests and investigations, which are ordered by the Engineer to ascertain subsequent conformance with the Contract Documents.

1.04 RIGHT OF REJECTION

A. The Engineer, acting for the Owner, shall have the right, at all times and places, to reject any articles or materials to be furnished hereunder which, in any respect, fail to meet the requirements of the Contract Documents, regardless of whether the defects in such articles or materials are detected at the point of manufacture or after completion of the Work at the site. If the Engineer or its representative, through an oversight or otherwise, has accepted materials or Work which is defective or which is contrary to the Contract Documents, such materials, no matter in what stage or condition of manufacture, delivery, or erection, may be subsequently rejected by the Engineer for the Owner.

B. The Contractor shall promptly remove rejected articles or materials from the site of the Work after notification of rejection. All costs of removal and replacement of rejected articles or materials as specified herein shall be borne by the Contractor.

1.05 OTHER CONSTRUCTION CONSIDERATIONS

A. Cutting and Patching: The Contractor shall perform all cutting and patching of the Work that may be required to make its several parts come together properly and fit it to receive or be received by such other work. The Contractor shall not endanger any work of others by cutting, excavating or otherwise altering their work and shall only cut or alter work with the written consent of the Engineer and of the other Contractor’s whose work will be affected.

B. Sleeves and Openings: The Contractor shall provide all openings, chases, etc., to fit its own work and that of any other subcontractors and Contractor’s. All such openings or chases shown on the Contract Drawings, or reasonably implied thereby, or as confirmed or modified by acceptable shop, setting or erecting drawings, shall be provided by the Contractor.

C. Where pipes or conduits are to pass through slabs or walls, or where equipment frames or supports are to be installed as integral part of an opening, the sleeves, openings, forms or frames shall be furnished by the installer of the pipes, conduits or equipment, but shall be placed by the Contractor. Where hanger inserts, anchor bolts and similar items are to be embedded in concrete as an integral part of a slab or wall, they shall be furnished by the installer of the pipe or other equipment requiring the hanger, etc, but shall be placed by the Contractor.
D. Any cost resulting from correction of defective, ill-timed, or mislocated work or for subsequent work which becomes necessary because of omitted openings, chases, sleeves, frames, inserts, etc., shall be borne by the Contractor or subcontractor responsible therefor. The Contractor shall not arbitrarily cut, drill, alter, damage, or otherwise endanger the work of another contractor. In no case shall beams, lintels, or other structural members be cut without the proper authorization of the Engineer. The nature and extent of any corrective or additional work shall be subject to the acceptance of the Engineer following consultation with the affected parties.

E. Weather Conditions: Work that may be affected by inclement weather shall be suspended until proper conditions prevail. In the event of impending storms, the Contractor shall take necessary precautions to protect all work, materials and equipment from exposure.

F. Fire Protection: The Contractor shall take all necessary precautions to prevent fires at or adjacent to the Work, including its own buildings and trailers. Adequate fire extinguisher and hose line stations shall be provided throughout the work area.

PART 2 - PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide for utilities and services for its own operations. These shall include electrical power, water, ventilation, sanitary facilities and telephone service. The Contractor shall furnish, install and maintain all temporary utilities during the contract period including removal upon completion of the work. Such facilities shall comply with regulations and requirements of the National Electrical Code, OSHA, Florida Power and Light, and applicable Federal, State and all jurisdictional codes.

1.02 TEMPORARY POWER

A. The Contractor shall arrange with Florida Power and Light (FPL) for construction period service and pay all costs for the work and power. The Contractor shall arrange and pay for a separate feeder to supply power from off-site directly from FPL service to the Contractor temporary power system. In addition to providing for a safe construction period distribution system the Contractor shall provide a safe and adequate artificial lighting system for work areas which do not have sufficient natural light. Temporary lighting shall be maintained during non-working periods if the area is subject to access by plant personnel.

1.03 TEMPORARY WATER

A. The Contractor shall supply all water used for construction, flushing, testing, and temporary sanitary facilities. The Contractor shall provide and maintain all piping, fittings, adapters, and valving required. It is the Contractor's responsibility to arrange through the Owner, for location and installation of a 2-inch water meter and backflow preventer at the fire hydrant shown on the drawings. A deposit to be paid by the Contractor is required for meter rental and all water shall be purchased at the prevailing rates.

1.04 TEMPORARY VENTILATION

A. The Contractor shall provide and maintain adequate ventilation for a safe working environment. In addition, forced air ventilation shall be provided for the curing of installed materials, humidity control and the prevention of hazardous accumulations of dust, gases or vapors, as necessary to comply with contract requirements.

1.05 TEMPORARY SANITARY FACILITIES

A. The Contractor shall provide and maintain adequate and clean sanitary facilities for the construction work force and visitors. The facilities shall comply with local codes and regulations and be situated at approved locations.

1.06 TEMPORARY TELEPHONE SERVICE

A. The Contractor shall provide for telephone services for its own operations and the field offices including arranging and paying for separate feeder(s) from off-site as required.
1.07 SECURITY

A. The Contractor shall install fences and employ security guards to protect the job site against vandalism, burglary, theft, trespassing, as required. The Contractor shall care for and protect against loss or damage of all material to be incorporated in the construction, the existing structures, equipment and materials for the duration of the Contract, and shall repair or replace damaged or lost materials and damage to structures.

B. The Contractor shall be responsible for providing, maintaining and securing gates used for construction purposes for the duration of the project as required for security purposes. Reference the drawings for additional requirements.

1.08 STAGING AREA

A. The Contractor can establish staging area(s) suitable for the storage of materials and equipment associated with the project, as defined on the Drawings, and shall be fully responsible for abiding all applicable rules, regulations and conditions having jurisdictional control at the site chosen.

B. The Contractor shall be aware that the staging area shall be limited to the area(s) defined on the Drawings. The Contractor shall arrange, coordinate and take all necessary steps regarding its work effort to work within these site constraints, including off-site parking and material equipment storage, as may required to complete the work. Costs associated with these efforts shall be included in the base bid items for this project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

- END OF SECTION -
SECTION 01520 – MAINTENANCE OF UTILITY OPERATIONS DURING CONSTRUCTION

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The existing Water Treatment Plant will be maintained in continuous operation by the Owner during the entire construction period of the Contract, except as otherwise noted in the Section entitled “Summary of Work”.

B. The intent of this Section is to outline the minimum requirements necessary to provide continuous Water Treatment Plant operation throughout the construction period.

C. Work under the Contract shall be scheduled and conducted by the Contractor so as not to impede any Water Treatment Plant process except as explicitly permitted hereinafter. In performing the work shown and specified, the Contractor shall plan and schedule its work to meet the plant’s daily and seasonal operating requirements, and the constraints and construction requirements as outlined in this Section.

D. The Contractor shall be responsible for coordinating the general construction and the schedules of electrical, control system, HVAC, plumbing and related trades and for ensuring that permanent or temporary power and controls are available for all existing, proposed, and temporary facilities that are required to be on line at any given time.

E. The Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without cost to the Owner (including additional Owner labor) and provided that all requirements of these Specifications are fulfilled. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section shall be consecutive calendar days.

F. The Contractor is advised that the work is to be performed in a fully operational raw water supply Water Treatment Plant, which is a source of potable water supply to the City of North Miami. The Contractor shall be fully responsible for all precautionary measures together with all remediation, cleanup, disinfection, regulatory agency fines and all other labor, materials, and costs associated with any contamination of the potable water supply caused directly or indirectly by the activities of the Contractor in the performance of the work.

G. Notwithstanding other indemnification requirements of the Contract Documents, the Contractor shall also indemnify, defend, and hold harmless the Owner, the Engineer and the Owner’s agents from any and all legal action which may arise from contamination of the potable water supply caused directly or indirectly by the Contractor in the performance of the work.

1.02 GENERAL CONSTRAINTS

A. The Contractor shall schedule the Work so that the Water Treatment Plant is maintained in continuous operation. All treatment processes shall be maintained in continuous operation during the construction period except during approved process interruptions. All short-term system or partial systems shutdowns shall be acceptable to the Owner and the Engineer. Long-term process shutdowns and diversions shall conform to the requirements hereinafter.
specified and shall be minimized by the Contractor as much as possible. If in the judgement of the Owner or Engineer, a requested shutdown is not required for the Contractor to perform the Work, the Contractor shall utilize approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the Owner. Shutdowns shall not begin until all required materials are on hand and ready for installation. Each shutdown period shall commence at a time acceptable to the Owner, in writing.

B. If the Contractor completes all required Work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service.

C. The Contractor shall schedule short-term and extended shutdowns in advance and shall present all desired shutdowns in the 7-day “look-ahead” schedules at the construction progress meetings. Shutdowns shall be fully coordinated with the Owner and Engineer.

D. Owner personnel shall operate Owner's facilities involved in the short-term and extended shutdowns.

E. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the Contractor's work limits to maintain continuous and dependable Water Treatment Plant operation shall be furnished by the Contractor at no extra cost to the Owner.

F. The Owner shall have the authority to order Work postponed, stopped or prohibited that would, in its opinion, unreasonably result in interrupting the necessary functions of the Water Treatment Plant operations.

G. If the Contractor impairs performance or operation of the Water Treatment Plant as a result of not complying with specified provisions for maintaining Water Treatment Plant operations, then the Contractor shall immediately make all repairs or replacements and do all work necessary to restore the Water Treatment Plant to operation to the satisfaction of the Owner and the Engineer. Such work shall progress continuously to completion on a 24-hours per day, seven work days per week basis.

H. The Contractor shall provide the services of emergency repair crews on call 24-hours per day.

1.03 GENERAL OPERATING REQUIREMENTS, CONSTRAINTS, AND CONSTRUCTION REQUIREMENTS

A. Personnel Access: Water Treatment Plant operations personnel shall have access to all areas that remain in operation throughout the construction period. The Contractor shall locate stored material, dispose of construction debris and trash, provide temporary walkways, provide temporary lighting, and other such work as identified by the Engineer to maintain personnel access to areas in operation. Access for Water Treatment Plant personnel must be maintained throughout construction.

1.04 CONSTRUCTION SEQUENCE AND OPERATIONAL CONSTRAINTS

A. General: Work under the Contract shall be scheduled and performed in such a manner as to result in the least possible disruption to the operation of the existing treatment facilities.

B. Critical events in the sequence of construction are specified herein and in the Section entitled “Summary of Work”. The outlined sequence of construction does not include all
items necessary to complete the work, but is intended to identify the sequence of critical events necessary to minimize disruption to the on-going plant operations and to ensure compliance with regulatory requirements. It shall be understood by the Contractor that the critical events identified are not all inclusive and that additional items of work not shown may be required. The sequence of construction is a precedence requirement and does not attempt to schedule the Contractor's work. It is intended only to indicate which activities must precede other activities in order to minimize interferences and disruptions.

C. At no time shall the Contractor undertake to close off any pipelines, or open valves, or take any other action that would affect the operation of the existing system, until authorization is granted by the Owner or Engineer and after proper notification.

D. The work to be performed by the Contractor may involve additions, temporary facilities, and modifications to major operational systems within the treatment plant and other minor sub-processes. The Contractor will be required to "interface" with these active facilities and should ensure that these systems remain operational during all construction activities. Specific constraints to be placed on the work to be performed are summarized below. Note that this listing is subject to revision based on actual conditions.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

- END OF SECTION -
SECTION 01530 - PROTECTION OF EXISTING FACILITIES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall be responsible for the preservation and protection of property adjacent to the work site against damage or injury as a result of its operations under this Contract. Any damage or injury occurring on account of any act, omission or neglect on the part of the Contractor shall be restored in a proper and satisfactory manner or replaced by and at the expense of the Contractor to an equal or superior condition than previously existed.

B. The Contractor shall comply promptly with such safety regulations as may be prescribed by the Owner or the local authorities having jurisdiction and shall, when so directed, properly correct any unsafe conditions created by, or unsafe practices on the part of, its employees. In the event of the Contractor's failure to comply, the Owner may take the necessary measures to correct the conditions or practices complained of, and all costs thereof will be deducted from any monies due the Contractor. Failure of the Engineer to direct the correction of unsafe conditions or practices shall not relieve the Contractor of its responsibility hereunder.

C. In the event of any claims for damage or alleged damage to property as a result of work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defense against such claims. Prior to commencement of work in the vicinity of property adjacent to the work site, the Contractor, at its own expense, shall take such surveys as may be necessary to establish the existing condition of the property. Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained.

1.02 PROTECTION OF WORK AND MATERIAL

A. During the progress of the work and up to the date of final payment, the Contractor shall be solely responsible for the care and protection of all work and materials covered by the Contract.

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

1.03 EXISTING UTILITIES AND STRUCTURES

A. The term existing utilities shall be deemed to refer to both publicly owned and privately owned utilities such as electric power and lighting, telephone, water, gas, storm drains, process lines, sanitary sewers and all appurtenant structures.

B. Where existing utilities and structures are indicated on the Drawings, it shall be understood that all of the existing utilities and structures affecting the work may not be shown and that the locations of those shown are approximate only. It shall be the responsibility of the Contractor to ascertain the actual extent and exact location of existing utilities and structures. In every instance, the Contractor shall notify the proper authority having jurisdiction and obtain all necessary directions and approvals before performing any work in the vicinity of existing utilities.
C. Prior to beginning any excavation work, the Contractor shall, through field investigations, determine any conflicts or interferences between existing utilities and new utilities to be constructed under this project. This determination shall be based on the actual locations, elevations, slopes, etc., of existing utilities as determined in the field investigations, and locations, elevation, slope, etc. of new utilities as shown on the Drawings. If interference exists, the Contractor shall bring it to the attention of the Engineer as soon as possible. If the Engineer agrees that interference exists, it shall modify the design as required. Additional costs to the Contractor for this change shall be processed through a Change Order as detailed elsewhere in these Contract Documents. In the event the Contractor fails to bring a potential conflict or interference to the attention of the Engineer prior to beginning excavation work, any actual conflict or interference which does arise during the Project shall be corrected by the Contractor, as directed by the Engineer, at no additional expense to the Owner.

D. The work shall be carried out in a manner to prevent disruption of existing services and to avoid damage to the existing utilities. Temporary connections shall be provided, as required, to insure uninterruption of existing services. Any damage resulting from the work of this Contract shall be promptly repaired by the Contractor at its own expense in a manner approved by the Engineer and further subject to the requirements of any authority having jurisdiction. Where it is required by the authority having jurisdiction that they perform their own repairs or have them done by others, the Contractor shall be responsible for all costs thereof.

E. Where excavations by the Contractor require any utility lines or appurtenant structures to be temporarily supported and otherwise protected during the construction work, such support and protection shall be provided by the Contractor. All such work shall be performed in a manner satisfactory to the Engineer and the respective authority having jurisdiction over such work. In the event the Contractor fails to provide proper support or protection to any existing utility, the Engineer may, at its discretion, have the respective authority to provide such support or protection as may be necessary to insure the safety of such utility, and the costs of such measures shall be paid by the Contractor.

1.04 TREES WITHIN PROJECT LIMITS

A. General: The Contractor shall exercise all necessary precautions so as not to damage or destroy any trees on the project site, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or Owner. All existing trees which are damaged during construction shall be replaced by the Contractor or a certified tree company to the satisfaction of the Owner.

B. Replacement: The Contractor shall immediately notify the Owner if any tree is damaged by the Contractor's operations. If, in the opinion of the Owner, the damage is such that replacement is necessary, the Contractor shall replace the tree at its own expense. The tree shall be of a like size and variety as the tree damaged, or, if of a smaller size, the Contractor shall pay to the Owner compensatory payment acceptable to the Owner.

1.05 NOTIFICATION BY THE CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way the Contractor shall notify the respective authorities representing the Owners or agencies responsible for such facilities not less than three days nor more than seven days prior to excavation so that a representative
PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor is advised that the work is to be performed in a fully operational wellfield, which is the principal source of raw water supply to the City of North Miami Winson Water Treatment Plant. The Contractor shall be fully responsible for all precautionary measures together with all remediation, cleanup, disinfection, regulatory agency fines and all other labor, materials, and costs associated with any contamination of the potable water supply caused directly or indirectly by the activities of the Contractor in the performance of the work.

B. Notwithstanding other indemnification requirements of the Contract Documents, the Contractor shall also indemnify, defend, and hold harmless the Owner, the Engineer and the Owner’s agents from any and all legal action which may arise from contamination of the water supply caused directly or indirectly by the Contractor in the performance of the work.

C. Contractor is notified that their work will be within the Westside Wellfield protection area as defined by Miami-Dade County. The Contractor is further notified of the following:

1. The Contractor shall comply with all requirements of Chapter 24-43, Wellfield Protection Ordinance of the Miami-Dade County Code and Chapter 62-521, Wellhead Protection Rule of the Florida Administrative Code.

2. The Contractor shall review the Chapter 24-43(5) of the Miami-Dade County Code of Ordinances regarding prohibition of hazardous materials within wellfield protection areas.

3. The Contractor shall complete an affidavit on their letterhead, signed by an authorized officer of the firm which itemizes the regulated chemicals that the Contractor proposes to use at the City of North Miami wellfield during construction.

4. Submit the affidavit in accordance with the Section entitled “Submittals”.

5. Notify the Miami-Dade County Department of Environmental Resources Management (DERM) to acquire permission to initiate construction within the wellfield.

6. Contact Miami-Dade County Department of Environmental Resources Management for additional assistance regarding compliance with the Wellfield Protection ordinance.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials and equipment to demolish associated piping, equipment and accessories designated to be removed on the Drawings.

B. It is important to note that limited record drawings are available for the existing facilities where demolition work is to be implemented under the scope of this project. To this end, the demolition drawings are generally intended to illustrate the existing conditions through a series of pictures taken as noted. As such, not all existing improvements may be discernible from the contract drawings.

C. The Contractor shall retain full responsibility for coordinating with Owner staff as necessary to visit the Project site, verify existing conditions, and properly include all costs associated with demolition, protection of existing improvements and facilities, and the installation of all Work through Project completion and closeout in accordance with all requirements noted in these specifications, in its base bid.

D. No additional payment to the Contractor will be made as a result of impacts to the Work that may result from existing conditions and improvements, whether readily identifiable on the contract drawings or not.

E. By submitting a Bid, the Contractor acknowledges that it has investigated the site prior to bidding and satisfied itself as to the conditions affecting the demolition work. The Contractor further acknowledges that it has satisfied itself as to the character, quality and quantity of materials and/or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, or any contiguous site, as well as from information presented by the Drawings and Specifications made a part of this Contract, or any other information made available to it prior to receipt of Bids. Any failure by the Contractor to acquaint itself with the available information will not relieve it from responsibility for estimating properly the difficulty or cost of successfully performing the work.

F. The Owner assumes no responsibility for any conclusions or interpretations made by the Contractor on the basis of the information made available by the Owner.

G. The Contractor shall include all costs associated with demolition work in its Base Bid.

1.02 DIMENSIONS OF EXISTING FACILITIES AND COMPONENTS

A. Where the dimensions, locations, number and type of existing improvements are of critical importance, the Contractor shall verify such in the field prior to submission of its Base Bid.

1.03 SUBMITTALS – DEMOLITION WORK PLAN

A. The Contractor shall submit for review, in accordance with the Section entitled "Submittals" a "Demolition Work Plan" indicating the proposed methods, equipment and operation sequence, including coordination for shut-off and isolation of existing facilities and utilities, temporary connections for continuation of service, and other applicable items to ensure no interruption of plant operations except as agreed to with Owner.
1.04 TITLE TO EQUIPMENT AND MATERIALS

A. The Contractor shall have no right or title to any of the equipment, materials or other items to be removed from the existing structures unless and until said equipment, materials and other items have been removed from the premises. The Contractor shall not sell or assign, or attempt to sell or assign any interest in the said equipment, materials or other items until the said equipment, materials or other items have been removed.

B. Reference the Demolition drawings and review Article 1.05 below for general discussion of items to be salvaged by the Owner prior to commencement of demolition.

C. All Items remaining after the Owner has completed its salvage work shall become the responsibility of the Contractor to demolish and dispose of per jurisdictional requirements.

D. The Contractor shall have no claim against the Owner because of the absence of materials that it may have assumed to remain that the Owner salvages.

1.05 CONDITION OF STRUCTURES AND EQUIPMENT

A. The Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.

B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner to the extent practicable.

C. The information regarding the existing structures and equipment shown on the Drawings is based on visual inspection and a walk-through survey only. Neither the Engineer nor the Owner will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

D. The Contractor shall perform all requisite field investigations to properly establish costs for such work and include these in its Base Bid.

E. It is of critical importance that the Contractor schedule and perform the requisite number of pre-bid field visits it deems necessary to ascertain the conditions, construction dimensions, components and general complexity and makeup of both interior, exterior and buried facilities to be demolished under the scope of this Project, as not all improvements may be visible from an external surface observation.

PART 2 – PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 DEMOLITION AND REMOVALS

A. The removal of all equipment and piping, and all materials from the demolition effort shall, when released by the Owner and Engineer, become the Contractor's property, unless otherwise noted, for disposition in any manner not contrary to the Contract requirements and shall be removed from the site to the Contractor's own place of disposal.

B. The Contractor shall de-energize all panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar power equipment prior to removal, as applicable. Any electric panels or equipment that are to be retained shall be relocated or isolated prior to the removal of the equipment specified herein. All existing electrical
equipment to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to keep the integrity of the grounding systems.

C. Conduits and wires shall be abandoned or removed where noted or as shown on the Drawings. All wires in abandoned conduits shall be removed. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth, approved manner. Exposed conduits and their supports shall be disassembled and removed from the project site. Repair all areas of removal to prevent rust spots on exposed surfaces.

D. The Contractor shall proceed with the removal of equipment, piping and appurtenances in a sequence designed to maintain the plant in continuous operation as described in the Section entitled "Maintenance of Utility Operations During Construction", and shall proceed only after approval of the Engineer and Owner.

E. Any equipment piping and appurtenances removed without proper authorization, which are necessary for the operation of the existing facilities, shall be replaced to the satisfaction of the Engineer at no cost to the Owner.

F. No removals shall be started until it is acceptable to the Engineer.

3.02 PROTECTION OF EXITING FACILITIES AND PLANT OPERATIONS

A. Demolition and removal work shall be performed by competent experienced workmen for the various type of demolition and removal work and shall be carried out through to completion with due regard to the safety of Owner employees, workmen on-site and the public. The work shall be performed with as little nuisance as possible.

B. The work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, all governing codes, and as hereinafter specified.

C. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. The Contractor shall give particular attention to shoring and bracing requirements so as to prevent any damage to new or existing construction.

D. The Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

E. The Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.

F. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new work is being done, connections made, materials handled or equipment moved.

G. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing buildings affected by the operations under this Section shall be protected by dust-proof
partitions and other adequate means. Existing electrical and mechanical equipment to remain shall be protected from damage, dust, and debris.

H. The Contractor shall provide adequate fire protection in accordance with local Fire Department requirements.

I. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.

J. The Contractor shall be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.

3.03 WORKMANSHIP

A. The demolition and removal work shall be performed as described in the Contract Documents. The work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration and new work in accordance with applicable Technical Sections of the Specifications and in accordance with the details shown on the Drawings. Prior to starting of work, the Contractor shall provide a detailed description of methods and equipment to be used for each operation and the sequence thereof for review by the Engineer.

B. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. Concrete bases, anchor bolts and other supports shall be removed to approximately 1-inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas. Superstructure wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified under applicable Sections of these Specifications, as shown on the Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate Sections of these Specifications, as shown on the Drawings, and as directed and approved by the Engineer.

C. Materials or items designated to remain the property of the Owner shall be as hereinafter tabulated. Such items shall be removed with care and stored at a location at the site to be designated by the Owner.

D. Where equipment is shown or specified to be removed and relocated, the Contractor shall not proceed with removal of this equipment without specific prior approval of the Engineer. Upon approval, and prior to commencing removal operations, the equipment shall be operated in the presence of representatives of the Contractor, Owner and Engineer. Such items shall be removed with care, under the supervision of the trade responsible for reinstallation and protected and stored until required. Material or items damaged during removal shall be replaced with similar new material or item. Any equipment that is removed without proper authorization and is required for plant operation shall be replaced at no cost to the Owner.

E. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.
F. Materials or items demolished and not designated to become the property of the Owner or to be reinstalled shall become the property of the Contractor and shall be removed from the property and legally disposed of.

G. The Contractor shall execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the structures.

H. In general, masonry shall be demolished in small sections, and where necessary to prevent collapse of any construction, the Contractor shall install temporary shores, struts, and bracing.

I. Where alterations occur, or new and old work join, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, so as to leave the altered work in as good a condition as existed prior to the start of the work. The materials and workmanship employed in the alterations, unless otherwise shown on the Drawing or specified, shall comply with that of the various respective trades which normally perform the particular items or work.

J. The Contractor shall clean existing surfaces of dirt, grease, loose paint, etc., before refinishing.

K. The Contractor shall cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.

l. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the work.

3.04 MAINTENANCE

A. The Contractor shall maintain the buildings, structures and public properties free from accumulations of waste, debris and rubbish, caused by the demolition and removal operations.

B. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish, and it shall wet down dry materials to lay down and prevent blowing dust.

C. At reasonable intervals during the progress of the demolition and removal work or as directed by the Engineer, the Contractor shall clean the site and properties, and dispose of waste materials, debris and rubbish.

3.05 CLEANUP

A. The Contractor shall, promptly and on a regular basis, remove from the project site all debris resulting from the demolition and removal operations as it accumulates. Upon completion of the demolition work, all materials, equipment, waste and debris of every sort shall be removed and the premises shall be left clean, neat and orderly.

B. Upon completion of the demolition work the disturbed areas shall be graded and prepared to receive proposed construction as specified in Division 2 of these documents.

- END OF SECTION -
PART 1 - GENERAL

1.01 HIGHWAY LIMITATIONS

A. The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work. It shall be the Contractor's responsibility to construct and maintain any haul roads required for its construction operations.

1.02 TEMPORARY CROSSINGS

A. General: Wherever necessary or required for the convenience of the public or individual residents at street or highway crossings, private driveways, or elsewhere, the Contractor shall provide suitable temporary bridges over unfilled excavations, except in such cases as the Contractor shall secure the written consent of the individuals or authorities concerned to omit such temporary bridges, which written consent shall be delivered to the Owner prior to excavation. All such bridges shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the Contractor shall adopt designs furnished by said authority for such bridges, or shall submit designs to said authority for approval, as may be required.

B. Street Use: Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work hereunder, and it shall so conduct its operations as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleys, ways, or parking areas. No street shall be closed to the public without first obtaining permission of the Owner and proper governmental authority. Where excavation is being performed in primary streets or highways, one lane in each direction shall be kept open to traffic at all times unless otherwise provided or shown. Toe boards shall be provided to retain excavated material if required by the Owner or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the Work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made by the Contractor to assure the use of sidewalks and the proper functioning of all gutters, sewer inlets, and other drainage facilities.

C. Traffic Control: For the protection of traffic in public or private streets and ways, the Contractor shall provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the "Manual of Uniform Traffic Control Devices, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations," published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1). The Contractor shall take all necessary precautions for the protection of the Work and the safety of the public. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. The Contractor shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. All signs, signals, and barricades shall conform to the requirements of Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.
D. **Street Closure**: If closure of any street is required during construction, a formal application for a street closure shall be made to the authority having jurisdiction at least 30 days prior to the required street closure in order to determine necessary sign and detour requirements.

1.03 CONTRACTOR SITE ACCESS

A. The Winson water Treatment Plant maintains a perimeter fence and security gates.

B. Contractor access to Water Treatment Plant will be via a new gate to be installed by the Contractor as shown on the drawings.

C. The Contractor shall implement a security access card system for its personnel.

D. Contractor personnel shall be required to wear the security card at all times while on site.

E. Contractor vehicles required to enter the Water Treatment Plant shall use the Contractor installed gate.

F. The Contractor shall maintain site security through its gate at all times.

1.04 CONTRACTOR WORK AND STORAGE AREA

A. Storage areas shall be provided within the designated staging area shown on the Drawings.

B. The Contractor shall clear, grade and install the staging area improvements as shown on the drawings.

C. Responsibility for protection and safekeeping of equipment and materials at or near the staging site will be solely that of the Contractor and no claim shall be made against the Owner by reasons of any act of an employee or trespasser. Should an occasion arise necessitating access to an area occupied by stored equipment and/or materials, the Contractor shall immediately move them.

D. No equipment or materials shall be placed upon the Owner's property until it is acceptable to the Owner.

E. If the Contractor requires additional staging area than shown on the Drawings, the Contractor shall obtain such areas from off-site sources at no additional cost to the Owner.

F. Contractor parking shall be restricted to the area shown for staging. If the Contractor requires additional parking or work areas other than shown on the Drawings, the Contractor shall obtain such areas from off-site sources at no additional cost to the Owner.

G. Upon completion of the Contract, the Contractor shall remove all of its equipment, surplus materials and restore the staging area to original grades and install sod per the requirement of the Section entitled “Sodding”.

1.05 TRAFFIC CONTROL

A. The Contractor shall maintain traffic and protect the public from all damage to persons and property within the Contract Limits, in accordance with all applicable state, local, and city regulations. The Contractor shall conduct its operations so as to maintain and protect access, for vehicular and pedestrian traffic, to and from all properties and business establishments and joining or adjacent to those streets affected by its operations, and to subject the public to a minimum of delay and inconvenience. Suitable signs, barricades, railing, etc., shall be erected and the Work outlined by adequate lighting at night. Danger
lights shall be provided as required. Watchmen and flagmen shall be provided as may be necessary for the protection of traffic.

B. The use of on-site plant roads, entrance gates, parking areas and property for the Contractor's personnel parking shall not be permitted except as designated on the Drawings.

C. The Contractor shall be responsible for enforcing on-site parking regulations. Violators of these on-site parking restrictions will be towed or booted.

D. All dirt or debris spilled from the Contractor's trucks on existing pavements or other active areas of the facility shall be removed by the Contractor immediately.

1.06 SECURITY

A. The Contractor shall care for and protect against loss or damage of all material to be incorporated in the construction for the duration of the project and shall repair or replace damaged or lost materials and damage to structures.

B. The Contractor shall maintain the new gate at the staging area in a secure manner at all times.

1.07 SAFETY AND PROTECTION DEVICES

A. It shall be the sole responsibility of the Contractor to protect persons from injury and to avoid property damage. Adequate barricades, construction signs, torches, red lanterns, and guards as required shall be placed and maintained during the progress of the construction work for the protection of the public in compliance with all federal, OSHA and local ordinances.

B. The Contractor shall have unit responsibility for and be required to make good, at its own expense, all damage to property or adjacent properties caused in the execution of this Contract.

C. The Contractor shall take all necessary precautions for the safety of its employees on the job and shall comply with all applicable provisions of federal, State, County, and municipal safety laws and regulations to prevent accidents or injury to persons on, about, or adjacent to the premises where the Work is being performed.

D. In the event, the Contractor's tools or materials delivered to the premises are stolen or damaged, it shall be responsible for such theft.

1.08 DELIVERY LOGS

A. The Contractor shall provide a daily log of deliveries to the WTP site for the project. The daily log shall include deliveries received each day with the driver's name and truck license number, in addition to expected deliveries for the following day. The log shall be submitted to the Owner and the Engineer at the end of each day. This log will be used by the Owner at its discretion for security purposes at the plant site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

- END OF SECTION -
PART 1 - GENERAL

1.01 EXPLOSIVES AND BLASTING
   A. The use of explosives on the Work will not be permitted.

1.02 DUST ABATEMENT
   A. The Contractor shall furnish all labor, equipment, and means required and shall carry out effective measures wherever and as often as necessary (as determined by the Engineer) to prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity. The Contractor shall be responsible for any damage resulting from any dust originating from its operations. The dust abatement measures shall be continued until the Contractor is relieved of further responsibility by the Engineer. No separate payment will be allowed for dust abatement measures and all costs thereof shall be included in the Contractor’s bid price.

1.03 RUBBISH CONTROL
   A. During the progress of the Work, the Contractor shall keep the site of the Work and other areas used by it in a neat and clean condition, and free from any accumulation of rubbish. The Contractor shall dispose of all rubbish and waste materials of any nature occurring at the Work site, and shall establish regular intervals of collection and disposal of such materials and waste. The Contractor shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of all rubbish and surplus materials shall be off the site of construction in accordance with local codes and ordinances governing locations and methods of disposal, and in conformance with all applicable safety laws, and to the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

1.04 SANITATION
   A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.
   B. Such facilities shall be made available when the first employees arrive on the Work, shall be properly secluded from public observation, and shall be constructed and maintained in suitable numbers and at such points and in such manner as may be required.
   C. The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all time and shall enforce their use. It shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the Owner, or on adjacent property.
   D. The Owner and the Engineer shall have the right to inspect any building or other facility erected, maintained, or used by the Contractor, to determine whether or not the sanitary regulations have been complied with.
   E. Sanitary and Other Organic Wastes: The Contractor shall establish a regular daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the
Contractor's operations shall be disposed of away from the site in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto.

F. The Contractor shall not be permitted to use Owner toilet facilities.

1.05 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, paint, fuel, solvent or reactant of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. The handling, storage, use and disposal of all such chemicals and disposal of residues shall be in strict accordance with all applicable rules and regulations of Federal, State and local jurisdictional agencies and the printed instructions of the manufacturer and all regulatory requirements. Copies of antidote literature shall be kept at the storage site and at the Contractor's job site office. A supply of antidotes shall be kept at the Contractor's office.

1.06 NOISE CONTROL

A. Noise resulting from the Contractor's work shall not exceed the noise levels and other requirements stated in local ordinances. The Contractor shall be responsible for curtailing noise resulting from its operation. It shall, upon written notification from the Engineer or noise control officers, make any repairs, replacements, adjustments, additions and furnish mufflers when necessary to fulfill requirements.

1.07 EROSION ABATEMENT AND WATER POLLUTION

A. It is imperative that any Contractor dewatering operation not contaminate or disturb the environment of the properties adjacent to the Work. The Contractor shall, therefore, schedule and control its operations to confine all runoff water from disturbed surfaces, water from dewatering operations that becomes contaminated with silt, muck and other deleterious matter, fuels, oils, bitumens, calcium chloride, chemicals and other polluting materials.

B. The Contractor shall construct temporary silting basin(s) of adequate size and provide all necessary temporary materials, operations and controls including, but not limited to, filters, coagulants, screens, and other means necessary to attain the required discharge water quality.

C. The Contractor shall be responsible for providing, operating and maintaining materials and equipment used for conveying the clear water to the point of discharge. All pollution prevention procedures, materials, equipment and related items shall be operated and maintained until such time as the dewatering operation is discontinued. Upon the removal of the materials, equipment and related items, the Contractor shall restore the area to the condition prior to its commencing work.

D. The Contractor shall be responsible for acquiring all applicable permits for discharge of waters as necessary, except as may have otherwise been provided in other sections of these specifications.

1.08 PRECAUTIONS DURING ADVERSE WEATHER

A. During adverse weather, and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work may be properly done and satisfactory in all
respects. When required, protection shall be provided by use of tarpaulins, wood and building paper shelters, or other acceptable means. The Contractor shall be responsible for all changes caused by adverse weather.

B. The Owner may suspend construction operations at any time when, in its judgment, the conditions are unsuitable or the proper precautions are not being taken, whatever the weather conditions may be, in any season.

1.09 HURRICANE AND STORM WARNINGS

A. The Contractor shall take all precautions necessary to protect the job site during hurricane and storm watches and warnings.

1.10 PERIODIC CLEANUP AND BASIC SITE RESTORATION

A. During construction, the Contractor shall regularly remove from the site all accumulated debris and surplus materials of any kind which results from its operations. Unused equipment and tools shall be stored at the Contractor's yard or base of operations for the project.

B. The Contractor shall perform the cleanup work on a regular basis and as frequently as ordered by the Owner. Basic site restoration in a particular area shall be accomplished immediately following the installation or completion of the required facilities in that area. Furthermore, such work shall also be accomplished, when ordered by the Engineer, if partially completed facilities must remain incomplete for some time period due to unforeseen circumstances.

C. Upon failure of the Contractor to perform periodic clean-up and basic restoration of the site to the Engineer's satisfaction, the Engineer may, upon five days prior written notice to the Contractor, employ such labor and equipment as it deems necessary for the purpose, and all costs resulting therefrom shall be charged to the Contractor and deducted from amounts of money that it may be due.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The provision of a Contractor field office is optional.

B. If the Contractor elects to furnish a field office for its own use at the project site, the Contractor shall comply with the requirements specified herein.

C. The Contractor shall locate the specified field office within the boundaries of the staging location shown on the contract documents. The field office shall remain the property of the Contractor and shall be removed (including mountings, connections and hookups) from the site upon completion of the Work, returning the site and all improvements to their pre-Notice-to-Proceed condition.

D. The Contractor is responsible for utility hookups for electric, telephone, water and sewer.

E. The Contractor shall prepare and submit all necessary drawings with sufficient detail as necessary to the applicable Building Department and jurisdictional agencies for permitting of the field office and utility hookups. The Contractor shall comply with all Building Department requirements accordingly.

1.02 GENERAL FIELD OFFICE REQUIREMENTS

A. The Contractor shall provide steps and platforms with handrails to permit entry to the offices. This work shall conform to the Florida Building Code and OSHA requirements.

B. Trailers shall be blocked up and hurricane straps installed conforming to the applicable building codes.

1.03 UTILITIES FOR THE CONTRACTOR FIELD OFFICE

A. The Contractor shall furnish and install necessary sanitary, water, electric, and telephone connections between the source and its trailer. In addition, the Contractor shall coordinate with the local utility to arrange for startup and invoicing of electric and telephone services accordingly.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The word "Products," as used herein is defined to include purchased items for incorporation into the Work, regardless of whether specifically purchased for project or taken from Contractor's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form units of Work. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," "special construction," and similar terms, which are self explanatory and have recognized meanings in the construction industry.

1.02 QUALITY ASSURANCE

A. Source Limitations: To the greatest extent possible for each unit of Work, the Contractor shall provide products, materials, or equipment of a singular generic kind from a single source.

B. Compatibility of Options: Where more than one choice is available as options for Contractor's selection of a product, material, or equipment, the Contractor shall select an option which is compatible with other products, materials, or equipment already selected. Compatibility is a basic general requirement of product/material selections.

1.03 DESIGN

A. Equipment and appurtenances shall be designed in conformity with the ASME, AIEE, NEMA and other generally accepted applicable standards and shall be rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation and all conditions of operation. All bearings and moving parts shall be adequately protected by bushings or other acceptable means against wear, and provision shall be made for adequate lubrication by readily accessible devices. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance.

B. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The Contractor shall deliver, handle, and store products in accordance with supplier's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at site and overcrowding of construction spaces. In particular, the Contractor shall provide delivery/installation coordination to ensure minimum holding or storage times for products recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other sources of loss.
B. The Contractor shall provide a daily log of deliveries to the WTP site for the project. The daily log shall include deliveries received each day with the driver's name and truck license number, in addition to expected deliveries for the following day. The log shall be submitted to the Owner and to the Engineer at the end of each day. This log will be used by the Owner at its discretion for security purposes at the plant site.

1.05 TRANSPORTATION AND HANDLING

A. Products shall be transported by methods to avoid product damage and shall be delivered in undamaged condition in supplier's unopened containers or packaging, dry.

B. The Contractor shall provide equipment and personnel to handle products, materials, and equipment including those provided by Owner, by methods to prevent soiling and damage.

C. The Contractor shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

1.06 STORAGE AND PROTECTION

A. Products shall be stored in accordance with supplier's written instructions, with seals and labels intact and legible. Sensitive products shall be stored in weather-tight enclosures and temperature and humidity ranges shall be maintained within tolerances required by supplier's written instructions.

B. For exterior storage of fabricated products, they shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering; ventilation shall be provided to avoid condensation.

C. Loose granular materials shall be stored on solid surfaces in a well drained area and shall be prevented from mixing with foreign matter.

D. Storage shall be arranged to provide access for inspection. The Contractor shall periodically inspect to assure products are undamaged and are maintained under required conditions.

E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.07 MAINTENANCE OF STORAGE

A. Stored products shall be periodically inspected on a scheduled basis. The Contractor shall maintain a log of inspections and shall make said log available to the Engineer on request.

B. The Contractor shall verify that storage facilities comply with supplier's product storage requirements.

C. The Contractor shall verify that Supplier required environmental conditions are maintained continually.

D. The Contractor shall verify that surfaces of products exposed to the elements are not adversely affected and that any weathering of finishes is acceptable under requirements of Contract Documents.
1.08 MAINTENANCE OF EQUIPMENT STORAGE

A. For mechanical and electrical equipment in long-term storage, the Contractor shall provide a copy of the Supplier service instructions to accompany each item, with notice on enclosed instruction shown on exterior of package.

B. Equipment shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document to the Engineer.

1.09 LUBRICANTS

A. During testing and prior to acceptance, the Contractor shall furnish all lubricants necessary for the proper lubrication of all equipment furnished under this Contract.

1.10 SPECIAL TOOLS

A. For each type of equipment furnished by it, the Contractor shall provide a complete set of all special tools (including calibration and test equipment) which may be necessary for the adjustment, operation, maintenance and disassembly of such equipment.

B. Special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such special tools until completion of the Work, at which time they shall be delivered to the Owner.

1.11 PROTECTION AGAINST ELECTROLYSIS

A. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

1.12 FASTENERS

A. All necessary bolts, anchor bolts, nuts, washers, plates and bolt sleeves shall be furnished by the Contractor in accordance herewith. Bolts shall have suitable washers and, where so required, their nuts shall be hexagonal.

B. All bolts, anchor bolts, nuts, washers, plates, and bolt sleeves shall be Type 316 stainless steel.

C. Unless otherwise specified, stud, tap, and machine bolts shall be of the best quality refined bar iron. Hexagonal nuts of the same quality of metal as the bolts shall be used.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

- END OF SECTION -
SECTION 01660 - EQUIPMENT TESTING AND PLANT STARTUP

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Equipment testing and startup are requisite to satisfactory completion of the contract and, therefore, shall be completed within the contract time. The Contractor shall allow sufficient time in its construction schedule to complete testing, trouble shooting and start-up activities.

B. As construction of the project enters the final stages of completion, the Contractor shall in accordance with the requirements set forth in the Contract Documents, attend to the following items:

1. Schedule equipment manufacturer's visits to site.
2. Calibration of instruments and controls.
3. Perform required testing, adjusting and balancing of project components.
4. Schedule start-up and initial operation.
5. Furnish skilled personnel during initiation operation to provide back up maintenance services to equipment, as necessary.
6. Furnish operation and maintenance training to Owner's personnel per requirements of the Contract documents.

1.02 EQUIPMENT TESTING

A. The Contractor shall provide the services of an experienced and authorized representative of the supplier of each item of equipment (excluding minor items of equipment specifically exempted by the Engineer in writing), who shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the Contractor shall arrange to have the supplier's representative revisit the job site as often as necessary until any and all trouble is corrected and the equipment installation and operation are satisfactory to the Engineer. The Contractor shall provide effective coordination of all parties necessary for complete system testing, including component suppliers, subcontractors, the Engineer, and the Owner.

B. The Contractor shall require that each supplier's representative furnish to the Engineer a written report addressed to the Owner, and copied to the Engineer, certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, has been operated satisfactorily under full-load conditions is ready for operation and the Owner's operating personnel have been instructed in the operation, maintenance and lubrication of the equipment.

C. The Contractor shall be responsible for scheduling all operations testing. The Contractor is advised that the Engineer and the Owner's operating personnel will witness operations testing.

D. The supplier's representative shall instruct the Owner's operating personnel in correct operation and maintenance procedures. The instruction shall demonstrate start-up,
operation, control, adjustment, trouble shooting, servicing, maintenance, and shutdown of each item of equipment. Such instruction shall be scheduled at a time arranged with the Owner at least 2 weeks in advance and shall be provided while the respective representative's equipment is fully operational. On-site instruction shall be given by qualified persons who have been made familiar in advance with the equipment and systems in the plant. The Contractor shall have submitted, and had accepted, the O&M Manuals (specified in the Section entitled "Submittals") prior to commencement of training.

E. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test or Owner training session.

F. Training shall be provided to three separate shifts of the Owner's personnel. Training may occur anytime over a 24-hour period.

1.03 STARTUP

A. The Contractor shall provide the effective coordination of all parties necessary for the successful startup, including suppliers, subcontractors, the Engineer, and the Owner.

B. It is not the intent of the Engineer to instruct the Contractor in the startup of the facilities; however, the Engineer will be available prior to and during startup to provide technical support to the Contractor.

C. The Contractor shall be required to startup the equipment, under direction of the Engineer and Owner, and operate it for a continuous 7-day (24 hours per day) period at design conditions. The Contractor shall be available at all times during this period to provide necessary maintenance support services as may be deemed necessary by the Owner and/or Engineer.

D. Not less than one (1) month prior to startup, the Contractor shall submit to the Engineer for review, a detailed schedule of operations which will be necessary to effect a successful initial operation and sustained period of operation for the duration of the required startup period.

E. The startup shall not be commenced until all required leakage tests, disinfection, and equipment tests, as applicable, have been completed to the satisfaction of the Engineer.

F. All defects in materials or workmanship which appear during this startup period shall be immediately corrected by the Contractor. Time lost for equipment repairs, wiring corrections, control point settings, or other reasons which actually interrupt the startup may, at the discretion of the Engineer, be justifiable cause for extending the startup test duration.

G. During the startup, the Contractor shall provide the services of authorized representatives of the suppliers, in addition to those services required under operations testing, as necessary, to correct faulty equipment operation.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

- END OF SECTION -
SECTION 01700 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 FINAL CLEANUP

A. The Contractor shall promptly remove from the vicinity of the completed Work, all rubbish, unused materials, concrete forms, construction equipment, temporary structures and facilities, construction signs, tools, scaffolding, materials, supplies and equipment which may have been used in the performance of the Work. Contractor shall broom clean paved surfaces and rake clean other surfaces of grounds. Final acceptance of the Work by the Owner will be withheld until the Contractor has satisfactorily complied with the foregoing requirements for final cleanup of the project site.

B. The Contractor shall thoroughly clean all materials, equipment and structures; all marred surfaces shall be touched up to match adjacent surfaces, all glass surfaces cleaned and floors cleaned.

C. The Contractor shall remove spatter, grease, stains, fingerprints, dirt, dust, labels, tags, packing materials and other foreign items or substances from interior and exterior surfaces, equipment, signs and lettering.

D. The Contractor shall remove paint, clean and restore all equipment and material nameplates, labels and other identification markings.

E. The Contractor shall maintain cleaning until project, or portion thereof, is occupied by the Owner.

F. The Contractor shall:

1. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

2. Use each type of cleaning material on only those surfaces recommended by the cleaning material manufacturer.

3. Use only materials which will not create hazards to health or property.

1.02 CLOSEOUT TIMETABLE

A. The Contractor shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the Owner, the Engineer, and their authorized representatives sufficient time to schedule attendance at such activities.

1.03 FINAL SUBMITTALS

A. Before the final acceptance of the project, the Contractor shall submit to the Engineer (or to the Owner if indicated) certain records, certifications, etc., which are specified elsewhere in the Contract Documents. Missing, incomplete or unacceptable items, as determined by the Engineer or the Owner, shall constitute grounds for withholding final payment to the Contractor. A partial list of such items appears below, but is shall be the Contractor’s responsibility to submit any other items which are required in the Contract Documents:
1. Written Test results of project components, where required.

2. Performance affidavits for equipment, where required.

3. During the entire construction operation, the Contractor shall maintain records of all deviations from the Drawings and Specifications and shall prepare therefrom record drawings showing correctly and accurately all changes and deviations from the Work made during construction to reflect the Work as it was actually constructed. These drawings shall conform to recognized standards of drafting, shall be neat, legible and on mylar or other reproducible material acceptable to the Engineer. The Engineer will verify that the Contractor is maintaining the record drawings in an acceptable manner on a monthly basis.

4. Operation and Maintenance Manuals for equipment.

5. Written guarantees, where required.

6. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

7. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

1.04 PUNCH LISTS

A. Final cleaning and repairing shall be scheduled upon completion of the project.

B. The Engineer will make its final inspection whenever the Contractor has notified the Engineer that the work is ready for the inspection. Any work not found acceptable and requiring cleaning, repair and/or replacement will be noted on the "Punch" list. Work that has been inspected and accepted by the Engineer shall be maintained by the Contractor, until final acceptance of the entire project.

C. Whenever the Contractor has completed the items on the punch list, it shall again notify the Engineer that it is ready for final inspection. This procedure will continue until the entire project is accepted by the Engineer. The "Final Payment" will not be processed until the entire project has been accepted by the Engineer and all of the requirements in previous Article 1.03 "Final Submittals" have been satisfied.

1.05 TOUCH-UP AND REPAIR

A. The Contractor shall touch-up and repair damage to all field painted and factory finished equipment. Touch-up of equipment panels, etc., shall match as nearly as possible the original finish. If in the opinion of the Engineer the touch-up work is not satisfactory, the Contractor shall repaint the item.

1.06 MAINTENANCE AND GUARANTEE

A. The Contractor shall comply with all maintenance and guarantee requirements of the Contract Documents.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing
constructed by the Contractor which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the Contractor shall have obtained a statement in writing from the affected private Owner or public agency releasing the Owner from further responsibility in connection with such repair or resurfacing.

C. The Contractor shall make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the Work and the Contractor and its surety shall be liable to the Owner for the cost thereof.

1.07 GREASE, OIL AND FUEL

A. All grease, oil and fuel required for testing of equipment shall be furnished by the Contractor. The Contractor shall also furnish a one year's supply of lubricants including grease and oil of the type recommended by the manufacturer for each item of equipment supplied.

1.08 TOOLS

A. Any special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, and maintenance of any equipment shall be furnished with the respective equipment. The Contractor shall furnish a complete list of tools and instructions for their use, recommended by the manufacturer or supplier with the Shop Drawing Submittal.

1.09 SPARE PARTS

A. Spare parts for equipment shall be furnished where indicated in the equipment specifications. Spare parts shall be identical and interchangeable with original parts. Parts shall be supplied, prepared for storage, in clearly identified containers, except large or bulky items which may be wrapped in polyethylene.

B. The parts shall be stored separately in a locked area, maintained by the Contractor, and shall be delivered to the Owner at a location designated by the Owner. The Contractor shall furnish an inventory listing all spare parts for each piece of equipment in the form included at the end of this section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)
## SPARE PARTS INVENTORY
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- END OF SECTION -
SECTION 02015 - MOBILIZATION, SITE PREPARATION AND DEMOBILIZATION

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Work specified in this Section consists of all Work necessary to move in personnel and equipment and prepare the site for construction, complete and to remove the same personnel and equipment from the site when construction is complete.

B. The limits of the Contractor's staging area and other applicable restrictions shall be as shown on the Drawings and specified throughout these documents.

PART 2 - PRODUCTS

2.01 TEMPORARY UTILITIES

A. The Contractor shall provide all temporary facilities required for performing the Work as specified in the Section entitled "Utilities and Services".

PART 3 -- EXECUTION

3.01 LAYOUT

A. The Contractor shall set up construction facilities in a neat and orderly manner within designated areas as noted on the Staging Plan drawing of the Contract documents. It shall accomplish all required Work in accordance with applicable portions of these specifications and shall confine its operations to Work areas as shown on the drawings.

3.02 DEMOBILIZATION

A. At the completion of Work the Contractor shall remove its personnel, equipment, and temporary facilities from the site in a timely manner. The Contractor shall also be responsible for transporting all unused materials belonging to the Owner to a place of storage on site designated by the Engineer and for removing from the site and disposing of all other materials and debris resulting from the construction. It shall then return all areas used for its activities to a condition as noted on the Contract documents.

- END OF SECTION -
PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall perform all cleaning, flushing, hydrostatic tests and conveyance of test water from Owner designated source to point of use, including all disposal thereof, complete and acceptable, for the rehabilitated filters, as specified herein and in accordance with the requirements of the Contract Documents.

1.02 SUBMITTALS

A. The Contractor shall submit plans, procedures, and schedules for testing for review and concurrence of the Engineer. The Contractor's proposed plans for water conveyance, control and disposal shall be submitted in writing for approval a minimum of 48 hours before testing.

B. When leakage or weepage is observed, submit for review and approval the proposed repair methods and materials required to achieve water-tightness requirements specified herein.

C. Test reports: Test reports shall include the results of the water tightness testing as follows: Test locations in the structure, dates of testing, water level measurements, amounts of precipitation or evaporation (when applicable), measured temperatures and volume corrections (if any), retest results, corrective actions taken, and final results. Final reports shall be provided within 7 days of test completion.

1.04 WATER TIGHTNESS OF STRUCTURES

A. It is the intent of these Specifications that all concrete work, sealing work around built in items and penetrations be performed as required to ensure that groundwater, surface water, and water or liquids in tanks, basins, channels and containers will not intrude into any equipment rooms, pipe trenches, pipe gallery, habitable areas or other generally dry areas.

B. The required watertightness shall be achieved by quality construction and proper sealing of all joints and penetrations.

C. Each filter basin shall be tested separately and the leakage tests shall be made before equipment is installed. However, surface wash supply piping may be installed prior to leakage testing.

D. The Contractor shall provide at its own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests.

E. All pipe sleeves, built in items and wall penetrations shall be sealed as detailed and as required to ensure a continuous watertight seal.

PART 2 – PRODUCTS (Not Used)
PART 3 - EXECUTION

3.01 GENERAL

A. Water for hydrostatic testing will be furnished by the Owner. However, the Contractor shall make all necessary provisions for conveying the water from the Owner designated source to the points of use.

B. All testing operations shall be done in the presence of the Engineer and the Owner.

C. Paint finishes, waterproofing coatings or other protective coatings which are to be applied to the surfaces of the filter shall be applied prior to testing.

D. Release and disposal of water from structures after hydraulic testing has been completed, shall be acceptable to the Engineer.

3.02 FILTER BASIN HYDROSTATIC TESTING

A. General: Test preparation shall be in accordance with the requirements of section entitled “Hydrostatic Tightness Test for Open or Covered Containment Structures” of ACI 350.1-10.

B. Leakage Test and Repairs: The test shall consist of two parts in conformance with the requirements of ACI 350.1-10.

1. Part 1 shall be a visual test. Failure criteria for Part 1 of the test shall be in accordance with the requirements of section entitled "Hydrostatic Tightness Test of Open or Covered Containment Structures" of ACI 350.1-10. Water level shall be the maximum operating water surface. All visible leakage shall be repaired in accordance with repair methods specified herein and in applicable sections of these Specifications.

2. After the filter basin has been filled, visible leaks repaired, and Part 1 of the test has been successful, part 2 shall start. Part 2 shall be a quantitative test in accordance with the requirements of section entitled “Hydrostatic Tightness Test for Open or Covered Containment Structures” of ACI 350.1-10. Water loss shall not be greater than 0.025% of volume per day.

3. The method for calculating allowances shall be agreed upon by both Engineer and Contractor prior to testing.

4. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the test period and appropriate action taken to correct the problem before commencing a new test period. Should the structure fail to pass the test, the test may be repeated once.

6. If the structure still fails to pass Part 2 of the leakage test, the Contractor shall empty the structure as acceptable to the Engineer and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage.

7. Any cracks shall be "vee'd" and sealed / patched in accordance with the Sections entitled “Filter Basin Interior Waterproofing” and “Concrete and Grout".
8. Any evidence of leakage shall be repaired. The Contractor shall propose repair methods to the Engineer for acceptance.

9. Following repair operations, the Contractor shall again hydrostatically test the filter basin. The filter basin hydrostatic test will not be accepted until the water loss leakage test is passed and all visible leakage repaired.

- END OF SECTION -
SECTION 02668 - DISINFECTION AND BACTERIOLOGICAL TESTING

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall perform all disinfection and bacteriological testing as specified herein and in accordance with the requirements of the Contract Documents. Work shall include conveyance of test water from Owner designated source to point of use and subsequent disposal.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

   ANSI / AWWA B300 Hypochlorites
   ANSI / AWWA B301 Liquid Chlorine
   ANSI / AWWA C652 Disinfection of Water Storage Facilities
   ANSI / AWWA / WEF Standard Methods for the Examination of Water and Wastewater

1.03 SUBMITTALS

A. Shop Drawings: The Contractor shall submit plans, procedures, and schedules for disinfection and testing for review and concurrence of the Engineer. The proposed plans shall address water conveyance, control, disposal and disinfection procedures.

PART 2 – PRODUCTS

2.01 WATER SUPPLY

A. The Owner shall provide reasonable quantities of water necessary for the disinfection of all facilities associated with this Contract.

2.02 CHEMICALS

A. The Contractor shall be responsible for all chemicals and chemical feed equipment required for disinfection.

2.03 TEMPORARY MATERIALS AND EQUIPMENT

A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined and provided by the Contractor.

PART 3 - EXECUTION

3.01 DISINFECTION OF FILTERS

A. The Contractor shall disinfect filters in accordance with ANSI / AWWA C653, unless herein modified after all work is completed and before the filter is placed in service.
B. **Scheduling Sequence for Filter Disinfection:** Each filter under this contract shall be disinfected in accordance with the following sequence:

1. Complete all work at one filter in accordance with the Contract Documents.

2. Once the Contractor deems that it has completed all work within a filter, it shall request a Substantial Completion inspection for that filter.

3. The Engineer will make an inspection and issue a punch list.

4. Once the punch list items have been signed off by the Engineer as being satisfactorily addressed, a Partial Certificate of Substantial Completion for the filter will be issued.

5. Disinfection operations shall be scheduled by the Contractor as soon as possible after the Contractor receives the Partial Certificate of Substantial Completion for the filter that is being rehabilitated.

6. The Contractor shall disinfect the filter in accordance with this specification.

7. Once the filter has been disinfected and successfully completed bacteriological testing, it may be placed into service.

8. Reference the Section entitled “Summary of Work” for additional sequencing requirements.

C. **Disinfection Procedure:**

1. With all filter valves closed, the filter shall be filled with finished water pumped to the filter. The Contractor shall provide a temporary pump. The water level shall be maintained approximately 6 inches below the top of the filter box.

2. **Chlorination:** A strong chlorine solution (approximately 500 ppm) shall be sprayed on all interior surfaces of the filter. Following this, the filter shall be partially filled with water to a depth of approximately 0.5-foot. During the filling operation, a chlorine-water mixture shall be injected by means of a solution-feed chlorinating device. The dosage applied to the water shall be of sufficient strength to produce a chlorine residual of at least 50 ppm upon completion of the partial filling operation. Precautions shall be taken to prevent the strong chlorine solution from flowing back into the lines supplying the water. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the lines with heavily chlorinated water.

3. **Retention Period:** Chlorinated water shall be retained in the filter long enough to destroy all non-spore-forming bacteria, and in any event, for at least 24 hours. After the chlorine-treated water has been retained for the required time, the chlorine residual in the structure and appurtenance piping shall be at least 25 ppm. All valves shall be operated while the lines are filled with the heavily chlorinated water.

4. **Final Filling of Filter:** After the chlorine residual has been checked, and has been found to satisfy the above requirement, the water level in the structure shall be raised to its final elevation by addition of potable water. Before final filling is commenced, the quantity of heavily-chlorinated water remaining in the filter after filling the piping shall, unless otherwise determined by the Engineer, be sufficient when the water
level is raised to its final elevation to produce a chlorine residual of between 1 and 2 ppm. After the structures have been filled, the strength of the chlorinated water shall be determined by the Engineer. If the chlorine residual is less than 1 ppm, an additional dosage shall be applied to the water in the filter. If the chlorine residual is greater than 2 ppm, the structure shall be partially emptied and additional potable water added. In no case shall water be retained prior to the expiration of the required retention period.

3.02 DISINFECTION OF PIPING

A. Disinfect proposed piping as specified in the Section entitled “Pipeline Testing and Disinfection”

3.07 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, HTH shall be added at the points of connection.

3.03 BACTERIOLOGICAL SAMPLING AND TESTING

A. After successful completion of the disinfection procedure, the Owner will flush the filter of chlorinated water. After flushing, the Owner will fill the filter with finished water.

B. Bacteriological testing shall be performed by the Contractor’s testing laboratory. Testing procedures and results of the bacteriological testing shall be satisfactory to the Miami-Dade County Permitting, Environment and Regulatory Affairs Department (PERA).

C. Once satisfactory bacteriological test results are achieved, the Engineer will give the Contractor written permission to initiate work in another filter.

D. If results of the tests are not acceptable, the disinfection of the system shall be repeated until the bacteriological test is satisfactory.

- END OF SECTION –
SECTION 02910 - SODDING

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, supplies, equipment and materials necessary to install sod where disturbed within Project corridors as noted on the drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Protection of Existing Facilities

1.03 QUALITY ASSURANCE

A. All Sodding work shall be performed by a licensed landscaping firm specializing in sodding.

1.04 SUBMITTALS

A. The Contractor shall submit applicable shop drawings in accordance with the Section entitled "Submittals".

1.05 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall time deliveries so that sod will be placed within 24 hours after delivery.

B. The Contractor shall take necessary precautions to protect sod from drying.

C. Transporting:

1. Sod transported to the project in open vehicles shall be covered with tarpaulin or other suitable covers securely fastened to the body of the vehicle to prevent injury to the sod material. Closed vehicles shall be adequately ventilated to prevent overheating of the sod. Evidence of inadequate protection against drying out during transit shall be cause for rejection.

2. Sod shall be kept moist, fresh and protected at all times. Such protection shall encompass the entire period during which the sod is in transit, being handled, or in temporary storage.

3. Upon arrival at the site of work, sod shall be inspected for proper shipping procedures. Should the roots be dried out, the Engineer will reject the sod. When sod has been rejected, the Contractor shall remove it at once from the area of the work and replace it.

4. Unless otherwise authorized by the Engineer, the Contractor shall notify the Engineer at least 48 hours in advance of the anticipated delivery date of sod material. A legible copy of the invoice, showing species and variety of sod included
for each shipment shall be submitted to the Engineer. Certificate of Inspection must accompany each sod shipment.

1.06 JOB CONDITIONS

A. Begin installation of sod after preceding related work is accepted.

B. Environmental Requirements:
   1. Install sod during conditions acceptable to the Engineer.
   2. Do not install sod on saturated soil.

C. Erect signs and barriers to control vehicular traffic.

1.07 SPECIAL PROJECT WARRANTY

A. The Contractor shall warranty sod until final acceptance.

PART 2 – PRODUCTS

2.01 SOD

A. Sod shall be Bahiagrass (Paspalum notatum Flugge)

B. Sod shall be free of weeds and undesirable native grasses.

C. Sod shall be machine cut to a pad thickness of 4 inches plus or minus .5 in., exclusive of top growth and thatch.

D. Sod shall be viable and not dormant at time of delivery.

E. Sod shall be furnished in uniform pad sizes with a specified maximum deviation in either length or width.

F. Broken pads with uneven ends shall be rejected.

G. Sod pads incapable of supporting their own weight, when held vertically with a firm grasp, shall be rejected.

H. Furnish viable sod of uniform density, color, and texture strongly rooted and capable of vigorous growth and development where planted.

I. All sod shall be nursery grown.

J. Sod shall have been mowed regularly and carefully maintained from planting to harvest.

2.02 WATER

A. The Contractor shall be required to water sodded areas until firmly established.
2.03 STAKES

A. Stakes shall be required when areas sodded are excessively sloped and sod would not remain in position, in the opinion of the Owner. Stakes shall be made of wood.

PART 3 - EXECUTION

3.01 PREPARATION OF SURFACE FOR SODDING

A. All areas to be sodded shall be checked by the Engineer to assure that preceding work affecting ground surface is completed prior to commencing the sodding operations.

3.02 PREPARATION

A. Subgrade of lawn areas to be sodded shall be loosened.

B. Rocks, stones or other deleterious materials shall be removed.

C. Areas prepared for sodding shall be limited to those that can be sodded during the same continuous workday.

D. Areas shall be fine graded to a smooth, even surface with loose uniformly fine texture.

E. Fertilizer shall be tilled to a specified depth into the topsoil at a specified application rate (lbs/100 sq. ft).

F. Dry topsoil shall be watered to a specified depth prior to sodding, to obtain a loose friable bed.

3.03 SOD INSTALLATION

A. Lay sod within 24 hours after stripping. If such time frame is not met, the Engineer shall have the right to reject the sod.

B. Sod shall be laid so as to form a solid mass with tightly fitted ends.

C. All ends be abutted, not overlapped.

D. All sod strips shall be staggered to offset joints in adjacent courses.

E. All placed sod shall be tamped or rolled lightly to ensure contact with the subgrade.

F. Sifted soil shall be worked into minor cracks between sod strips.

G. Excess sod shall be removed to avoid injury to adjacent grass.

- END OF SECTION -
SECTION 03305 CONCRETE AND GROUT

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The grout used in installing the underdrain blocks is specified under the Section entitled “Filter Underdrains”. Grout specified under this section shall only be used if called for as part of a change order.

B. This Section is included in the Contract Documents for reference, in the event field conditions warrant a change order requiring the use of the materials described herein.

C. The Contractor shall furnish all materials for concrete in accordance with the provisions of this Section and shall form, mix, place, cure, repair, finish, and do all other work as required to produce finished concrete, all in accordance with the requirements of the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the requirements of the Florida Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

1. ACI 318 - Building Code Requirements of Reinforced Concrete.

2. ACI 350 – Environmental Engineering Concrete Structures.


1.03 SUBMITTALS

A. Mix Designs: Prior to beginning the Work, the Contractor shall submit to the Engineer, for review, proposed concrete mix designs which shall show the proportions and gradations of all materials proposed for each class and type of concrete specified herein in accordance with the Section entitled “Submittals”. The design mix to be used shall be prepared by qualified persons and submitted for review. The design of the mix is the responsibility of the Contractor subject to the limitations of the specifications. Review processing of this submission will be required only as evidence that the mix has been designed by qualified persons and that the minimum requirements of the specifications have been met. Such review will in no way alter the responsibility of the Contractor to furnish concrete meeting the requirements of the specifications relative to strength and slump. If in the progress of the work the sources of materials change in characteristics or the Contractor requests a new source in writing, the Contractor shall, at its expense submit new test data and information for the establishment of a new design mix. Mix design submittals shall include the following:

1. Sources of all materials and certifications of compliance with specifications for all sources of each material.

2. Certified current (less than one year old) chemical analysis of Portland Cement to be used.
3. Certified current (less than one year old) chemical analysis of fly ash to be used.

4. Aggregate test results showing compliance with required standards, i.e. sieve analysis, aggregate soundness tests, etc.

5. Manufacturer’s data on all admixtures stating compliance with required standards and are compatible with one another.

6. Field experience records and/or trial mix data for the proposed concrete mixes.

B. **Grout**: The Contractor shall submit shop drawings for all types of grout for use in this Project. Shop drawings shall include certified test results verifying the compressive strength, shrinkage, and expansion requirements specified herein; and manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of grout used in the work.

C. **Accessories**: The Contractor shall submit shop drawings for all types of concrete accessories to be used for this project including, but not limited to, form ties, water stops, joint materials and curing agents.

D. **Certified Delivery Tickets**: Where ready-mix concrete is used, the Contractor shall provide certified weigh master delivery tickets at the time of delivery of each load of concrete. In addition to the information required by ASTM C 94, each ticket shall show the public weigh master's signature, and the total quantities, by weight of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall, in addition, state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to when the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.

E. **Reinforcing Steel**: The Contractor shall furnish shop bending diagrams, placing lists, and Drawings of all reinforcing steel prior to fabrication in accordance with the requirements of the Section entitled “Submittals”.

1. Details of the concrete reinforcing steel and concrete inserts shall be submitted by the Contractor at the earliest possible date after receipt by the Contractor of the Notice to Proceed. Said details of reinforcing steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. The shop Drawings shall include bar placement diagrams which clearly indicate the dimensions of each bar splice.

2. Where mechanical couplers are shown on the Drawings to be used to splice reinforcing steel, the Contractor shall submit manufacturer’s literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop Drawings which show the location of each coupler with details of how they are to be installed in the formwork.

3. If reinforcing steel is spliced by welding at any location, the Contractor shall submit mill test reports which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS DI.4. The Contractor shall submit a written
welding procedure for each type of weld for each size of bar which is to be spliced by welding, merely a statement that AWS procedures will be followed is not acceptable. Welding of rebar shall be done only where shown on the Drawings or allowed in writing by the Engineer.

1.04 QUALITY ASSURANCE

A. Plant equipment and facilities shall meet all requirements of the Check List for Certification of Ready Mixed Concrete Production facilities of the National Ready Mixed Concrete Association and ASTM C 94.

B. Tests for compressive strength and slump of concrete will be performed as specified herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.

C. The cost of initial trial mixes and initial laboratory tests to design the mixes including compression tests, sieve analysis, and tests on trial mixes shall be included in the Contract Price.

D. The cost of all tests will be borne by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications.

E. Concrete for testing shall be supplied by the Contractor at no cost to the Owner, and the Contractor shall provide assistance to the Engineer in obtaining samples. The Contractor shall dispose of and clean up all excess material.

F. Construction Tolerances

1. The Contractor shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 347 and Section 03100 entitled "Concrete Formwork" of this Specification.

G. The Contractor is fully responsible for all reinforced concrete work, and shall reject all delivered concrete and finishes not meeting these Specifications.

1.05 QUALITY CONTROL

A. Compressive Strength

1. Compression test specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each placement in excess of five cubic yards, or for each fifty (50) cubic yards of concrete placed, or for each 5000 square feet of surface area for slabs or walls, whichever is greater.

2. Samples of freshly mixed concrete shall be obtained in accordance with ASTM C 172, and compression test specimens for concrete shall be made in accordance with ASTM C 31. Specimens shall consist of at least five 6-inch diameter by 12-inch high cylinders, or eight 4-inch diameter by 8-inch high cylinders. Each cylinder shall be
identified by a tag attached to the side of the cylinder.

3. The CONTRACTOR shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens from falling over, being jarred or otherwise disturbed during the period of initial curing. The box shall be erected, furnished and maintained by the CONTRACTOR. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.

4. Compression test shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at 7 days and 2 at 28 days. For 4x8 cylinders, three test cylinders will be tested at 7 days and three at 28 days. The remaining cylinders will be held to verify test results, if needed.

B. Consistency

1. Consistency of the concrete will be checked by the Engineer by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for delays, material or labor costs due to such eventualities.

2. Slump tests shall be made in accordance with ASTM C 143. Slump tests shall be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

C. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the Engineer in accordance with ASTM C 231.

2. Air content tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

D. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318, Chapter 5 "Concrete Quality Mixing and Placing", and as specified herein.

2. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.

3. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at the cost of the Contractor. Additional testing may also be required to verify compressive strength of concrete. Additional testing shall involve extraction and testing of concrete cores in accordance with ASTM C 42. Engineer shall determine locations where concrete cores shall be taken.
Nondestructive test methods shall not be used to verify strength of in-place concrete.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

A. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

B. All materials furnished for the work shall comply with the requirements of ACI 301, as applicable.

C. Storage of materials shall conform to the requirements of ACI 301.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand Portland cement conforming to ASTM C 150, Type II.

2. Water shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities.

3. Aggregates shall be obtained from pits acceptable to the Engineer, shall be non-reactive, and shall conform to the Florida Building Code and ASTM C 33. Maximum size of coarse aggregate shall be as specified in Paragraph 2.05B. Lightweight sand for fine aggregate will not be permitted.

   a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size not greater than 1-inch. When the aggregates are proportioned for each batch of concrete the two size groups shall be combined.

   b. Fine aggregates shall be manufactured sand that is hard and durable.

   c. Combined aggregates shall be well graded from coarse to fine sizes, and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

   d. When tested in accordance with "Potential Reactivity of Aggregates (Chemical Method)" (ASTM C 289), the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

   e. When tested in accordance with "Organic Impurities in Sands for Concrete" (ASTM C 40), the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

   f. When tested in accordance with "Resistance to Abrasion of Small size Coarse Aggregate by Use of the Los Angeles Machine" (ASTM C 131), the coarse
aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.

g. When tested in accordance with "Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate" (ASTM C 88), the loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using sodium sulfate.

4. Ready-mix concrete shall conform to the requirements of ASTM C 94.

5. Air-entraining agent meeting the requirements of ASTM C 260 shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent. The Owner reserves the right, at any time, to sample and test the air-entraining agent received on the job by the Contractor. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.

6. Admixtures: Water reducing and retarding admixture shall be required by the Engineer's discretion or, if not required, may be added at the Contractor's option and measured as recommended by the manufacturer. In either case, the addition of an admixture shall be at the Contractor's expense and the use of an admixture shall be subject to acceptance by the Engineer. Admixtures shall contain no free chloride ions and be non-toxic after 30 days. The addition of the admixture shall be separate from the air entraining admixture. The addition of the admixture shall be completed within one minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Water reducing and set retarding admixtures shall be in conformance with ASTM C 494, Type D.

2.02 CURING MATERIALS

A. Materials for curing concrete shall conform to ASTM C 309, Type 1-D, Class B and shall be Sure Cure 30 by Kaufman Products, Cure and Seal 30 Plus by Symons Corporation, CS 309-30 by WR Meadows; or equal. The curing compound shall contain a fugitive dye so that areas of application will be readily distinguishable.

2.03 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. Preformed joint filler shall be of the preformed non- extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint filler shall conform to the requirements and tests set forth is ASTM D 1752 for Type I, except as otherwise specified herein.

2. Elastomeric joint sealer for vertical and horizontal joints bordered on both sides by concrete, masonry, precast concrete or other porous building material shall be a single component polyurethane sealant meeting ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation, DynaTrol 1-XL by Pecora Corporation, or Sonolastic NP-1 by BASF Construction Chemicals.
3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth hereinafter, if testing is required by the Engineer.

B. Joint Cleaner: Joint cleaner shall be as recommended by the sealant caulking compound manufacturer.

C. Joint Primer: Joint primer shall be as recommended by sealant manufacturer.

2.04 REINFORCING STEEL

A. All reinforcing steel for all reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A615 for Grade 60 Billet Steel Reinforcement with supplementary requirement S-1, and shall be manufactured in the United States.

2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A185. All welded wire fabric reinforcement shall be galvanized.

B. Accessories: Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Bolsters, chairs, spacers and other devices for supporting and fastening reinforcing in place shall be galvanized wire type complying with CRSI recommendations conforming to Class 1 bar supports. Slab bolsters shall have gray plastic-coated legs.

C. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher comprehensive strength as specified for the concrete in which it is located. Where the concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

D. Couplers used to mechanically splice reinforcing steel shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcing bar being spliced. Hot forged sleeve type couplers shall not be used. Acceptable mechanical couplers are: Dayton Superior Dowel Bar Splicer System by Dayton Superior.

2.05 DOWEL ADHESIVE SYSTEM

A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix. The adhesive system shall be IBC compliant for use in both cracked and un-cracked concrete, must comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. The adhesive mix shall be injected with a static mixing nozzle following manufacturer's instructions. All holes shall be drilled
with a carbide bit unless otherwise recommended by the manufacturer. If coring holes is allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and reinforcing bar. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. The embedment depth of the bar shall be per manufacturer's recommendations, so as to provide a minimum allowable bond strength that is equal to 125 percent of the yield strength of the bar, unless noted otherwise on the Drawings. The adhesive system shall be "Epcon System G5" as manufactured by ITW Redhead, "HIT HY 150 MAX-SD Injection Adhesive Anchor System" as manufactured by Hilti, Inc. "SET-XP" as manufactured by Simpson Strong-Tie Co. or "PE-1000+" by Powers Fasteners. Engineer's approval is required for use of this system in locations other than those shown on the Drawings. Fast-set epoxy formulations shall not be acceptable. No or equal products will be considered, unless pre-qualified and approved by Engineer and Owner.

B. All individuals installing dowel adhesive system shall be certified as an Adhesive Anchor Installer in accordance with the ACI-CRSI Anchor Installation Certification Program.

2.06 CONCRETE DESIGN REQUIREMENTS

A. General: Concrete shall be composed of cement, admixtures, aggregates, and water. These materials shall be of the qualities specified. The exact proportions of these materials shall be based on the results of field experience or laboratory trial mixes in conformance with Section 5.3 "Proportioning on the Basis of Field Experience and/or Laboratory Trial Mixtures" of ACI 318. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. Mix designs with more than 41 percent of sand of the total weight of fine and coarse aggregate shall not be used. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the Owner. All changes shall be subject to review by the Engineer.

1. When field experience records are inadequate to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318, or when required by the Engineer, an independent testing laboratory designated by the Contractor and acceptable to the Engineer shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PART 2 -- PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the County.
2. An independent testing laboratory shall observe the preparation of the trial batch, and they shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and unit weight (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No._______, and Product ________." If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the County. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

B. The Contractor is cautioned that the limiting parameters specified below are not design mixes. Additional cement or water reducing agent may be required to achieve workability demanded by the Contractor's construction methods. The Contractor is responsible for any costs associated with furnishing concrete with the required workability.

C. Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than that specified in the following tabulation:

<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Min. 28-Day Compressive Strength (psi)</th>
<th>Max. Size Aggregate (in.)</th>
<th>Min. Cement per cu yd (sacks)</th>
<th>Max. W/C Ratio (by wt.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Concrete:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All reinforced concrete unless</td>
<td>4,500 (Class A)</td>
<td>1</td>
<td>6.0</td>
<td>0.45</td>
</tr>
<tr>
<td>noted otherwise below.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitework Concrete:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sidewalks and Erosion Control.</td>
<td>3,000 (Class B)</td>
<td>1</td>
<td>5.0</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Note: One sack of cement equals 94 lbs.

C. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the Contractor shall be entitled to no additional compensation because of such changes.

2.06 CONSISTENCY

A. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143.

2.07 READY-MIXED CONCRETE

A. Ready-mixed concrete shall conform to meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.
B. Ready-mixed concrete shall be delivered to the site of the work, and discharge shall be completed within one and one-half hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first. In hot weather or under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 60 minutes.

2.08 NON-SHRINK GROUT

A. Non-shrink grout shall be a prepackaged, inorganic, non-gas liberating, nonmetallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.

B. Non-shrink grouts shall have a minimum 28-day compressive strength of 5000 psi and shall meet the requirements of CRD C 621.

C. Cement based grout shall be Five Star Grout as manufactured by Five Star Products, Inc., Fairfield, Connecticut, or equal.

D. Cementitious non-shrink grout shall be used at locations where there are no dynamic loads, the grout will not come in contact with wastewater or wastewater gases, and where non-shrink grout is identified on the Drawings. Applications include, but are not limited to, structural steel column base plates, gate frames and guides, and precast concrete to cast-in-place concrete joints.

2.09 EPOXY GROUT

A. Epoxy grout shall be a pourable, non-shrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any nonreactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

B. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.

C. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.

D. The epoxy grout shall develop a compressive strength of 5000 psi in 24 hours and 10,000 psi in seven days when tested in accordance with ASTM C 579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C 827.

E. Non-shrink epoxy grout shall be Five Star DP Epoxy Grout by Five Star Products, Inc., Fairfield, Connecticut, or equal.

2.10 FORM MATERIALS
A. Except as otherwise expressly accepted by the Engineer, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be steel panels, plywood or tongue and groove lumber.

B. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS I for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.

2.11 PREFABRICATED FORMS

A. Form materials shall be metal, wood, plywood, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall be an acceptable type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

2.12 FORMWORK ACCESSORIES

A. Unless otherwise shown, exterior corners in concrete members shall be provided with ¾-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise shown.

B. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1½-inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.

C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "Bug Holes" in cast-in-place concrete.

PART 3 - EXECUTION

3.01 PROPORTIONING AND MIXING

A. Proportioning: Proportioning of the concrete mix shall conform to the requirements of Chapter 3 "Proportioning" of ACI 301.

B. Mixing: Mixing of concrete shall conform to the requirements of Chapter 7 of said ACI 301 Specifications.

C. Slump: Maximum slumps shall be 4 inches, plus or minus 1 inch.
D. **Retempering:** Retempering of concrete or mortar which has partially hardened will not be permitted.

### 3.02 PREPARATION OF SURFACES FOR CONCRETING

A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. No concrete shall be placed until the reinforcement steel and formwork have been erected in a manner acceptable to the Engineer. The Contractor shall notify the Engineer not less than 2 working days prior to concrete placement, allowing for inspection and any corrective measures which are required.

C. Existing concrete surfaces upon or against which concrete is to be placed shall be given a roughened surface for good bond. Joint surfaces shall be cleaned of all laitance, loose or defective concrete, and foreign material. Such cleaning shall be accomplished by sandblasting followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

D. All anchor bolts called for on the drawings shall be cast-in-place in the concrete. Drilled, impact, adhesive or other types of anchors shall not be substituted for anchor bolts. Anchor bolts shall conform to the requirements set forth in the Section entitled “Miscellaneous Metalwork”.

E. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding to the reinforcement will not be permitted.

F. Anchor bolts shall be accurately set, and shall be maintained in position by templates while being embedded in concrete.

G. **Cleaning:** The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

### 3.03 HANDLING, TRANSPORTING, AND PLACING

A. **General:** Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section.

B. **Nonconforming Work or Materials:** Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the Work. Concrete that is not placed in accordance with these Specifications, or that is of inferior quality, shall be removed and replaced by and at the expense of the Contractor.

C. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the Engineer. The Contractor shall notify the Engineer in writing at least 24 hours in advance of placement of any concrete.
D. **Placement in Slabs:** Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the pour. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

### 3.04 FINISHING CONCRETE SURFACES

**A. General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous, hard surface. Allowable deviations from plumb or level and from profiles and dimensions shown on the Drawings are defined as tolerances and are specified herein. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

**B. Formed Surfaces:** After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 of this Section entitled "Concrete Finish Schedule". Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.

1. **Type I - Rough:** All fins, burrs and other projections left by the forms shall be removed. All holes left by removal of ends of ties, and all other holes, depressions, or voids shall be filled solid with cement grout after first being thoroughly wetted. Honeycombs shall be chipped back to solid concrete as directed, prior to patching with cement grout. Holes shall be filled with a small tool that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. **Type II - Grout Cleaned:** Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been pre-dampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Any surplus shall be removed by scraping and then rubbing with clean burlap. The finish shall be kept damp for at least 36 hours after application.

3. **Type III - Smooth Rubbed:** Where this finish is required, it shall be applied after the completion of the Type I finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted.

**C. Unformed Surfaces:** After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

1. **Type "A" - Screeded:** This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is
subsequently to be applied, the surface of the screeded concrete shall be roughened with a stiff brush or rake prior to final set.

2. Type "B" - Wood Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood float until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. The finished surface shall be true, even, and free from blemishes and other irregularities.

3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.

4. Type "D" - Steel Trowled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, only one troweling operation is required. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.

5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish.

6. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip shake-on aggregate concurrently with the application of a Type "D" finish. Application procedure shall be in accordance with manufacturer's instructions.

D. Concrete Finish Schedule

<table>
<thead>
<tr>
<th>Item</th>
<th>Type of Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner face of walls of tanks, flow channels, wet wells, perimeter</td>
<td>II*</td>
</tr>
<tr>
<td>walls, and miscellaneous concrete structures to be coated in</td>
<td></td>
</tr>
<tr>
<td>accordance with Section 09900:</td>
<td></td>
</tr>
<tr>
<td>Exterior concrete walls below grade</td>
<td>I</td>
</tr>
<tr>
<td>Exterior exposed concrete walls, ceilings, beams, manholes,</td>
<td>III</td>
</tr>
<tr>
<td>handholes, miscellaneous structures and columns (including top of</td>
<td></td>
</tr>
<tr>
<td>wall) to one foot below grade. All other exposed concrete surfaces</td>
<td></td>
</tr>
<tr>
<td>not specified elsewhere</td>
<td></td>
</tr>
<tr>
<td>All interior exposed concrete walls and vertical surfaces in buildings</td>
<td>III</td>
</tr>
<tr>
<td>Interior exposed ceiling, including beams</td>
<td>III</td>
</tr>
<tr>
<td>Floors of process equipment tanks or basins, and slabs to receive</td>
<td>B</td>
</tr>
<tr>
<td>roofing material or waterproof membranes</td>
<td></td>
</tr>
<tr>
<td>All interior finish floors of buildings and structures and walking</td>
<td>C</td>
</tr>
<tr>
<td>surfaces which will be continuously or intermittently wet</td>
<td></td>
</tr>
<tr>
<td>All interior finish floors of buildings and structures which are not</td>
<td>D</td>
</tr>
<tr>
<td>continuously or intermittently wet</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Type of Finish</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Floors to receive tile, resilient flooring, or carpeting</td>
<td>D</td>
</tr>
<tr>
<td>Concrete floors in flow channels</td>
<td>D</td>
</tr>
<tr>
<td>Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather</td>
<td>E</td>
</tr>
<tr>
<td>Floors of process equipment tanks indicated on Drawings to receive grout topping</td>
<td>F</td>
</tr>
</tbody>
</table>

* Finish shall be acceptable to the coating applicator and manufacturer. See the Section entitled "Painting".
3.05 CURING AND DAMP PROOFING

A. All concrete shall be cured for not less than 7 days after placing, in accordance with the methods specified herein for the different parts of the work, and described in detail in the following paragraphs.

B. When concrete is placed in cold weather as defined in ACI 306, the concrete shall be protected and cured in accordance with the requirements of ACI 306, Cold Weather Concreting.

C. When concrete is placed in hot weather as defined in ACI 305, the concrete shall be protected and cured in accordance with the requirements of ACI 305, Hot Weather Concreting.

D. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removed. If steel forms are used, the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 14 days of placing the concrete, curing shall be continued in accordance with Method 4.

E. Method 2: The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

F. Method 3: The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

G. Method 4: When acceptable to the Engineer, the surface shall be sprayed with a liquid curing compound. It shall be applied in accordance with the manufacturers printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film which will seal thoroughly.

H. Care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

I. Wherever curing compound may have been applied by mistake to faces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

J. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms from contact with formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as provided herein.
3.06 PROTECTION

A. The Contractor shall protect all concrete against injury until final acceptance by the Owner. Fresh concrete shall be protected from damage due to rain. The Contractor shall provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring.

B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

C. When concrete is placed in cold weather as defined in ACI 306, the concrete shall be protected and cured in accordance with the requirements of ACI 306, Cold Weather Concreting.

D. When concrete is placed in hot weather as defined in ACI 305, the concrete shall be protected and cured in accordance with the requirements of ACI 305, Hot Weather Concreting.

3.07 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the Contractor at its own expense.

B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2 inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32 inch depth of the surface film from all hard portions, by means of an efficient sandblast. The material proposed for repair shall be a repair mortar acceptable to the Engineer.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed, but shall be repaired in an approved manner with dry-packed cement grout.

D. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of this Section, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.
3.08 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense. This stipulation includes concrete experiencing cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an epoxy injection system approved by the Engineer. Non-structural cracks shall be repaired using a hydrophilic resin pressure injected grout system approved by the Engineer, unless other means or repair are deemed necessary and approved by the Engineer.

3.09 FABRICATION OF REINFORCING STEEL

A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.

3.10 PLACING REINFORCING STEEL

A. Reinforcing steel shall be accurately positioned as shown on the Drawings, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or metal supports, spacers, or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcing steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the Contractor shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.

3.11 CLEANING AND PROTECTION OF REINFORCING STEEL

A. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

B. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be re-inspected and, if necessary, re-cleaned.

3.12 GENERAL

A. All surface preparation, curing, and protection of cement grout shall be as specified herein. The finish of the grout surface shall match that of the adjacent concrete.

B. The Contractor through the manufacturer of non-shrink grout and epoxy grout shall provide on-site technical assistance to the Engineer upon request, at no additional cost to the Owner.
C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

D. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

- END OF SECTION -
SECTION 05010 - METAL MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Materials for fasteners shall be as specified in the Section entitled "Metal Fastening".

B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

ASTM A36 Standard Specification for Structural Steel
ASTM A47 Standard Specification for Malleable Iron Castings
ASTM A48 Standard Specification for Gray Iron Castings
ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A446 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529 Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)
ASTM A536 Standard Specification for Ductile Iron Castings
ASTM A570 Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
1.04 SUBMITTALS

A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.
PART 2 -- PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

A. Material types and ASTM designations shall be as listed below:

1. Structural W Shapes A 992 (50 ksi)
2. Structural S, M, C, L Shapes A 36 (36 ksi)
3. Structural HP shape A 572, Grade 50 (50 ksi)
4. Structural Tubing A 500, Grade B or A 501 (42 ksi)
5. Structural Pipe A 53, Type E or S, Grade B (35 ksi)
6. Plates and Bars A 36 U.N.O. (36 ksi)
7. Sheet Steel A 570, Grade C
8. Cold-Formed Structural Studs and Joists (18-22 gauge) A 446, Grade C
9. Cold-Formed Structural Studs and Joists (12-16 gauge) A 446 Grade D

2.02 STAINLESS STEEL

A. All stainless steel fabrications shall be Type 316.

B. Material types and ASTM designations are listed below:

1. Plates and Sheets ASTM A167 or A666 Grade A
2. Structural Shapes ASTM A276

2.03 ALUMINUM

A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

1. Structural Shapes ASTM B308
2. Castings ASTM B26, B85, or B108
3. Extruded Bars ASTM B221 - Alloy 6061
4. Extruded Rods, Shapes and Tubes ASTM B221 - Alloy 6063
5. Plates ASTM B209 - Alloy 6061
6. Sheets ASTM B221 - Alloy 3003

C. All aluminum structural members shall conform to the requirements of the Section entitled "Structural Aluminum".
D. All aluminum shall be provided with mill finish unless otherwise noted.

E. Where bolted connections are indicated, aluminum shall be fastened with Type 316 stainless steel bolts.

F. Aluminum in contact with dissimilar materials shall be insulated with an approved dielectric.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

1. Gray
   ASTM A48 Class 30B

2. Malleable
   ASTM A47

3. Ductile
   ASTM A536 Grade 60-40-18

2.05 BRONZE

A. Material types and ASTM designations are listed below:

1. Rods, Bars and Sheets
   ASTM B138 - Alloy B Soft

2.06 HASTELLOY

A. All Hastelloy shall be Alloy C-276.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 05050 - METAL FASTENING

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Metal Materials

B. Handrails and Railings

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Florida Building Code

2. AISC Code of Standard Practice

3. AWS D1.1 Structural Welding Code - Steel

4. AWS D1.2 Structural Welding Code - Aluminum

5. Aluminum Association Specifications for Aluminum Structures

6. ASTM A572/A572M-94C Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50


8. ASTM A325 Standard Specification for High-Strength Bolts for Structural Steel Joints


10. ASTM A490 Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints

11. ASTM A563 Standard Specifications for Carbon and Alloy Steel Nuts


15. ASTM F467  Standard Specification for Nonferrous Nuts for General Use

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the Section entitled “Submittals”, the Contractor shall submit the following:
   1. Shop Drawings providing the fastener’s manufacturer and type and certification of the fastener’s material and capacity.
   2. Manufacturer’s installation instructions.
   3. Copy of valid certification for each person who is to perform field welding.
   4. Certified weld inspection reports, when required.
   5. Welding procedures.

1.05 QUALITY ASSURANCE

A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.

B. Installer Qualifications: Drilled-in anchors shall be installed by an installer with at least three years of experience performing similar installations.

C. Installer Training: Conduct a thorough training with the manufacturer of the manufacturer’s representative for the installer on the project. Training shall consist of a review of the complete installation process for drilled-in anchors, to include but not be limited to the following:
   1. Hole drilling procedure
   2. Hole preparation and cleaning technique.
   3. Adhesive injection technique and dispenser training/maintenance.
   4. Rebar doweling preparation and installation.
   5. Proof loading/torquing.

D. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. Certifications of field welders shall be submitted prior to performing any field welds.

E. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.

F. The Owner may engage an independent testing agency to perform testing of welded
connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.

G. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Appendix E of AWS D1.1 with relevant information presented.

PART 2 - PRODUCTS

2.01 ANCHOR BOLTS
A. Anchor bolts shall conform to ASTM F1554 Grade 36 except where stainless steel or other approved anchor bolts are shown on the Drawings or specified herein. Anchor bolts shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.
B. Where anchor bolts are used to anchor galvanized steel or otherwise specified to be galvanized, bolts and nuts shall be hot-dip galvanized in accordance with ASTM A307.
C. Where pipe sleeves around anchor bolts are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.02 HIGH STRENGTH BOLTS
A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS
A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Unless otherwise specified, fasteners for aluminum and stainless steel members shall be Type 316 stainless steel.
B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

2.04 CONCRETE ANCHORS
A. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. Unless otherwise noted, all concrete anchors which are submerged, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by a commercial testing laboratory.
There are two types used:

1. Expansion anchors shall be wedge, sleeve, or drop-in mechanical anchors.

2. Adhesive anchors shall be two part injection type.

B. All concrete anchors shall be considered structural anchors that transmit load between structural elements and/or life-safety related attachments. Expansion anchors shall be recommended by the anchor manufacturer for use in cracked concrete and shall be evaluated according to ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete. Adhesive anchors shall be tested in accordance with the ICC Evaluation Service acceptance criteria to be creep resistant and capable of resisting long-term tensile loads.

C. Wedge anchors shall be “Kwik Bolt TZ” by Hilti, Inc., “Trubolt Wedge Anchor or TruBolt +” by ITW Redhead, “Strong-Bolt” by Simpson Strong-Tie Co. or “Powerstud SD-1” by Powers Fasteners. Sleeve anchors shall be “HSL/HSL-3 Heavy Duty Sleeve Anchors” by Hilti, Inc. “Power-Bolt” by Powers Fasteners or “Prima High Expansion/Heavy Duty Sleeve Anchor” by ITW Redhead. Drop-in anchors shall be “Drop-In” by Simpson Strong-Tie Co. or “Multi-Set II Drop-In Anchor” by ITW Redhead. Undercut anchors shall be “HDA Undercut Anchor” by Hilti, Inc. All anchors shall be embedded to the depths shown on the Drawings. If no embedment depth is given, the minimum embedment depth as recommended by the manufacturer shall be used. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.

D. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and threaded rod/bolt. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. Wipe rod free from oil that may be present from shipping or handling. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt unless noted otherwise on the Drawings. The adhesive system shall be “Epcon System G5” as manufactured by ITW Redhead, “SET-XP” as manufactured by Simpson Strong-Tie Co., or “PE-1000 SD” by Power Fasteners. Fast-set epoxy formulations shall not be used.

E. Concrete anchors used to anchor steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized.

F. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 316 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.
TABLE 1
Allowable Tensile Capacity (Kips)

<table>
<thead>
<tr>
<th>Size</th>
<th>A36 Threaded Rod/Bolt</th>
<th>SST Threaded Rod/Bolt</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8-inch</td>
<td>2.1</td>
<td>1.9</td>
</tr>
<tr>
<td>1/2-inch</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>5/8-inch</td>
<td>5.9</td>
<td>5.6</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>8.4</td>
<td>8.2</td>
</tr>
<tr>
<td>7/8-inch</td>
<td>11.5</td>
<td>11.4</td>
</tr>
<tr>
<td>1-inch</td>
<td>15.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

2.05 MASONRY ANCHORS

A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.

B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispersed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust with nylon (not wire) brush prior to installation of adhesive and anchor. Contractor shall follow manufacturer’s installation instructions. The adhesive system shall be “Epcon System A7 or C6” as manufactured by ITW Ramset/Redhead, “SET Epoxy-Tie” or “AT Acrylic-Tie” as manufactured by Simpson Strong-Tie Co., or “AC-100 Gold SD by Powers Fasteners.

C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer’s recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, anchors shall also be galvanized.

D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 316 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

2.06 WELDS

A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).

B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.

C. Electrodes for welding stainless steel and other metals shall comply with AWS code.
2.07 WELDED STUD CONNECTORS
   A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.08 EYEBOLTS
   A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.09 HASTELLOY FASTENERS
   A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

2.10 ANTI-SEIZE LUBRICANT
   A. Anti-seize lubricant shall be Graphite 50 Anti-Seize by Loctite Corporation, 1000 Anti-Seize Paste by Dow Corning, 3M Lube and Anti-Seize by 3M, or equal.

PART 3 - EXECUTION

3.01 MEASUREMENTS
   A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 BOLT INSTALLATION
   A. Anchor Bolts, Concrete Anchors, and Masonry Anchors
      1. Anchor bolts shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template.
      2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.
      3. Concrete anchors shall not be used in place of anchor bolts without Engineer's approval.
      4. All stainless steel threads shall be coated with anti-seize lubricant.
   B. High Strength Bolts
      1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC "Specification for Structural Joints, using A325 or A490 Bolts." All high strength bolts installed by the "turn-of-nut" method shall have the turned portion marked with reference to the steel being connected after the nut has been made snug and prior to final tightening. These marks will be considered in inspection.
2. All stainless steel bolts shall be coated with anti-seize lubricant.

C. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal. Unless otherwise specified, where aluminum and steel members are connected together they shall be fastened with Type 304 stainless steel bolts and insulated with micarta, nylon, rubber, or equal.

3.03 WELDING

A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.04 INSPECTION

A. High strength bolting will be visually inspected in accordance with AISC "Specification for Structural Joints Using A325 or A490 Bolts." Rejected bolts shall be either replaced or retightened as required. In cases of disputed bolt installation, the bolts in question shall be checked by a calibrated wrench certified by an independent testing laboratory. The certification shall be at the Contractor's expense.

B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

C. Inspection of post installed anchors shall be per requirements of the corresponding ICC ES ER.

- END OF SECTION -
SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 THE REQUIREMENT

   A. The Contractor shall furnish, fabricate, and install miscellaneous metalwork and 
      appurtenances, complete, all in accordance with the requirements of the Contract 
      Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

   A. Metal Fastening

   B. Handrails and Railings

   C. Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

   A. Without limiting the generality of other requirements of these Specifications, all work 
      specified herein shall conform to or exceed the requirements of the Florida Building 
      Code and the applicable requirements of the following documents to the extent that the 
      provisions of such documents are not in conflict with the requirements of this Section:

   1. American Society for Testing and Materials (ASTM), specifications as referred to 
      herein.

   2. American Welding Society (AWS) "Structural Welding Code-Steel" (AWS D1.1) 
      which includes qualification procedures for welders.

   3. American Institute of Steel Construction (AISC) "Specifications for the Design, 
      Fabrication, and Erection of Structural Steel for Buildings" and "Commentary on 
      the AISC Specification."

   4. American Iron and Steel Institute (AISI) "Specifications for the Design of Cold-
      Formed Steel Structural Members" and "Commentary on the AISI Specification."

   5. Occupational Safety and Health Administration (OSHA) Regulations.

   6. Aluminum Association "Specifications for Aluminum Structures" and "Engineering 
      Data for Aluminum Structures."


   B. References herein to "Building Code" shall mean the Florida Building Code.

1.04 SUBMITTALS

   A. Shop drawings of all miscellaneous metalwork shall be submitted to the Engineer for 
      review in accordance with the Section entitled "Submittals".

   B. Safe working load capacity in tension and shear for each size and type of concrete 
      anchor used shall be submitted to the Engineer for review.
PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials are specified in the Section entitled “Metal Materials”.

B. Unless otherwise shown, miscellaneous "steel" metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with the Section entitled “Painting” and shall not be galvanized prior to coating. Unless otherwise shown, all other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

C. Unless otherwise shown, aluminum metalwork shall be of Alloy 6061-T6. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the Section entitled “Painting”. Aluminum design shall be in accordance with the Aluminum Association standards. Aluminum shall be fastened with Type 316 stainless steel bolts.

D. Unless otherwise shown, iron castings shall conform to the requirements of ASTM A48 “Specifications for Gray Iron Castings,” Class 30B or better.

E. Fasteners shall meet all design requirements for intended application. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified and required quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.

2.02 BOLTS AND CONCRETE ANCHORS

A. For all conditions, all bolts, concrete anchors, anchor bolts, and nuts shall be Type 316 stainless steel unless otherwise noted on the Drawings. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads for all bolts and nuts.

B. If any bolts, anchor bolts, nuts and similar threaded fasteners are specified to be galvanized, they shall conform to ASTM A307. After being properly cleaned, when called for to be galvanized, shall be galvanized in accordance with the requirements of ASTM A 153 "Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware." Field repairs to galvanizing shall be made using "Galvinox," "Galo-Weld," or approved equal.

C. Concrete Anchors are specified in Specification Section 05050 entitled “Metal Fastening”.

D. Unless otherwise noted, all concrete anchors which are submerged, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.

2.03 STEEL PIPE BUMPER GUARDS

A. Steel pipe bumper guards shall be as detailed on the Drawings, including pipe sleeves, concrete fill, crushed fill and grouting to secure parts. Pipe for guards shall be galvanized steel, Schedule 40 pipe that conforms to ASTM A53.

B. Painting shall be in accordance with the Section entitled “Painting”.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Verify that field conditions are acceptable and are ready to receive work.
   B. Beginning of installation means erector accepts existing conditions.

3.02 PREPARATION
   A. Clean and strip primed steel items to bare metals where site welding is required.
   B. Supply items required to be cast into concrete with setting templates, to appropriate sections.

3.03 INSTALLATION
   A. Install items plumb and level, accurately fitted, free from distortion or defects.
   B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
   C. Field weld components indicated on Drawings.
   D. Obtain Engineer approval prior to site cutting or making adjustments not scheduled.
   E. Fabrication and Erection: Except as otherwise shown, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

3.04 WELDING
   A. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
   B. In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp comers of material which is to be painted shall be ground to a minimum of 1/32-inch on the flat.

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT
A. The Contractor shall make modifications to handrails and railings and appurtenances all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Metal Fastening
B. Metal Fabrications
C. Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
A. Without limiting the generality of the other requirements of the specifications, all work specified herein shall conform to or exceed the requirements of the Florida Building Code, and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Florida Building Code
2. Aluminum Association Specifications for Aluminum Structures
3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS
A. Shop drawings of all handrails and railings shall be submitted to the Engineer for review in accordance with the Section entitled “Submittals”.

PART 2 - PRODUCTS

2.01 ALUMINUM RAILING SYSTEM
A. General: Where indicated on the Drawings, aluminum guardrail and handrail shall be provided. In addition, guardrail and handrail shall be supplied as required by the Florida Building Code and OSHA whether indicated on the Drawings or not. Guardrail shall consist of all railings, posts, toe boards, baseplates, anchors, and accessories required for a complete installation.

1. All metal railing systems shall be fabricated from extruded aluminum alloy 6061-T6 or 6105-T5, with Aluminum Association M12C22A41 clear anodized finish.

B. Vertical pipe supports shall include cast aluminum base flange or side mount bracket with set screws as indicated on Drawings and as manufactured by Thompson Fabricating, Hollaender Railings, or approved equal. Removable posts shall be sleeved. The joint between upright and sleeve shall be cemented with non-shrink grout.
C. Wall brackets for handrail shall be of designs indicated on the Drawings and shall be as manufactured by Moultrie Manufacturing Company, J.G. Braun Company, Fulton Metal Products Company, or equal.

D. All connections between vertical posts and horizontal railing or between sections of horizontal railings shall be shop welded continuous in as long of sections as practical. All welds shall be water tight and ground smooth. Field assembly of welded sections may be made by mechanical fasteners. Location and type of field connections shall be subject to the Engineer's review. Weep holes shall be shop drilled in all vertical posts of external railing.

E. Design Load: All components of the railings and the railing system shall be adequately designed to resist the design loads of the Florida Building Code. In no case shall the spacing of vertical pipe supports exceed five feet.

F. Aluminum Guardrails and Handrails: Exterior aluminum pipe railing guardrail posts shall be nominal 1-1/2 inch diameter, Schedule 80 (minimum). Guardrail posts shall be adequately reinforced to meet the code specified design loads. Horizontal top and intermediate railing of the guardrails shall be aluminum pipe railing, nominal 1½-inch diameter, Schedule 40 (minimum). In staircases and other location indicated on the Drawings, horizontal handrail shall be provided. Such additional railing shall be Schedule 40, 1-inch diameter aluminum pipe, alloy 6060-T6. Horizontal handrails shall be in addition to guardrails provided in open staircases.

G. Kickplates: Kickplates where not specifically called for in the Drawings shall be furnished and installed typically at the edges of all metal walkways and at other handrail installations. Kickplates shall be ¼-inch thick, must meet OSHA requirements, shall project 4-inches above walkway surface, may not infringe on minimum required walkway width and material must be the same as that of handrail construction. Kickplates shall be connected to handrail posts as detailed on the drawings.

H. Expansion joint splices shall be provided at 30 feet maximum spacing and at all expansion joints in the structure supporting the handrail. Material for expansion joint splice shall be the same as railing material.

I. Where safety chains are required in handrails as shown on the Drawings, chains shall be constructed of Type 304 stainless steel. Chains shall be straight link style, 3/16-inch diameter, with at least twelve links per foot, and with snap hooks on each end. Snap 3/4-inch eye diameter welded to the railing posts. Two (2) chains, four inches longer than the anchorage spacing shall be supplied for each guarded area.

J. Finish: All aluminum handrails and guardrails shall be provided with a mill finish, unless otherwise noted on the Drawings.

2.02 FASTENERS

A. Type 316 stainless steel fasteners shall be furnished.
PART 3 - EXECUTION

3.01 EXAMINATION

A. The Contractor shall verify that field conditions are acceptable and are ready to receive work.

B. Beginning the installation means the Contractor accepts existing conditions.

3.02 PREPARATION

A. Clean and strip primed items to bare metals where site welding is required.

B. Supply items required to be cast into concrete with setting templates, to appropriate sections.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Provide anchors and plates required for connecting railings to structure.

C. Aluminum Railings: Aluminum railing fabrication shall be performed by craftsmen experienced in the fabrication of architectural metal work. Exposed surfaces shall be free from defects or other surface blemishes. Dimensions and conditions shall be verified in the field. All joints, junctions, miters and butting sections shall be precision fitted with no gaps occurring between sections, and with all surfaces flush and aligned. Electrolysis protection of materials shall be provided. All dissimilar materials shall be isolated.

3.04 EXPANSION BOLTS

A. Expansion bolts shall be spaced 10d apart and 5d edge distance (d=diameter of bolt). A safety factor of four shall be provided on expansion bolt pull out values published by the manufacturer.

3.05 ALUMINUM SURFACES

A. Aluminum surfaces in contact with concrete, grout or dissimilar metals shall be protected with a coat of bitumastic or other approved materials.

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials, labor, and equipment required to provide all gratings, floor plates, and hatches in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Metal Fabrications

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Florida Building Code
2. Aluminum Association Specifications for Aluminum Structures
3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

A. Submit the following in accordance with the Section entitled “Submittals”.

1. Complete fabrication and erection Drawings of all gratings, floor plates, access hatches, and access doors specified herein.

2. Other submittals as required in accordance with the Section entitled “Metal Fabrications”.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for gratings, floor plates, and hatches shall conform to the Section entitled “Metal Materials” unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for gratings, floor plates, and hatches shall conform to the Section entitled “Metal Fastening” unless noted otherwise.

2.03 GRATING

A. General: Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.
1. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.

2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No section of grating shall weigh in excess of 50 lbs. No fasteners shall be permitted to project above the walking surface.

3. Grating shall be designed for a loading of 100 psf unless a depth is required by the Drawings. Minimum grating depth shall be 1½-inches.

4. Cutouts in grating shall be provided for valve operators, conduits, pipes, etc. Edges of cutouts shall be banded.

B. Aluminum Grating

1. Aluminum grating shall be of I-bar type with cross bars at 2 inches on center and shall consist of extruded bearing bars positioned and locked by crossbars. All supports, cross members, etc. shall be aluminum. Plank clips for grating holddowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel.

2. Grating shall be aluminum swage locked "I-Bar" Type IF, as manufactured by IKG Borden or equal.

3. Grating shall be provided with a mill finish.

C. Aluminum Plank Grating

1. Aluminum plank grating shall be un-punched, consisting of 6-inch wide extruded sections, heavy duty type with 6 ribs and plain sides, fabricated in standard sections as manufactured by Ohio Gratings, McNichols, IKG Borden, or approved equal. All planks shall be provided with extruded grating frame cast in concrete.

2. Grating panels shall be made from 6-inch wide extruded sections and banded to form standard panel widths.

3. Removable sections shall be edge banded in sections and provided with stainless steel flush mounted lift handles with necessary plank reinforcing and holdown anchors.

4. Hinged sections shall be shop fabricated ready for field installation. Panels shall be edge banded with a continuous hinge, flush mounted lifting handles (1 section minimum), stainless steel bolts and hardware. Grating frame shall be provided with removable temporary braces to maintain the required opening width during casting. Provide necessary grating reinforcing for lift handles, hinge connections, holdown anchors, etc.

5. Plank grating shall be provided with a mill finish.

D. Steel Grating

1. Steel grating shall be custom welded heavy duty steel grating per ANSI/NAMM MBG 532-000. Minimum bearing bar size shall be 2-1/4" x 1/4". All supports, cross
members, etc. shall be galvanized steel. Plank clips for grating hold downs shall be stainless steel. Bolts shall be galvanized steel.

2. All openings shall be banded.

3. Steel grating shall be galvanized in accordance to Section 05035, Galvanizing.

4. Main bearing bars shall conform to ASTM A36. Cross bars shall be flush with the top of the grating.

5. Grating span shall be 36 inches maximum and shall satisfy AASHTO loading for H-20 truck unless noted otherwise on the drawings.

6. Grating shall be manufactured by IKG Borden Industries, Leeds, AL.

2.04 CHECKERED PLATES

A. Checkered plates shall be aluminum Alloy 6061-T6, or galvanized steel as indicated on the Drawings. Aluminum checkered plates shall be provided in mill finish, except when otherwise indicated on the Drawings, and designed for a live load of 150 pounds per square foot of the gross projected area. The allowable deflection under the above loadings shall be L/240 but not more than 1/4-inch.

B. Checkered plates shall be standard pattern non-slip of the thickness and sizes on the Drawings. Minimum thickness shall be 3/8 inch. Stiffener angles shall be provided as required to meet the load requirements specified above. All checkered plate sections shall be cut that no one section shall weigh more than 100 pounds.

C. Flush type lifting handles and hinges and neoprene seals for air tight construction shall be provided where shown on the Drawings.

D. At locations noted, neoprene gaskets shall be provided between floor plates and frames. Plates shall be screwed into frames when noted on the Drawings.

E. Hinges, where indicated on the Drawings, shall be heavy-duty, cadmium plated bronze with stainless steel pins and fasteners.

F. Removable Sections: Plates shall be fabricated in removable sections with weight not exceeding 60 pounds each with flush mounted handles and removable holdown stainless steel bolts.

2.05 ALUMINUM ACCESS HATCHES

A. General

1. Door opening sizes, number and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings show the clear opening requirements.

2. All doors shall be aluminum (mill finish) unless otherwise noted. All doors in locations subject to direct vehicular traffic shall be galvanized steel designed for H-20 live loads.
3. Openings larger than 42 inches in either direction shall have double leaf doors, unless noted otherwise on the Drawings.

4. Doors shall be designed for flush mounting and for easy opening from both inside and outside.

5. All doors shall be provided with an automatic hold-open arm with release handle.

6. Double leaf doors shall be provided with 316 SS safety chains to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.

7. All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be 316 stainless steel.

8. Cylinder locks with keyway protected by a cover plug shall be provided with all hatches.

9. Door leafs shall be 1/4-inch aluminum diamond plate reinforced and suitable for 150 PSF live load.

10. Access door frames shall be watertight type channel fabricated from ¼-inch aluminum with an anchor flange around the perimeter. The door frame shall be equipped with a 1 1/2-inch drainage coupling. Drain piping shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.

11. Single leaf access hatches shall be model K as manufactured by The Bilco Company, or equal. Dual leaf access hatches shall be model KD as manufactured by The Bilco Company, or equal.

12. Hatches shall be guaranteed against defects for a period of five years.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work. Fabrication shall begin only after such field measurements.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection, unless sections have to be removable. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050 - Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All gratings, access hatches, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

-END OF SECTION-
SECTION 06610 – MOLDED FRP GRATINGS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all fiberglass items as specified herein and as shown on the Drawings. The Contractor shall be responsible for the coordination with related work specified elsewhere and to provide all hardware, accessories and appurtenances required for a complete installation, including all fabrication and mounting hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 5 - Metals

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. PS15 - National Bureau of Standards
3. ASTM D3647 - Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition

1.04 SUBMITTALS

A. The Contractor shall submit shop drawings showing fabrication details and erection for all items specified herein in accordance with the Sections entitled "Submittals" and "Materials and Equipment". Contractor shall include plans, elevations, framing supports and details of sections and connections. Show type and location of all fasteners.

B. Certification of compliance with ASTM Standards.

1.05 QUALITY ASSURANCE

A. All fiberglass items of the same type provided shall be the products of a single manufacturer for compatibility.

B. It shall be the Contractor's responsibility to insure that the fiberglass items and appurtenances furnished shall be compatible and have the necessary operating clearances with the structural elements and equipment shown on the Drawings.
1.06 ACCEPTABLE MANUFACTURERS

A. Molded gratings shall be Fibergrate® as manufactured by Fibergrate Composite Structures Inc. or equal.

PART 2 – PRODUCTS

2.01 GRATING AND TREADS

A. Fiberglass grating shall be molded.

B. Fiberglass grating and treads shall be furnished and installed in areas shown on the Drawings including all FRP angle supports, fasteners and accessories. Gratings and treads shall consist of extruded bearing bars positioned and locked by crossbars.

C. Grating and treads shall be installed in accordance with the manufacturer's recommendations. Grating shall be fabricated into easily removable sections as large as possible up to 50 lbs. per section.

D. Fasteners shall not project above the walking surface.

E. The grating and tread supplier shall supply all shelf support angles, embedded angles with anchors, concrete anchors and necessary Type 316 stainless steel grating clips coated with epoxy paint per the Section entitled “Painting”, for a complete system.

F. Grating shall be constructed of fiberglass roving reinforced thermoset plastic produced in a one-piece mold.

G. The resin shall be selected by the manufacturer and be completely suitable for the indicated service. The manufacturer through the Contractor shall submit an affidavit of compliance in accordance with the Section entitled “Submittals”.

H. **Glass Content:** Shall not exceed 35% by weight so as to achieve maximum corrosion resistance.

I. The color of the grating shall be yellow.

J. All grating products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test. Gratings shall also have tested burn time of less than 30 seconds and an extent of burn rate of less that or equal to 10 millimeters per ASTM D635.

K. All mechanical grating clips, nuts, bolts, washers and fasteners shall be manufactured of Type 316 SS (stainless steel).

L. **General -** Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.

   1. All exposed bearing ends of grating shall be coated with ambient cured vinyl ester resin to assure corrosion resistance. Opening in grating shall be cut along a perpendicular load bar. No sharp edges shall remain after cutting and sealing.

   2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No
section of grating shall weigh in excess of 50 lbs. No fasteners shall be permitted to project above the walking surface by more than 1/16-inch.

3. **Mesh configuration:** Grating shall have a 2-inch thickness with a 2-inch square mesh pattern.

4. Grate shall support a maximum uniform distributed load of 100 PSF over the gross projected area with a maximum deflection of 0.25-inch or grating span/240, whichever is less.

M. **Non-slip surfacing:** Grating shall be manufactured with a secondarily applied grit on the top of each bar providing maximum slip resistance not to exceed 1/16-inch thickness.

### 2.02 GRATING FLOOR SYSTEM

A. Fiberglass grating floor system shall be furnished and installed in areas shown on the Drawings and shall include all FRP angle supports, FRP adjustable pedestal supports, FRP cross bracing, fasteners, and accessories as required for a complete system. Grating shall consist of bidirectional molded FRP gratings. Grating and supports shall be provided by a single manufacturer and installed in accordance with the manufacturer’s recommendations to provide a level walking surface.

B. Grating shall be fabricated into easily removable sections as large as possible up to 150 lbs. per section.

C. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and materials as the main bars, including at all cutouts.

D. Fasteners shall not project above the walking surface.

E. Fiberglass grating and supports shall be manufactured of polyester resin except for sodium hypochlorite applications where vinyl ester resin shall be used. Grating and supports shall be produced by Corgrate, Fibergrate, Inc., Strongwell, or equal.

F. Grating and supports shall be designed for a uniform loading of 100 psf. Grating deflection shall be limited to 0.25”.

G. Grating clips and metal fasteners shall be Type 316 stainless steel.

### PART 3 – EXECUTION

#### 3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work. Fabrication shall begin only after such field measurements.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection, unless sections have to be removable. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished.

3.02 QUALITY ASSURANCE

A. The Contractor shall inspect grating upon delivery to the job site and after installation for defects. Grating shall be free from visual defects such as delaminations, blisters, surface crazing, streaking, and voids. Defective grating shall be replaced at no cost to the Owner.

3.03 HANDLING AND STORAGE

A. For long-term storage, store grating on pallets. Keep all FRP materials covered. Do not drag panels across one another. Seal any scratches, crushed or chipped edges.

3.04 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All gratings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. All cut or sanded surfaces shall be coated with resin furnished by manufacturer and applied in accordance with manufacturer’s instructions.

D. Contractor shall install gratings in accordance with manufacturer assembly drawings, and lock grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer’s instructions. Follow manufacturer’s instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

E. Use anchoring devices as supplied by, or approved by, the manufacturer and in accordance with manufacturers’ instructions.

F. Handrails shall be erected with true horizontal and vertical alignment and shall be smooth and free of surface defects. All cut edges and holes shall be sealed with a compatible resin system.

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, tools, materials, supervision and equipment necessary to do all the work specified herein and as required for a complete installation.

1.02 GENERAL INFORMATION AND DESCRIPTION

A. The term "paint," as used herein, includes emulsions, enamels, paints, stains, varnishes, sealers, cement filler, cement-latex filler and other coatings, whether used as prime, intermediate, or finish coats.

B. All paint for concrete and metal surfaces shall be especially adapted for use around water treatment plants and shall be applied in conformance with the manufacturer's published specifications.

C. All paint for final coats shall be fume resistant, compounded with pigments suitable for exposure to gases, especially to hydrogen sulfide and to carbon dioxide. Pigments shall be materials which do not tend to darken, discolor, or fade due to the action of sewage gases. If a paint manufacturer proposes use of paint which is not designated "fume resistant" in its literature, it shall furnish full information concerning the pigments used in this paint.

D. Coatings used in conjunction with potable water supply systems shall have U.S. Environmental Protection Agency (EPA), National Science Foundation (NSF), and Food and Drug Administration (FDA) approval for use with potable water and shall not impart a taste or odor to the water.

E. All building, facilities, structures, and appurtenances, as indicated on the Drawings and as specified herein, shall be painted with not less then one shop coat and two field coats, or one prime coat and two finish coats of the appropriate paint. Items to be painted include, but are not limited to exterior and interior concrete, structural steel, miscellaneous metals, steel and aluminum doors and frames, concrete block, ductwork, sluice gates, operators, pipe fittings, valves, mechanical equipment, motors, conduit, and all other work which is obviously required to be painted unless otherwise specified.

F. Baked-on enamel finishes and items with standard shop finishes such as graphic panels, electrical equipment, toilet partitions, lockers, instrumentation, etc., shall not be field painted unless the finish is damaged during shipment or installation. Aluminum, stainless steel, fiberglass and bronze work shall not be painted unless color coding and marking is required or otherwise specified. A list of surfaces not to be coated is included in Article 1.09 of this Section.

G. The Contractor shall obtain all permits, licenses and inspections and shall comply with all laws, codes, ordinances, rules and regulations promulgated by authorities having jurisdiction which may bear on the work. This compliance will include Federal Public Law 91-596 more commonly known as the "Occupational Safety and Health Act of 1970".
1.03 MANUFACTURERS

A. All painting materials shall be as manufactured by Tnemec, Carboline, Ameron, Sherwin Williams, DuPont, or approved equal.

1.04 SUBMITTALS

A. The Contractor shall submit paint manufacturer's data sheets, application instructions, and samples of each finish and color to the Engineer for review, before any work is started in accordance with the Section entitled, "Submittals."

B. Submitted samples of each finish and color shall be prepared so that the area of each sample indicates the appearance of the various coats. For example, where a three-coat system is specified, the sample shall be divided into three areas indicating one coat only, two coats and all three coats. The Engineer will provide written authorization constituting a standard, as to color and finish only, for each coating system.

C. The Contractor shall prepare a complete schedule of surfaces to be coated and shall identify the surface preparation and paint system it proposes to use. The Paint Schedule shall be in conformance with Article 3.03 of this Section. The schedule shall contain the name of the paint manufacturer, and the name, address and telephone number of the manufacturer's representative that will inspect the Work. The schedule shall be submitted to the Engineer for review as soon as possible following the Notice to Proceed so that the schedule may be used to identify colors and to specify shop painting systems on order for fabricated equipment.

D. Name and detailed qualifications of the protective coatings applicator or subcontractor. Qualifications shall include, but not be limited to, five (5) references which show that the painting applicator or subcontractor has previous successful experience with the specified or comparable coating systems, a list of installations that are currently in service and documentation that applicator or subcontractor is currently a qualified applicator or the proposed coatings by the manufacturer.

1.05 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall purchase paint from an acceptable manufacturer. The manufacturer shall assign a representative to inspect the application of its product both in the shop and field. The Contractor, through the manufacturer's representative, shall submit its report to the Engineer at the completion of its Work identifying the products used and verifying that said products were properly applied and that the paint systems were proper for the exposure and service.

B. Services shall also include, but not be limited to, inspecting prior coatings of paint, determination of best means of surface preparation, inspection of complete work, and re-inspection of painted work to be performed six months after the job is completed.

1.06 MANUFACTURER'S INSTRUCTIONS

A. The manufacturer's published instructions for use as a guide in specifying and applying the manufacturers proposed paint shall be submitted to the Engineer. Paint shall not be delivered to the job before acceptance of the manufacturer's instructions is given by the Engineer.
B. A manufacturer's paint will not be considered for use unless that manufacturer's published instructions meets the following requirements:

1. The instructions must have been written and published by the manufacturer for the purpose and with the intent of giving complete instruction for the use and application of the proposed paint in the locality and for the conditions for which the paint is specified or shown to be applied under this Contract.

2. All limitations, precautions, and requirements that may adversely affect the paint; that may cause unsatisfactory results after the painting application; or that may cause the paint not to serve the purpose for which it was intended; that is, to protect the covered material from corrosion, shall be clearly and completely stated in the instructions. These limitations and requirements shall, if they exist, include, but not be limited to the following:
   a. Methods of application
   b. Number of coats
   c. Thickness of each coat
   d. Total thickness
   e. Drying time of each coat, including primer
   f. Primer required to be used
   g. Primers not permitted
   h. Use of a primer
   i. Thinner and use of thinner
   j. Temperature and relative humidity limitations during application and after application
   k. Time allowed between coats
   l. Protection from sun
   m. Physical properties of paint including solids content and ingredient analysis
   n. Surface preparation
   o. Touch up requirements and limitations

C. Concrete surfaces specified by the paint manufacturer to be acid etched shall be etched in accordance with the manufacturer's instructions. The surface shall then be thoroughly scrubbed with clean water, rinsed, and allowed to dry. The surface shall be tested with a moisture meter to determine when dry before coating.
1.07 QUALITY ASSURANCE

A. The Contractor shall give the Engineer a minimum of three days advance notice of the start of any field surface preparation work of coating application work.

B. All such Work shall be performed only in the presence of the Engineer, unless the Engineer has specifically allowed the performance of such Work in its absence.

C. Review by the Engineer, or the waiver of review of any particular portion of the work, shall not relieve the Contractor of its responsibility to perform the Work in accordance with these Specifications.

D. Where coatings are to be performed by a subcontractor, the Contractor shall provide five references which show that the painting subcontractor has previous successful experience with the specified or comparable coating systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting subcontractor provided the protective coating.

1.08 SAFETY AND HEALTH REQUIREMENTS

A. In accordance with requirements of OSHA Safety and Health Standards for Construction (29CFR1926) and the applicable requirements of regulatory agencies having jurisdiction, as well as manufacturer's printed instructions, appropriate technical bulletins, manuals, and material safety data sheets, the Contractor shall provide and require use of personnel protective and safety equipment for persons working in or about the project site.

B. All paints must comply with the requirements of the National Ambient Air Quality Standards.

1.09 SURFACES NOT TO BE COATED

A. The following items shall not be coated unless otherwise noted:

1. Stainless steel work.
2. Galvanized checkered plate.
3. Aluminum handrails, walkways, windows, louvers, grating and checkered plate.
4. Flexible couplings, lubricated bearing surfaces and insulation.
5. Packing glands and other adjustable parts of mechanical equipment.
6. Finish hardware.
7. Plastic switch plates and receptacle plates.
8. Signs and nameplates.

1.10 QUALITY WORKMANSHIP

A. The Contractor shall be responsible for the cleanliness of its painting operations and shall use covers and masking tape to protect the work whenever such covering is necessary, or if so requested by the Owner. Any unwanted paint shall be carefully removed without damage to any finished paint or surface. If damage does occur, the entire surface,
adjacent to and including the damaged area, shall be repainted without visible lapmarks and without additional cost to the Owner.

B. The Contractor shall provide covers made of plywood or other acceptable material to protect Filters in operation while painting work is ongoing in off-line filter.

1.11 ADDITIONAL PAINT

A. At the end of the project, the Contractor shall turn over to the Owner a gallon can of each type and color of paint, primer, thinner or other coating used in the field painting. If the manufacturer packages the material concerned in gallon cans, then it shall be delivered in unopened labeled cans as it comes from the factory. If the manufacturer does not package the material in gallon cans, and in the case of special colors, the materials shall be delivered in new gallon containers, properly closed with type labels indicating brand, type, color, etc. The manufacturer's literature described the materials and giving directions for their use shall be furnished in three bound copies. A type-written inventory list shall be furnished at the time of delivery.

1.12 SHIPPING, HANDLING AND STORAGE

A. All painting materials shall be brought to the job site in the original sealed labeled containers of the paint manufacturer and shall be subject to review by the Engineer. Where thinning is necessary, only the product of the manufacturer furnishing the paint shall be used. All such thinning shall be done strictly in accordance with the manufacturer’s instructions, and with the full knowledge of the Engineer.

B. Materials and their storage shall be in full compliance with the requirements of pertinent codes and fire regulations. Receptacles shall be placed outside buildings for paint gates and containers. Paint waste shall not be disposed of in plumbing fixtures, process drains or other plant systems or process units.
PART 2 -- PRODUCTS

2.01 MATERIALS

A. Table 09850-1 depicts the coatings referenced in Article 3.03 of this Section entitled, "Paint Schedule". Table 09850-1 lists Tnemec products as a reference. Equivalent products by the manufacturers listed in Article 1.03 of this Section may be submitted for review.

TABLE 09850-1
PRODUCT LISTING

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Description</th>
<th>MANUFACTURERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>REFERENCE Tnemec</td>
</tr>
<tr>
<td>102</td>
<td>Inorganic Water-based Epoxy</td>
<td>1254 Epoxoblock WB</td>
</tr>
<tr>
<td>105</td>
<td>Polyamidoamine Epoxy</td>
<td>N69 – Hi Build Epoxoline II</td>
</tr>
<tr>
<td>106</td>
<td>Acrylic Emulsion</td>
<td>180 – W.B. Tneme-Crete</td>
</tr>
<tr>
<td>107</td>
<td>Acrylic Emulsion</td>
<td>6 – Tneme-Cryl</td>
</tr>
<tr>
<td>110</td>
<td>Endura Shield III</td>
<td>1074U Endurashield</td>
</tr>
<tr>
<td>114</td>
<td>Waterborne Polyamide Epoxy</td>
<td>151 - Elasto-Grip</td>
</tr>
<tr>
<td>115</td>
<td>Aromatic Urethane, Zinc Rich</td>
<td>90-97 Tneme Zinc</td>
</tr>
<tr>
<td>116</td>
<td>Cementitious Repair Mortar</td>
<td>217 Mortarcrete</td>
</tr>
<tr>
<td>117</td>
<td>Modified Polyamine Epoxy</td>
<td>215 Surfacing Epoxy</td>
</tr>
<tr>
<td>120</td>
<td>Water Repellent</td>
<td>Chemprobe Deck A Pell #668</td>
</tr>
<tr>
<td>121</td>
<td>Modified Polyamine Epoxy</td>
<td>141 Epoxoline</td>
</tr>
<tr>
<td>122</td>
<td>Aromatic Urethane, Zinc Rich</td>
<td>91-H20 Hydro Zinc</td>
</tr>
<tr>
<td>123</td>
<td>Polyamide Epoxy</td>
<td>161 – Tneme-Fascure</td>
</tr>
</tbody>
</table>

2.02 TRAFFIC PAINT

A. Paint for marking the parking lots shall be Sherwin-Williams PRO-MAR traffic marking paint, or equal. Color shall be white. Paint shall be applied in accordance with the manufacturer's recommendations. Striped areas shall be as indicated on the Plans.

PART 3 – EXECUTION

3.01 SURFACE PREPARATION

A. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale and all foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless acceptable to the Engineer or specified herein.

B. Except as otherwise provided, all preparation of metal surfaces shall be in accordance with Specifications SP-1 through SP-10 of the Steel Structures Painting Council (SSPC). Where Steel Structures Painting Specifications are referred to in these Contract Documents, the corresponding Pictorial Surfaces Preparation Standard shall be used to define the minimum final surface conditions to be supplied. Grease and oil shall be removed and the surface prepared by hand tool cleaning, power tool cleaning or blast cleaning in accordance with the appropriate Specification SP-1 through SP-10.
C. Weld flux, weld spatter and excessive rust scale shall be removed by power tool cleaning as per SSPC-SP-3-63.

D. Threaded portions of valve and gate stems, machined surfaces which are limited for sliding contact, surfaces which are to be assembled against gaskets, surfaces or shafting on which sprockets are to fit, or which are intended to fit into bearings, machined surfaces of bronze trim on slide gates and similar surfaces shall be masked off to protect them from the sandblasting of adjacent surfaces. Cadmium-plated or galvanized items shall not sandblasted unless hereinafter specified, except that cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment to the sandblasted shall be sandblasted in the same manner as the unprotected metal. All installed equipment, mechanical drives, and adjacent painted equipment shall be protected from sandblasting. Protection shall prevent any sand or dust from entering the mechanical drive units or equipment where damage could be caused.

E. Hardware accessories, machined surfaces, plates, lighting fixtures and similar items in place prior to cleaning and painting, and not intended to be painted, shall be protected or removed during painting operations and repositioned upon completion of painting operations.

F. Any abraded areas of shop or field applied coating shall be touched up with the same type of shop or field applied coating, even to the extent of applying an entire coating, if necessary. Touch-up coating and surface preparations shall be in addition to and not considered as the first field coat.

G. Sand from sandblasting shall be thoroughly removed, using a vacuum cleaner if necessary. No surface which has been sandblasted shall be painted until inspected by the Engineer.

H. Exposed Pipe

1. Bituminous coated pipe shall not be used in exposed locations. Pipe which shall be exposed after project completion shall be primed in accordance with the requirements herein. Any bituminous coated ferrous pipe which is inadvertently installed in exposed locations shall be sandblasted to SSPC-SP-5 White Metal before priming and painting.

2. After installation and prior to finish painting, all exterior, exposed flanged joints shall have the gap between adjoining flanges and gaps between the pipe wall and threaded-on flanges sealed with a single component Thiokol caulking to prevent rust stains.

I. Ferrous Metal Surfaces

1. All ferrous metal surfaces not required to be galvanized shall be cleaned of all oil grease, dirt, rust and tight and loose mill scale by blasting in accordance with the following: SSPC-SP-5, White Metal Blast Cleaning and comply with the visual standard NACE 1, for submerged metal. SSPC-SP-10 Near White Metal Blast Cleaning, and comply with the visual standard NACE 2 for all other locations. Pickling, complying with SSPC-SP-8, may be substituted for Near White Blast in areas as determined by the Engineer. Priming shall follow sandblasting before any evidence of corrosion occurs, before nightfall and before any moisture is on the surface.

J. Field surface preparation of small, isolated areas such as field welds, repair of scratches, abrasions or other marks to the shop prime or finish shall be cleaned by power tools in
accordance with SSPC-SP-3, or in difficult and otherwise inaccessible areas by hand cleaning in accordance with SSPC-SP-2 and spot primed.

K. Primed or Coated Surfaces and Non-Ferrous Surfaces

1. All coated surfaces shall be cleaned prior to application of successive coats. All non-ferrous metals not to be coated shall be cleaned. This cleaning shall be done in accordance with SSPC-SP-1, Solvent Cleaning.

L. Shop Finished Surfaces

1. All shop-coated surfaces shall be protected from damage and corrosion before and after installation by treating damaged areas immediately upon detection. Abraded or corroded spots on shop-coated surfaces shall be prepared in accordance with SSPC-SP-2, Hand Tool Cleaning and then touched up with the same materials as the shop coat.

2. All shop coated surfaces which are faded, discolored, or which require more than minor touch-up, in the opinion of the Engineer, shall be repainted. Cut edges of galvanized sheets, electrical conduit, and metal pipe sleeves, not to be finish painted, shall be cleaned in accordance with SSPC-SP-1, Solvent Cleaning and primed with zinc dust-zinc oxide metal primer.

M. Galvanized and Copper Alloy Surfaces

1. All copper or galvanized metal surfaces shall be brush blasted and given one coat of epoxy primer.

N. Concrete and Masonry Surfaces

1. Concrete and masonry surfaces to be painted shall be prepared by removing efflorescence, chalk, dust, dirt, grease, oil, form coating, tar and by roughening to remove glaze. All surfaces shall be repaired prior to commencement of the coating operation.

2. Concrete and masonry surfaces are to be cured for at least 28 days prior to coating them.

O. New concrete immersion surfaces that are to be coated shall be brush blasted per SSPC-SP7 to produce the necessary "sandpaper texture" surface required for satisfactory adherence of the paint. Areas of concrete, which contain blow holes or voids, shall be filled with the manufacturer's approved filler material.

P. Existing Painted Concrete and Masonry Surfaces

1. Existing painted concrete and masonry surfaces requiring paint as identified herein shall be prepared by applying a minimum 3500 psi high pressure water blast to the existing painted surface to remove all loose paint, chalk, dust, dirt, grease, oil, latents, and other foreign materials. Cracks, chips or voids in the existing concrete shall be repaired in accordance with paint manufacturer recommendations.

Q. PVC Pipe Surfaces

1. All pipe surfaces shall be lightly sanded before painting.
3.02 SHOP PAINTING

A. All fabricated steel work and equipment shall receive at the factory at least one shop coat of prime paint compatible with the paint system required by these Specifications. The Contractor shall coordinate all shop priming to ensure compatibility with paint system specified. Surface preparation prior to shop painting shall be as specified. Finish coats may be applied in the shop if acceptable to the Engineer. All shop painted items shall be properly packaged and stored until they are incorporated in the Work. Any painted surfaces that are damaged during handling, transporting, storage or installation shall be cleaned, scraped, and patched before field painting begins so that Work shall be equal to the original painting received at the shop. Equipment or steel Work that is to be assembled on the site shall likewise receive a minimum of one shop coat of paint at the factory. Surfaces of exposed members that will be inaccessible after erection shall be prepared and painted before erection.

B. The Contractor shall specify the shop paints to be applied when ordering equipment in order to assure compatibility of shop paints with field paints. The paints and surface preparation used for shop coating shall be identified on shop drawings submitted to the Engineer for review. Shop paint shop drawings will not be reviewed until the final project paint system has been submitted by the Contractor and reviewed by the Engineer.

C. Shop finish coats may be the standard finish as ordinarily applied by the manufacturer if it can be demonstrated to the Engineer that the paint system is equal to and compatible with the paint system specified. However, all pumps, motors and other equipment shall receive at least one field applied finish coat after installation.

3.03 PAINT SCHEDULE

A. The Contractor shall adhere to this paint schedule, providing those paints named or equal. DFT shall mean the minimum dry film thickness per application measured in mils. Products are referenced by numbers listed in Article 2.01 of this Section entitled "Product Listing." The paint schedule identifies the minimum DFT required per coat. If the Contractor does not achieve the specified DFT range in a single coat, it shall provide additional coats as necessary at no additional cost to the Owner.

B. Metal Surfaces, Atmospheric (Exterior) Exposure

1. Existing Metal surfaces exposed to the atmosphere, and that do not come into contact with wastewater or corrosive atmosphere, including the following types of surfaces shall be painted as described below:
   a. Bird deterrent metal framing system
   b. Exposed surfaces of conduit, ductwork, etc.

Surface Preparation: Blast clean in accordance with SSPC-SP5

<table>
<thead>
<tr>
<th>Ferrous Metal</th>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>First -1 coat</td>
<td>115</td>
<td>Aromatic Urethane Zinc Rich</td>
<td>2.0 - 4.0</td>
<td></td>
</tr>
<tr>
<td>Second - 1 coat</td>
<td>123</td>
<td>Polyamide Epoxy</td>
<td>3.0 - 5.0</td>
<td></td>
</tr>
<tr>
<td>Third</td>
<td>105</td>
<td>Polyamidoamine Epoxy</td>
<td>5.0 - 7.0</td>
<td></td>
</tr>
<tr>
<td>Finish - 1 coat</td>
<td>110</td>
<td>Endura Shield</td>
<td>2.0 - 3.0</td>
<td></td>
</tr>
</tbody>
</table>

Min. Total: 15.0 Mils
C. Metal Surfaces, Interior Exposure

1. Existing and proposed interior metal surfaces (non-submerged) that do not come in contact with wastewater or the corrosive atmosphere including the following types of surfaces shall be painted as follows:

a. Pumps, motors, process equipment, machinery, etc.
b. Piping, valves and supports.
c. Miscellaneous steel shapes, angles, rails, etc. including steel pipe support system
d. Exposed surfaces of conduit, ductwork, etc.

Surface Preparation: Blast clean in accordance with SSPC-SP5

<table>
<thead>
<tr>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>First - 1 coat</td>
<td>115</td>
<td>Aromatic Urethane Zinc Rich</td>
<td>2.0 - 4.0</td>
</tr>
<tr>
<td>Second - 1 coat</td>
<td>123</td>
<td>Polyamide Epoxy</td>
<td>3.0 - 5.0</td>
</tr>
<tr>
<td>Finish – 1 coat</td>
<td>105</td>
<td>Polyamidoamine Epoxy</td>
<td>5.0 - 7.0</td>
</tr>
</tbody>
</table>

Min. Total 10.0 Mils

D. Metal Surfaces, Submerged Exposure

1. Metal surfaces that are submerged in water or subjected to gases shall be painted as described below:

Surface Preparation: SSPC-SP5

<table>
<thead>
<tr>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>First – 1 coat</td>
<td>115</td>
<td>Tneme Zinc</td>
<td>3.0 – 3.5</td>
</tr>
<tr>
<td>Stripe coat</td>
<td>121</td>
<td>Modified Polyamine Epoxy</td>
<td>4.0 – 6.0</td>
</tr>
<tr>
<td>First – 1 coat</td>
<td>121</td>
<td>Modified Polyamine Epoxy</td>
<td>4.0 – 6.0</td>
</tr>
<tr>
<td>Finish - 1 coat</td>
<td>121</td>
<td>Modified Polyamine Epoxy</td>
<td>4.0 – 6.0</td>
</tr>
</tbody>
</table>

Min. Total (excluding stripe coat) 18.0 Mils

E. Existing Ductile Iron Pipe, Interior Exposure

1. Ductile iron pipe exterior or interior exposure shall receive the following types of paint:

Surface Preparation: Blast clean in accordance with SSPC-SP5

<table>
<thead>
<tr>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime – 1 coat</td>
<td>122</td>
<td>Aromatic Urethane, zinc rich</td>
<td>2.0 – 4.0</td>
</tr>
<tr>
<td>First - 1 coat</td>
<td>123</td>
<td>Polyamide Epoxy</td>
<td>3.0 - 5.0</td>
</tr>
<tr>
<td>Finish - 1 coat</td>
<td>105</td>
<td>Hi-Build Epoxoline II</td>
<td>5.0 - 7.0</td>
</tr>
</tbody>
</table>

Min. Total 13.0 Mils
F. PVC Pipes, Exterior or Interior Exposure
1. PVC pipes, valves, and accessories, shall receive the following types of paint:
   Surface Preparation: Light sanding
<table>
<thead>
<tr>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>First - 1 coat</td>
<td>105</td>
<td>Hi-Build Epoxoline</td>
<td>2.0 - 3.0</td>
</tr>
<tr>
<td>Finish - 1 coat</td>
<td>110</td>
<td>Endura Shield</td>
<td>2.0 - 3.0</td>
</tr>
</tbody>
</table>
   Min. Total: 4.0 Mils

G. Exterior/Interior of Existing Painted Concrete and Masonry walls.
1. Interior masonry and concrete walls of the pipe gallery and exterior of entire north wall of the Filter Basin Structure shall be painted as described below:
   Surface Preparation: Remove unsound paint, excess mortar, laitance, and efflorescence. Pressure wash with TSP/Chlorine solution and fresh water rinse.
<table>
<thead>
<tr>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surfacer (*)</td>
<td>116</td>
<td>Cementitious Repair Mortar</td>
<td>As req’d</td>
</tr>
<tr>
<td>Surfacer (**)</td>
<td>117</td>
<td>Modified Polyamine Epoxy</td>
<td>As req’d</td>
</tr>
<tr>
<td>Surfacer (***)</td>
<td>102</td>
<td>Inorganic Waterbased Epoxy</td>
<td>As req’d</td>
</tr>
<tr>
<td>First - 1 coat</td>
<td>114</td>
<td>Waterborne Polyamide Epoxy</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>Finish - 1 coat</td>
<td>106</td>
<td>Acrylic Emulsion</td>
<td>7.0 - 9.0</td>
</tr>
</tbody>
</table>
   Min. Total: 10.0 Mils

(*) Surfacer to be applied to fill voids > 1/4-inch deep
(**) Surfacer to be applied to fill voids < ¼-inch deep
(***) Surfacer to be applied to new CMU as required (75-150 sq. ft per gallon)

J. Interior of Existing Concrete ceilings.
Surface Preparation: Remove excess mortar, laitance, and efflorescence. Pressure wash with TSP/Chlorine solution and fresh water rinse.
1. Interior concrete ceiling of the pipe gallery shall be painted as described below:
<table>
<thead>
<tr>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>First - 1 coat</td>
<td>114</td>
<td>Waterborne Polyamide Epoxy</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>Second – 1 coat</td>
<td>107</td>
<td>Acrylic Emulsion</td>
<td>1.0 - 3.0</td>
</tr>
<tr>
<td>Finish - 1 coat</td>
<td>107</td>
<td>Acrylic Emulsion</td>
<td>1.0 - 3.0</td>
</tr>
</tbody>
</table>
   Min. Total: 6.0 Mils

(*) Surfacer shall only be applied to fill voids.
N. Concrete Floor Surfaces

1. Concrete floor surfaces of the pipe gallery shall receive the following:

   Surface Preparation: SSPC-SP7 to meet ICRI-CSP2/3 Condition.

<table>
<thead>
<tr>
<th>Application</th>
<th>No.</th>
<th>Description</th>
<th>DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish - 1 coat</td>
<td>120</td>
<td>Water Repellent</td>
<td>150 SFT/Gal</td>
</tr>
</tbody>
</table>

3.04 PAINTING

A. All paint shall be applied by experienced painters with brushes or other applicators acceptable to the Engineer.

B. Paint shall be applied without runs, sags, thin spots, or unacceptable marks. Paints shall be applied at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. Additional coats of paint shall be applied, if necessary, to obtain thickness specified.

C. Paint shall be applied with spraying equipment only on those surfaces approved by the Engineer. If the material has thickened or must be diluted for application by spray gun, each coat shall be built up to the same film thickness achieved with undiluted brushed-on material. Where thinning is necessary, only the products of the particular manufacturer furnishing the paint shall be used; and all such thinning shall be done in strict accordance with the manufacturer's instructions, as well as with the full knowledge of the Engineer.

D. Surfaces not accessible to brushes or rollers may be painted by spray by dauber or sheepskins and paint mitt. If any of these methods is to be used, it shall be done in strict accordance with the manufacturer's instructions, as well as with the full knowledge of the Engineer.

E. Drying Time

1. A minimum of twenty-four hours drying time shall elapse between application of any two coats of paint on a particular surface unless shorter time periods are a requirement of the manufacturer or specified herein. Longer drying times shall be required for abnormal conditions as defined by the manufacturer.

F. Weather Restrictions

1. No painting whatsoever shall be accomplished in rainy or excessively damp weather when the relative humidity exceeds 85 percent, or when the general air temperature cannot be maintained at 50 degrees Fahrenheit or above throughout the entire drying period. No paint shall be applied when it is expected that the relative humidity will exceed 85 percent or that the air temperature will drop below 50 degrees Fahrenheit within 18 hours after the application of the paint.

2. Dew or moisture condensation should be anticipated; and if such conditions are prevalent, painting shall be delayed until midmorning to be certain the surfaces are dry. The day's painting shall be completed well in advance of the probable time-of-day when condensation will occur.
G. Inspection of Surfaces

1. Each and every field coat of priming and finishing paint shall be inspected by the Engineer or its authorized representative before the succeeding coat is applied. The Contractor shall follow a system of tinting successive paint coats so that no two coats for a given surface are exactly the same color. Areas to receive black protective coatings shall in such cases be tick marked with white or actually gauged as to thickness when finished.

H. Before application of the prime coat and each succeeding coat, any defects or deficiencies in the prime coat or succeeding coat shall be corrected by the Contractor before application of any subsequent coating.

I. Samples of surface preparation and of painting systems shall be furnished by the Contractor to be used as a standard throughout the job, unless omitted by the Engineer.

J. When any appreciable time has elapsed between coatings, previously coated areas shall be carefully inspected by the Engineer, and where, in its opinion, surfaces are damaged or contaminated, they shall be cleaned and recoated at the Contractor’s expense. Recoating times of manufacturer’s printed instructions shall be adhered to.

K. Coating thickness shall be determined by the use of a properly calibrated "Nordson-Mikrotest" (or equal) dry mil thickness gauge.

L. The Contractor shall provide free of charge to the Engineer two new "Nordson-Mikrotest" dry film gauges to be used to inspect coating by Engineer and Contractor. One gauge may be used by Contractor and returned each day to the Engineer. Engineer will return gauges to Contractor at completion of job.

M. Special Areas

1. All surfaces which are to be installed against concrete, masonry etc., and will not be accessible for field priming and/or painting shall be back primed and painted as specified herein, before erection. Anchor bolts shall be painted before the erection of equipment and then the accessible surfaces repainted when the equipment is painted.

N. Special attention shall be given to insure that edges, corners, crevices, welds and rivets receive a film thickness equivalent to that of the adjacent painted surfaces.

O. Safety

1. Respirators shall be worn by persons engaged or assisting in spray painting. The Contractor shall provide ventilating equipment and all necessary safety equipment for the protection of the workmen and the Work.

P. Quality Workmanship

1. The Contractor shall be responsible for the cleanliness of its painting operations and shall use covers and masking tape to protect the Work whenever such covering is necessary, or if so requested by the Owner. Any unwanted paint shall be carefully removed without damage to any finished paint or surface. If damage does occur, the entire surface, adjacent to and including the damaged area, shall be repainted without visible lapmarks and without additional cost to the Owner.
Q. Painting found defective shall be scraped or sandblasted off and repainted as the Engineer may direct. Before final acceptance of the Work, damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.

R. Any pipe scheduled to be painted and having received a coating of a tar or asphalt compound shall be painted with two coats or "Intertol Tar Stop", "Tnemec Tar Bar" or equal before successive coats are applied in accordance with the paint schedule.

3.05 SCHEDULE OF COLORS

A. All colors shall be as designated by the Engineer at the shop drawing review. The Contractor shall submit color samples including custom color choices as required to the Engineer as specified in Article 1.04 of this Section. The Contractor shall submit suitable samples of all colors and finishes for the surfaces to be painted, or on portable surfaces when required by the Engineer. The Engineer shall decide upon the choice of colors and other finishes when alternates exist. No variation shall be made in colors without the acceptance from the Owner. Color names and/or numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

3.06 COLOR CODING AND LETTERING OF PIPING

A. In general, the pumps and equipment shall be painted the same color as the piping system to which it is connected unless otherwise directed by the Engineer. Where colors are not designated for piping and conduit systems they will be selected during the shop drawing review from the paint manufacturer's standard color charts.

B. Lettering of Piping: The Contractor shall apply identification titles and arrows indicating the direction of flow of liquids to all types and sections of all new and existing plant piping. Titles shall be as directed by the Engineer. Identification titles shall be located midway between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located each fifteen feet in pipe length and shall be properly inclined to the pipe axis to facilitate easy reading. Titles shall also appear directly adjacent to each side of any wall or slab the pipeline passes through.

C. The titles shall be painted by use of stencils and shall identify the contents by complete names at least once in each area through which it passes and thereafter be abbreviated. Stencils shall be provided for titles and abbreviations listed in Table 09850-1.

| TABLE 09850-1

<table>
<thead>
<tr>
<th>PIPE IDENTIFICATION SCHEDULE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPE TITLE</td>
</tr>
<tr>
<td>FILTER INFLUENT</td>
</tr>
<tr>
<td>FILTER DRAIN</td>
</tr>
<tr>
<td>FILTERED WATER</td>
</tr>
<tr>
<td>BACKWASH SUPPLY</td>
</tr>
<tr>
<td>BACKWASH WASTE</td>
</tr>
<tr>
<td>SURFACE SCOUR SUPPLY</td>
</tr>
</tbody>
</table>

* Refer to Section 15000, Pipe Schedule for additional pipe titles
D. Title color shall be black or white as directed and shall have an overall height in inches in accordance with Table 09850-2. Letter type shall be Helvetica Medium upper case. The manufacturer's instructions shall be followed in respect to storage, surface preparation and application. For piping less than 3/4-inch diameter, the Contractor shall furnish and attach corrosion resistant color tags with the required lettering.

**TABLE 09850-2**

**HEIGHT OF PIPING LETTERING**

<table>
<thead>
<tr>
<th>DIAMETER OF PIPE OR PIPE COVERING</th>
<th>HEIGHT OF LETTERING</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 to 1-1/4 inches</td>
<td>1/2 inch</td>
</tr>
<tr>
<td>1-1/2 to 2 inches</td>
<td>3/4 inch</td>
</tr>
<tr>
<td>2-1/2 to 6 inches</td>
<td>1-1/4 inches</td>
</tr>
<tr>
<td>8 to 10 inches</td>
<td>2-1/2 inches</td>
</tr>
<tr>
<td>Over 10 inches</td>
<td>3-1/2 inches</td>
</tr>
</tbody>
</table>

Letter type shall be Helvetica Medium upper case. The manufacturer's instructions shall be followed in respect to storage, surface preparation and application.

For piping less than 3/4-inch diameter (as identified in Table 09850-2), the Contractor shall furnish and attach corrosion resistant color tags with the required lettering.

E. Banding: Where bands are indicated in the Pipe Color Coding Schedule (Table 09850-3), the pipe is to be painted for its full circumference with a band of the color indicated. The bands shall be six inches wide, neatly made by masking, and spaced eight feet apart. The Contractor may substitute precut prefinished bands on piping subject to acceptance by the Engineer. Where banded pipes are running concurrently in a space, bands shall be located so that on adjacently located pipes, bands will be grouped beside each other.

F. The Contractor shall paint all piping, valves, equipment, exposed conduits and all appurtenances which are integral to a complete functional mechanical pipe and electrical conduit system, in accordance with Table 09850-3 entitled "Pipe Color Coding Schedule". Where colors are not designated for piping and conduit systems they will be selected during the shop drawing review from the paint manufacturer's standard color charts.

**TABLE 09850-3**

**PIPE COLOR CODING SCHEDULE**

<table>
<thead>
<tr>
<th>EQUIPMENT/PIPING</th>
<th>SUGGESTED COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILTER INFLUENT</td>
<td>TBD</td>
</tr>
<tr>
<td>FILTER DRAIN</td>
<td>TBD</td>
</tr>
<tr>
<td>FILTERED WATER</td>
<td>TBD</td>
</tr>
<tr>
<td>BACKWASH SUPPLY</td>
<td>TBD</td>
</tr>
<tr>
<td>BACKWASH WASTE</td>
<td>TBD</td>
</tr>
<tr>
<td>SURFACE SCOUR SUPPLY</td>
<td>TBD</td>
</tr>
</tbody>
</table>
3.07 ANSI AND OSHA SAFETY COLORS

A. Items specified in the following subsections shall be safety color coated as specified. ANSI colors shall conform with (OSHA) ANSI Z53.1 and latest revisions. Materials shall be compatible with the system specified for the equipment, concrete, etc. Where a coating system is not specified and safety colors are required, the items shall be coated with a primer and two coats Glid-Guard Alkyd Industrial Enamel, or equal.

B. Red: Items listed in ANSI Z53.1, Section 2.1 shall be painted ANSI Red. In general, these items shall include fire protection equipment and apparatus; wall mounted breathing apparatus, danger signs and locations; and stop bars, buttons or switches. In addition, all hose valves and riser pipes, fire protection piping and sprinkler systems, and electrical stop switches shall be painted ANSI Red.

C. Orange: Items listed in ANSI Z53.1, Section 2.2 shall be painted ANSI Orange. ANSI Orange shall be used as a basic color for designating dangerous parts of machines or energized equipment which may cut, crush, shock, or otherwise injure and to emphasize such hazards when enclosure doors are open or when gear belt or other guards around moving equipment are open or removed, exposing unguarded hazards. In addition, moving machinery having a linear or peripheral speed in excess of 10 feet per minute, which is either inadequately guarded due to physical problems or may be operated with the guard removed, rims or sprockets, gears, pulleys, etc.; crossheads of large engines and compressors; and flywheels shall be coated ANSI Orange.

D. Yellow: Items listed in ANSI Z53.1, Section 2.3 shall be painted ANSI Yellow. Yellow shall be the basic color for designating caution and for marking physical hazards such as striking against, stumbling, falling, tripping, and "caught in between". In addition, an 8-inch wide strip on the top and bottom tread of stairways shall be coated.

E. Green: Items listed in ANSI Z53.1, Section 2.4 shall be painted ANSI Green. Green shall be the basic color for designating safety and the location of first-aid equipment. In general, gas masks, first-aid kits, eye wash facilities, and safety deluge showers shall be coated with ANSI Green.

F. Blue: Blue shall be used for designating caution, limited to warning against the starting, the use of, or the movement of equipment under repair or being worked upon.

G. Purple: Items listed in ANSI Z53.1, Section 2.5 shall be painted ANSI Purple. In general, atomic sludge density meters shall be coated ANSI Purple.

3.08 WORK IN CONFINED SPACES

A. The Contractor shall provide and maintain safe working conditions for all employees. Fresh air shall be supplied continuously to confined spaces through the combined use of existing openings, forced-draft fans, or by direct air supply to individual workers. Paint fumes shall be exhausted to the outside from the lowest level in the contained space.

B. Electrical fan motors shall be explosion proof if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done.

3.09 CLEANING

A. The buildings and all other Work area shall be at all times kept free from accumulation of waste material and rubbish caused by the Work. At the completion of the painting, all tools,
equipment, scaffolding, surplus materials, and all rubbish around the inside the buildings shall be removed and the Work left broom clean unless otherwise specified.

- END OF SECTION -
SECTION 11000 - EQUIPMENT GENERAL PROVISIONS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.

B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise specified or shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals
B. Metal Fabrications
C. Painting
D. Pumps, General
E. Piping
F. Valves and Appurtenances
G. Division 16-Electrical
H. Division 17-Instrumentation

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are specified in the Section entitled "Reference Standards".

B. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as specified in each Section of these specifications:

   2. American Public Health Association (APHA).
   4. American Society of Mechanical Engineers (ASME).
   5. American Water Works Association (AWWA).
6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).


11. Manufacturer's published recommendations and specifications.


15. American Standards Association (ASA).


17. Anti-Friction Bearing Manufacturers Association, Inc. (AFMBA).

18. Underwriters' Laboratories, Inc. (UL).

C. The following standards have been referred to in this Section of the specifications:

- ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
- ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
- ANSI B46.1 Surface Texture
- ANSI S12.6 Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
- ANSI/ASME B1.20.1 General Purpose Pipe Threads (Inch)
- ANSI/ASME B31.1 Power Piping
- ANSI/AWWA D100 Welded Steel Tanks for Water Storage
- AWWA C206 Field Welding of Steel Water Pipe
- ASTM A 48 Specification for Gray Iron Castings
1.04 SUBMITTALS

A. Shop Drawings: The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the Engineer in accordance with the Section entitled "Submittals".

B. Tools: The Contractor shall supply one complete set of special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright, finished heads and with work faces dressed to fit nuts. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover.

C. Spare Parts: The Contractor shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment. After review by the Engineer, Contractor shall furnish such spare parts suitably packaged and labeled with the part number, manufacturer’s description, and the associated equipment number. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the Owner, only, after expiration of the guaranty period.

D. Torsional Analysis: The Contractor shall furnish to the Engineer a torsional analysis submitted in accordance with the Section entitled "Submittals", where specified.

1.05 QUALITY ASSURANCE

A. Inspection, Startup, and Field Adjustment: The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment who shall visit the site of Work to perform the following tasks:

1. Assist the Contractor in the installation of the equipment.
2. To inspect, check, adjust if necessary and approve the equipment installation.
3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
5. To instruct Owner personnel in the operation and maintenance of the equipment. Instruction shall be performed separately for all three shifts of Owner operating personnel and shall include step-by-step trouble shooting procedures with all necessary test equipment.
6. Where reference is made to a day, it shall be construed to mean up to 24 hours or part thereof, as necessary.
B. **Costs:** The costs of all inspection, startup, testing, adjustment, and instruction work performed by said factory-trained representatives shall be borne by the Contractor. When available, the Owner’s operating personnel will provide assistance in the field testing.

C. **Public Inspection:** It shall be the responsibility of the Contractor to inform the local authorities, such as building and plumbing inspectors, fire marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, etc., to obtain all required permits and certificates, and pay all fees.

D. **Tolerances:** Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16 of an inch for members 30 feet or less in length, and not greater than 1/8 of an inch for members over 30 feet in length.

E. **Machine Finish:** The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

F. **Manufacturer’s Experience:** Unless otherwise directed by the Engineer, all equipment furnished shall have a record of at least 5 years of successful, trouble-free operation in similar applications, from the same manufacturer.

1.06 **CLEANUP**

A. After completion of the installation and testing, the Contractor shall remove all debris from the site, clean all equipment and controls, and hand over its work in perfect operating condition.

1.07 **GUARANTEES, WARRANTIES**

A. After completion, the Contractor shall furnish to the Owner the manufacturer’s written guarantees that the equipment will meet all requirements of these specifications. The Contractor shall also furnish the manufacturer’s warranties as published in its literature and as specified. All warranties shall begin at the time of acceptance of the equipment by the Owner.
2.01 GENERAL REQUIREMENTS

A. **Noise Level:** When in operation, no single piece of equipment shall exceed the OSHA noise level requirements for a one hour exposure.

B. **Service Factors:** Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise specified, the following load classifications shall apply in determining service factors:

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Load Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Types</td>
<td>Uniform</td>
</tr>
</tbody>
</table>

C. For service factors of electric motors, see Section entitled "Electric Motors". Where load classifications are not specified, best modern practice shall be used.

D. **Welding:** Unless otherwise specified or shown, all welding shall conform to the following:

1. ANSI/AWWA D100.
2. AWWA C206.
3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
4. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same. Contractor shall submit current certification of every welder's qualification for Engineer's approval at least fifteen (15) days before any welding work.
5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

E. **Protective Coatings:**

1. All equipment shall be painted or coated in accordance with the Section entitled "Painting", unless otherwise approved by the Engineer. Non-ferrous metal and corrosion-resistant steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.
2. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance.

F. Protection of Equipment: All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times.

G. Equipment having moving parts such as gears, electric motors, etc. and/or instruments, control panels, switchgear shall be stored in a temperature and humidity controlled building until such time as the equipment is to be installed.

H. Equipment with electric motors having space heaters shall have the space heaters energized unless stored in a temperature and humidity controlled building. Space heaters shall be energized at the time of installation and maintained until acceptance of the equipment.

I. For exterior storage of fabricated products, the items shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering; ventilation shall be provided to avoid condensation.

J. Identification of Equipment Items: Each item of equipment shipped shall have a legible identifying mark corresponding to the equipment number shown or specified for the particular item.

K. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations.

L. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the final reviewed and processed shop drawings.

2.02 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, and seismic loads. A seismic force of 0.25 of gravity shall be assumed for this purpose, unless otherwise required by local conditions.

B. Equipment Foundations: Equipment foundations shall be as per manufacturer's written recommendations. All mechanical equipment, tanks, control cabinets, etc. shall be mounted on minimum 4-inch high concrete bases, as shown on standard structural details, unless otherwise shown or specified. Foundation drawings shall be submitted to the Engineer for review in accordance with the requirements of the Section entitled "Submittals".
2.03 PIPE HANGERS, SUPPORTS, AND GUIDES

A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with the requirements of the Section entitled, "Pipe Supports".

2.04 FLANGES AND PIPE THREADS

A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; unless otherwise shown. All pipe threads shall be in accordance with ANSI/ASME Bl.20.1, in accordance with requirements of the Section entitled "Piping, General".

2.05 COUPLINGS

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings shall be furnished and installed.

B. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Taperlock bushings may be used to provide for easy installation and removal on shafts of various diameters.

D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

E. Flexible couplings shall be as manufactured by Woods Corp., or equal.

2.06 SHAFTING

A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as shown or specified unless furnished as part of an equipment assembly.

1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.

2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.

3. Corrosion-resistant shafting shall be stainless steel or monel, whichever is most suitable for the intended service.
C. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with two sets of universal type couplings shall be provided.

2.07 **BEARINGS**

A. **General:** Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.

C. All re-lubricatable type bearings shall be equipped with hydraulic grease fittings in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. All lubricated-for-life bearings shall be factory lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. **Bearing Life:** Except where otherwise specified or shown, all bearings shall have a minimum B-10 life expectancy of 60,000 hours.

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.08 **GEARS AND GEAR DRIVES**

A. Unless otherwise specified, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum B-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically accepted by the Engineer.

B. All gear speed reducers or increasers shall be of the enclosed type, oil or grease lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.

C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.
E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.

F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the Contractor shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.09 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains and meet ANSI Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

2.10 SPROCKETS

A. **General**: Sprockets shall be used in conjunction with all chain drives and chain-type material handling equipment.

B. **Materials**: Unless otherwise specified, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.

2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.

3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. All sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with keyseat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.

F. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.
2.11 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.

B. Unless otherwise specified, sheaves shall be machined from the finest quality gray cast iron.

C. All sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper lock or QD bushings as required.

E. Finish bored sheaves shall be furnished complete with keyseat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.12 DRIVE GUARDS

A. All power transmission, prime movers, machines, and moving machine parts shall be guarded to conform with the OSHA Safety and Health Standards (29CFR1910). Where required for lubrication or maintenance, guards shall have hinged access doors.

2.13 INSULATING CONNECTIONS

A. General: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section entitled "Piping, General".

2.14 GASKETS AND PACKING

A. Gaskets shall be in accordance with the requirements of the Section entitled "Piping, General".

B. Packing around check valve stems shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.

C. Packing around rotating shafts (other than check valve stems) shall be "O"-ring seals, or mechanical seals, as recommended by the manufacturer and accepted by the Engineer.

2.15 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.
2.16 SAFETY REQUIREMENTS

A. Where work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with acceptable breathing apparatus.

2.17 OVERLOAD PROTECTION

A. General: Unless otherwise specified in individual equipment Sections, all major equipment drives shall be provided with mechanical or electrical overload protection device as specified in the following paragraphs.

B. Mechanical System: The overload protection shall be a mechanical device to provide for reliable protection in the event of excessive overload. It shall be a ball detent type designed for long-term repeatability and life. It shall be infinitely adjustable by a single adjusting nut. Once set, it shall be tamper proof, and incorporate a torque monitoring and control system. It shall activate an alarm set for 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque. A visual torque indication shall be provided and oriented so that it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque. The design of the torque limiter should initiate the mechanical disengagement of the drive upon overload. Each unit shall be suitable for outdoor/corrosive environments with a protective finish, corrosion inhibiting lubricants and a stainless steel cover.

C. Electronic System: As an alternative to the mechanical system, the overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpm's, one level of overload and two levels of overload of the drive system. It shall incorporate a time-delay for start-up and a voltage monitoring and compensation circuit for up to +/-15 percent variation.

D. The overload device shall have an enclosure suitable for outdoor installation at temperatures of 0-70°F, and relative humidity up to 100 percent, unless unit is in an air conditioned environment where 95 percent shall be acceptable. A visual torque dial shall be provided and oriented so that it can be easily read from the walkway.

E. The torque monitoring system shall be calibrated to: alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down the motor at maximum continuous running torque of the equipment. The system shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.

F. Manufacturer or Equal:

1. American Autogard Corporation
2. Ferguson Machine Company
PART 3 - EXECUTION

3.01 INSTALLATION

A. General: All equipment shall be installed in accordance with acceptable procedures submitted with the shop drawings and as indicated on the Drawings, unless otherwise accepted by the Engineer.

B. Alignment: Equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The installation work shall include furnishing the necessary oil and grease for initial operation.

D. Couplings: The Contractor shall install the equipment in accordance with the equipment manufacturer's printed recommendations.

E. Insulating Connections: All insulating connections shall be installed in accordance with the manufacturer's printed recommendations.

F. Pipe Hangers, Supports and Guides: Hangers shall be spaced in accordance with ANSI/ASME B.31.1 and with tables in the Section entitled "Pipe Supports".

3.02 PROTECTIVE COATING

A. All exposed materials, except corrosion resistant metals which have not been shop painted shall be field coated as specified in the Section entitled "Painting". Shop painted items which suffered damage to the shop coating shall be touched up as specified in the referenced "Painting" Section.

-END OF SECTION-
SECTION 11300 – AIR COMPRESSOR

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place into satisfactory operation one (1) air compressor system as shown on the Drawings, specified and required for a complete and operable installation.

B. The air compressor shall consist be an electric driven, stationary, two-stage, splash lubricated, simplex, reciprocating compressor. The motor, compressor and controls shall be mounted integral with the vertical air receiver. The compressor shall include an air-cooled aftercooler and all required piping, valves, starters, automatic start/stop controls and associated appurtenances as shown in the Contract Drawings and described herein for a complete and operable installation.

C. For compatibility of equipment and controls, all air compressor equipment shall be designed and furnished as a package unit by the compressor manufacturer. The Contractor shall be responsible for providing a fully functioning system.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals
B. Materials and Equipment
C. Equipment Testing and Plant Start-up
D. Division 5 - Metals
E. Painting
F. Section 11000 - Equipment General Provisions
G. Division 15 - Mechanical
H. Division 16 - Electrical
I. Division 17 - Instrumentation

1.03 SUBMITTALS

A. Shop Drawings: Submit for review detailed shop drawings and product data of equipment under provisions of the Section entitled “Submittals”. Shop drawings shall include the following:

1. Manufacturer’s literature;
2. Equipment dimensions;
3. Manufacturer’s installation drawings.
B. **Operation and Maintenance Manuals**: Submit operation and maintenance manuals under provisions of the Section entitled “Submittals”.

C. **Field Performance Test Report**: In accordance with the requirements specified herein and the requirements specified in the Section titled “Equipment Testing and Plant Start-up” submit written report that includes a certification that the system has been properly installed, tested, and adjusted; that the system operates as specified or as required; and that all controls and protective devices operate properly, including date of final acceptance test, as well as a listing of all persons present during the tests.

1.04 **ACCEPTABLE MANUFACTURERS**

A. The compressed air equipment shall be manufactured by Ingersoll Rand or equal. All accessory equipment, such as controls, aftercoolers, etc. shall be supplied by the air compressor manufacturer.

**PART 2 -- PRODUCTS**

2.01 **AIR COMPRESSOR PACKAGE**

A. **General**: Air compressors and associated motor shall be mounted on the air receiver, and the complete compressed air system shall consist, controls, motor starter, control panel, piping, wiring and all other accessories required to provide a complete package unit ready for installation and operation.

B. **Air Compressor Package**: Requirements for the air compressor shall be as follows:

1. Number of Units: 1
2. Equipment Tag No.: CMPR 73100
3. Maximum Discharge Pressure: 175 psi
4. Number of Stages: 2
5. Free air capacity at max pressure: 16.8 CFM
6. Motor nameplate horsepower: 5 HP
7. Motor Type: Open Drip Proof (ODP)
8. Power supply Voltage/Phase/Hertz: 460 / 3 / 60
9. Air receiver orientation: Vertical
10. Air receiver volume: 80 gallons

C. **Air Receiver**: The receiver shall be designed and constructed in accordance with the ASME Boiler and Pressure Vessel Code and shall bear the code stamp.

D. **Manual Drain Valve**: Receiver shall be equipped with a manual drain valve for isolation of the drain piping.
E. **Drain Piping:** Drain piping from the receiver shall extend to the nearest floor drain selected by the Owner. The floor drain will be within 100 feet of the proposed equipment location. The Contractor shall furnish and install the drain piping.

F. **Controls:** The air compressor system shall include local controls that automatically start and stop the compressor to maintain a setpoint pressure in the air receiver.

G. **Coatings:** The air compressor receiver, motor and compressor shall have the manufacturer's standard factory applied coating.

### 2.02 AUTO DRAIN VALVE

A. Furnish and install one auto drain valve with each air compressor.

B. Auto drain valve requirements:

1. Maximum Pressure: 250 PSI,
2. Power supply Voltage/Phase/Hertz: 110 / 1 / 60
3. Drain Rate @ 100 PSI: 1.6 GPM
4. Inlet/Outlet Connection: 1/2 inch
5. Body Material: Low Lead Brass
6. Control: Adjustable timer (30 second to 45 minutes)

C. Auto drain valve shall be manufactured by Ingersoll Rand, or equal.

### 2.03 PRESSURE REDUCING VALVE

A. **Air Pressure Reducing Valve:**

1. Manufacturer and Product: Type D50 as manufactured by Spence Engineering Company, Inc., Or Equal
2. Type: Direct acting and suitable for steam, water or gas.
3. Inlet/Outlet Diameter: 1/2-inch FNPT
4. Body Material: Stainless steel ASTM 743 CF-8M
5. Valve Trim: stainless steel
6. Gasket: Teflon
7. Outlet Pressure Regulation Range: 30 to 140 psig (set to 90 psig)
8. Adjustment: Valve to have a standard aspirator to allow for outlet pressure adjustment
2.04  FILTER / REGULATOR

A. Manufacturer and Product, or equal:
   1. Wilkerson Model B18
   2. Speedaire by Dayton Model 4ZK93

B. Style: Piggyback Style.

C. Inlet and Outlet Port Size: ½-inch Female NPT

D. Housing Material: Polycarbonate.

E. Adjustment Range: 5 - 125 psig.

F. Minimum Air Flow: 80 CFM

G. Filter Rating: 5 Microns

H. Drain Type: Automatic

I. Supply filter / regulator with integral pressure gauge, 0 to 160 PSIG, 1-1/2” Dial Face, 1/4 NPT.

J. Supply filter / regulator with body type wall mounting brackets.

2.05  PIPING AND ACCESSORIES

A. Piping integral to the air compressor package shall be designed by the Air Compressor Manufacturer and as required for the intended service. Air piping outside of the scope of supply of this Section shall be furnished and installed by the Contractor per the applicable portions of Division 15.

B. Accessories, such as valves, blowoff silencers, automatic drain valves, safety valves, pressure gauges, etc. shall all be designed, selected and furnished by the Air Compressor Manufacturer as required to provide an operable system.

2.06  STARTUP AND MAINTENANCE KITS

A. General: Kits shall be shipped in a wooden or plastic box protected from damage, moisture and dirt accumulation during extended storage. The box shall be constructed with hinged cover, hasp, and lock, and designed as a permanent storage enclosure for the spare parts.

B. Startup Kit: Furnish one startup kit. The startup kit shall include all necessary lubricants and two air filters. The kit shall include product data sheets for the materials supplied.

C. Maintenance Kit: Furnish one maintenance kit. The maintenance kit shall include all necessary lubricants, air filter elements, head gasket, manifold gaskets, unloader gasket, o-rings and a maintenance reminder sticker.
PART 3 -- EXECUTION

3.01 MANUFACTURER’S FIELD SERVICES

A. For each equipment supplied under this Section, field services shall include the following site visits:

<table>
<thead>
<tr>
<th>Service</th>
<th>Number of Trips</th>
<th>Number of Days per Trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Supervision and Equipment Testing: Duties include:</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Check and supervise the equipment installation</td>
<td></td>
<td></td>
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<tr>
<td>Supervise functional testing and adjustments of the equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observe equipment during the operational testing phase and prepare field performance test report</td>
<td></td>
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<tr>
<td>O&amp;M Training: Instruct the Owner’s personnel in proper operation and maintenance of the equipment.</td>
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</tbody>
</table>

3.02 INSTALLATION

A. The Contractor shall install the compressed air system in accordance with the manufacturer’s instructions.

B. The compressor package shall be installed on a new concrete pad furnished by the Contractor.

C. The Contractor shall coordinate with the equipment manufacturer to ensure that the concrete equipment pad is properly sized. The concrete pad shall be finished smooth and level to the satisfaction of the Engineer. Anchor the compressor to the pad with Type 316 stainless steel anchor bolts.

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall remove the contents of each existing filter, including surface scour, media, underdrains and ancillary supports and equipment, as necessary to result in a suitably clean filter box, acceptable to the proposed Filter Underdrain, Supplier, for installation of new filter units as specified herein.

B. In this effort, the Contractor shall visit the site, perform exploratory work and otherwise meet and coordinate with the Plant Staff and Filter Underdrain Supplier to verify the actual content, construction of the existing filter units, properly coordinate shutdowns, demolition, disposal and installation of all new filter improvements.

C. The existing filters are covered with screen enclosures that shall remain in place at all times during construction. Therefore, the Contractor shall plan its work as necessary to ensure that the screen is not removed / damaged – except at times when materials/equipment required for the Work must be transferred from the exterior to the interior of the enclosed area.

D. The Contractor shall furnish, deliver, install, test and place in satisfactory operation the underdrain system for four (4) filters, complete with all necessary accessories at the locations shown on the Drawings and as specified herein.

E. All equipment and materials used in contact with the water shall meet NSF Standard 61.

F. All of the equipment described in this section shall be supplied by F.B. Leopold Company, Severn Trent Water Purification, Inc., or equal.

G. The Contractor shall be responsible for coordinating all equipment, materials and services required under this Contract for proper installation and operation of the filters rehabilitated. Coordination will be required during demolition, construction, start-up and testing.

H. It is the intent of this Specification is to obtain an installation complete in every necessary detail whether or not covered by the Specification. Any omission of required equipment from the Specification shall not relieve the manufacturer of its responsibility to satisfy this intent.

I. Reference the Section entitled “Summary of Work” for construction sequencing restrictions applicable to this Work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Hydrostatic Testing of Structures

B. Summary of Work

C. Maintenance of Utility Operations during Construction

D. Stainless Steel Pipe
E. Pipe Supports

F. Filter Basin Interior Waterproofing

G. Filter Media and Gravel

H. Surface Wash Agitator System

I. Demolition of Existing Facilities

J. Equipment Testing and Plant Startup

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. NSF Standard 61 Drinking Water System Components - Health Effects

1.04 SUBMITTALS

A. The Contractor shall submit complete Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified in accordance with sections entitled “Materials and Equipment” and “Submittals”.

B. **Shop Drawings:** Required information shall include manufacturer’s catalog information, descriptive literature, specifications, materials of construction and supports, headloss data for backwash, structural design calculations, complete installation and adjustment instructions and recommendations, flow distribution calculations, certification of compatibility of the underdrain system with the filter media specified in the Section entitled “Filter Media and Gravel”, NSF-61 certification of all underdrain components, details for installing reinforcing and other items to be embedded in concrete. Shop drawings shall show all important details of construction, dimensions, and location of endplates, bridging, anchorage and all other data which in the judgment of Engineer is necessary to demonstrate conformance with all requirements of the Contract Documents.

C. **Certificates:** The Contractor shall submit certificate of factory tests and test results prior to delivery of underdrains. Prior to shipment from the factory, one (1) out of every 50 underdrain blocks shall be tested for headloss and uniform dispersion of water. A full length lateral shall be tested in a test cell capable of isolating and physically measuring flow rate at 2-feet intervals. The results of the headloss and dispersion tests shall be within 10 percent of the manufacturer’s published values. Certification shall include that the underdrain system has been designed to resist all loads specified, implied, and reasonably anticipated.

D. **Schedule:** The Contractor shall submit a schedule of work for approval prior to commencement of work.

E. **Testing Procedure:** The Contractor shall submit detailed hydraulic test and start-up procedures as obtained from the underdrain manufacturer.

F. **Performance Affidavit:** Contractor shall provide manufacturer’s affidavit of proper installation and performance to the Owner upon completion of successful testing.

G. Two alternative filter designs are specified herein.
H. To facilitate generation of the contract drawings, the filter structure design shows a central sump per F.B. Leopold Supplier requirements.

I. The Contractor’s proposed Supplier shall have unit responsibility for reviewing the contract drawings and determining any proposed revisions needed for the central sump or proposed structure, ancillary equipment and materials to properly fit / accept the Suppliers equipment.

J. In cases, where revisions are recommended, the Supplier shall prepare revised drawings and meet with the Engineer to reach agreement as to any revisions that are to be incorporated into the Work. All such efforts, and any resulting modifications to structures, equipment and piping shall be at no additional costs to the Owner. In addition, Engineer participation in reviews shall be subject to conditions noted in the Section entitled “Submittals”.

K. In addition, all revisions shall be submitted under the seal of a Professional Engineer Registered in the State of Florida. The Supplier shall also assume responsibility for coordinating with the Contractor and fabricating the proper equipment and forming and casting proper structures to accept the Suppliers equipment, while maintaining the general intent of the design documents.

1.05 RESPONSIBILITIES AND GUARANTEE

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer’s recommendations.

B. The underdrain manufacturer shall guarantee to the Contractor and Owner compatibility of the underdrain system with the specified filter media and surface wash system. The underdrain manufacturer shall guarantee proper performance of the underdrain/media system with respect to influent and backwash flow distribution, short circuiting, proper cleaning of the media, plugging and related operational concerns.

C. The underdrain manufacturer shall be fully responsible for the structural design and integrity of the underdrain system including all anchorage and connections. The underdrain manufacturer shall warrant the underdrain blocks for materials and workmanship for a period of two (2) years after the completion of the project. Warranty shall be submitted with the Shop Drawings.

1.06 MANUFACTURER’S SERVICE REPRESENTATIVE

A. The services of a qualified Leopold technical representative who shall adequately supervise the installation and testing of all equipment furnished under this contract and instruct the Owner’s operating personnel in its maintenance and operation. The services of the manufacturer’s representative shall be provided for a period of not less than seven (7) days as follows:

   1. One (1) trip of at least three (3) days (8 hrs/day) to instruct the Contractor’s personnel on the proper installation technique of the underdrain system, including certification of the installation.
2. Four (4) trips of at least four (4) days (8 hrs/day) to complete underdrain system performance testing including instructing the Owner’s personnel in the proper operation and maintenance of the underdrain system.

B. The times specified are exclusive of travel to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

C. Any additional time required to achieve successful installation shall be at the expense of the Contractor.

D. Underdrain manufacturer’s services shall be at such times as requested by the Contractor and the Owner.

1.07 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Place or store underdrains and specialties only in designated staging areas shown on the Drawings and approved by the Owner.

B. Store underdrains and specialties off the ground, under ultraviolet-resistant tarps from time of delivery on-site until final installation of the filters.

C. Replace, at no charge to Owner, underdrains and specialties damaged during storage and delivery.

D. Underdrains and specialties are subject to inspection at the Engineer’s or Owner’s request if visual evidence of damage is observed.

1.08 CLEANUP

A. The Contractor shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter underdrain system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow.

B. Backwash water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter bays and flume shall be removed by brooming down and vacuuming.

C. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed.

D. As installation progresses, the Contractor shall ensure partially completed portions of the Work is protected with heavy visqueen or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the filter media is installed.

E. Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with ½-inch minimum plywood sheeting where necessary to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

F. Following installation of the underdrain system and grout curing, the system shall be completely cleaned and washed free of all loose materials and debris prior to placement of the filter media.
PART 2 — PRODUCTS

2.01 GENERAL

A. The filter underdrain system shall be designed and installed to ensure long-term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects that would in time cause loss of efficiency or effectiveness in its operation.

B. The underdrain system shall be designed to allow for the uniform collection of filtered water and uniform distribution of backwash water over the total area of the filter floor.

C. The system shall be designed to avoid localized areas of excessive flow (maldistribution) that may cause mounding, lateral displacement, or other deleterious disturbances in the filter media.

D. To ensure the underdrain will control distribution (limit maldistribution) and not be overpowered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than a 20-inch water column at a backwash flow rate of 20 gpm/sf of filter area when the water temperature is approximately 60°F.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. **Design Flow Rates:** The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:


B. **Flow Distribution:** The filter underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution of water flows during backwash shall not exceed +/- 2 percent of the maximum gpm/sf rates noted above. This shall include maldistribution, due to specific flume arrangement, entry conditions into both flume and underdrain laterals and flow velocities.

C. **Structural Design Requirement:** The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified under the following conditions:

1. The filter underdrain system, including anchorage and supports shall be designed to safely withstand loadings for the specified conditions.

2. The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 600 psf or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of gravel or filter media.

3. The filter underdrain system shall also be designed to withstand a net downward loading of not less than 1,400 psf.

2.03 UNDERDRAIN BLOCKS
A. The individual underdrain blocks shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces. The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface.

B. PVC construction shall not be acceptable.

C. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout. The block size and weight shall permit ease of handling and installation.

D. The block nominal dimensions vary by manufacturer.
   1. F.B. Leopold Company shall be 8-inches high by 11-inches wide by 48-inches long. The weight of the block shall be approximately 19 pounds.
   2. Severn Trent Water Purification, Inc shall be 8-inches high by 17-inches wide by 36-inches long. The weight of the block shall be approximately 25 pounds.
   3. The underdrain system for the filters shall be a dual parallel lateral type whereby feeder and compensating chambers are provided within the cross section of a single block. The cross section of the underdrain shall be so arranged that the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures will not be considered acceptable. The primary chamber should provide at least 30 square inches of cross sectional area per block to reduce flow velocity during backwash.
   4. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall be not less than 7/32 inches diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch. The top of each orifice shall be encircled by a depression approximately 3/8 inch x 3/4 inch, which shall act to prevent the gravel support media from resting directly on and thereby blocking the dispersion orifice.
   5. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of water coverage that direct flow vertically for effective penetration and cleaning of the media.
   6. The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining strips, closures, gaskets shall be the products of a single manufacturer/supplier.

2.04 GROUT RETAINER

A. Grout retaining strips for bridging flume blocks shall be of high-impact polystyrene properly keyed to fit the underdrain blocks to allow adjustment of lateral center-to-center distance without difficulty. Retaining strips shall be supplied by the filter underdrain manufacturer.
2.05 GROUT

A. The grout used in installing the underdrain blocks shall have a minimum compressive strength of 2500 psi after 30 days of curing. Use a grout with one part Portland cement and two parts clean silica sand properly mixed and wetted with a maximum water-cement ratio by weight equal to 0.50 to 0.55 for the base grout and 0.61 to 0.67 for the fill grout.

B. Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become “lumpy” shall not be used. Do not use non-shrink grout.

C. Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Agriculture water with a total dissolved solids of 1000 mg/l or higher, shall not be used.

D. Sand shall be clean and washed masonry sand. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 90% for an average of three samples, or less than 85% for any individual sample. 100% of sand particles shall pass No. 4 sieve and not more than 4% of sand particles shall pass No. 200 sieve.

PART 3 — EXECUTION

3.01 REMOVALS

A. All materials designated for disposal or required to be removed for new installations, such as underdrains, filter media, and piping shall, when released by the Owner, become the Contractor's property and shall be removed from the site to the Contractor's own place of disposal. Items identified by the Owner to be salvaged, shall be removed and given to the Owner.

B. The Contractor shall execute the demolition and removal work to prevent damage or injury to the other parts of the filter. The Contractor shall repair damage done to facilities to remain, or to any property belonging to the Owner in accordance with the procedures acceptable to the Owner.

3.02 INSTALLATION

A. The Contractor shall install the filter underdrain system in strict accordance with the manufacturer's written instructions and recommendations including the manufacturer's installation drawings, written directions provided by the manufacturer's technical representative who is supervising and observing the Work and any additional requirements specified herein. A manufacturer’s representative shall be on site to supervise the underdrain installation for at least one filter.

B. The Contractor shall exercise caution in preparing the filter floor slab and in setting the anchors to assure proper alignment and elevation. Steel anchor rods shall be furnished by the filter manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the Drawings provided. The floor slab shall be screened into a flat level plane and be free of protrusions and depressions.

C. The underdrain laterals shall be set in level rows on a bed of fresh grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer and installed by the Contractor. After all blocks have been set and
carefully aligned, setting the blocks, and the bed of grout is set-up, as soon as possible, grout all spaces between rows and end of blocks and walls so that the entire bed is totally sealed and held firmly in place. Prevent any grout from entering laterals, orifices, IMS cap pores.

D. Allow grout to cure for at least 3 full days before filter media is placed or any functional tests are performed.

E. The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter bay. The joints shall be sealed utilizing one (1) O-Ring seal, bell and spigot type with internal alignment tabs for proper joint alignment, and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation of the laterals.

3.03 PERFORMANCE TESTING

A. The filter underdrain system in each filter bay shall be given a series of visual, qualitative, flow distribution tests to verify that orifices are not clogged with debris and that flow distribution is uniform. These tests shall be performed before the filter media is placed.

B. During each test, the underdrain laterals shall be visually inspected for uniform distribution of water and for any signs of quiescent zones and excessive surface turbulence.

C. Working under the direction of the manufacturer and in the presence of the Owner's designated representative; the Contractor shall conduct underdrain start-up as outlined in the manufacturer's suggested start-up procedure.

D. Following installation of the blocks and prior to the placing of the filter media, independent water backwash tests shall be performed on the completed system. The Contractor shall notify water plant operations personnel and/or the Owner's representative when the filter is ready for backwashing. All backwashing operations shall be conducted by the Owner's staff.

E. Following completion of the manufacturer's suggested underdrain start-up procedure and prior to placement of the media, conduct separate hydraulic tests using rates specified in Article 2.02 under performance requirements for verification of proper underdrain installation.

F. During each test, the underdrain laterals shall be visually inspected for uniform distribution of water and for any signs of quiescent zones and excessive surface turbulence as outlined by the manufacturer's testing procedures.

G. Check for and correct leaks and non-uniform flow of backwash water, structural instability, or other defects.

H. If correction of defects is required, retest independently as necessary until results are acceptable and at no additional cost to the Owner.

I. All water used during underdrain system testing shall be directed to the washwater drain pipe or filter to waste pipe. None of this water should be directed to the filter effluent header pipe to the existing clearwell.
J. The Contractor shall notify the Engineer at least seven (7) days prior to any testing to enable the Engineer to witness the tests.

K. All laboratory costs, labor, power, equipment, water and incidentals required for the performance tests shall be furnished by the Contractor.

3.04 DISINFECTION

A. See the Section entitled “Disinfection and Bacteriological Testing”.

- END OF SECTION -
SECTION 13221 - FILTER BASIN INTERIOR WATERPROOFING

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the supply and proper application of a cementitious crystalline waterproofing to the interior walls of four (4) existing filters, including preparation of all surfaces to be waterproofed as shown in the Drawings and as specified herein.

B. All equipment and materials used in contact with water shall be certified as being in conformance with NSF Standard 61.

C. The Contractor shall be responsible for coordinating all equipment, materials and services required under this Contract for proper installation and operation of the filters rehabilitated. Coordination will be required during demolition, construction, start-up, and testing.

D. The Contractor shall be responsible for coordination between waterproofing materials supplier and applicator, if different.

E. Reference the Section entitled “Summary of Work” for construction sequencing restrictions applicable to this Work.

F. All walls in the Filters shall be visually inspected by the Contractor for structural defects such as honeycombing, rock pockets, faulty construction joints, cracks, leaks, or other unsuitable conditions. This inspection shall occur during the progress of the filter rehabilitation work.

G. Divider walls between Filters will be visually inspected by the Contractor for structural defects such as honeycombing, rock pockets, faulty construction joints, cracks, leaks, or other unsuitable conditions. This inspection shall occur during the progress of the filter rehabilitation work since the filter basin adjacent to the one under rehabilitation will be in operation while the adjacent filter basin is drained.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Summary of Work

B. Division 3 - Concrete

C. Painting

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM C 39-86 – Compressive Strength of Cylindrical Concrete Specimens.


D. CRD C48-73 – U.S. Army Corps of Engineers, Permeability of Concrete.


1.04 SUBMITTALS

A. The Contractor submittal shall include approved manufacturer's product literature, certifications, test data, and affidavits for each type of product required, including all special details, surface preparation, and recommended application procedures in accordance with the Sections entitled “Submittals” and “Materials and Equipment”.

B. Contractor shall provide a copy of manufacturer's representative's report certifying that surfaces to which waterproofing is to be applied are in an acceptable condition to receive same, that materials to be installed comply with specified requirements, and that applicator has the experience to install the materials in accordance with manufacturer's product data.

C. Contractor shall submit an affidavit obtained from the waterproofing applicator stating that all waterproofing products were applied in strict accordance with the approved manufacturers recommended procedures.

D. Contractor shall submit certified test reports for all waterproofing materials to be installed. Testing results shall meet or exceed performance characteristics and testing requirements specified herein. Certification shall be prepared by a licensed and recognized independent testing laboratory meeting the requirements of ASTM E 329 - Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction (latest edition).

E. Contractor shall submit NSF 61 certification of all waterproofing materials and chemicals to be applied to a surface in contact with drinking water.

1.05 RESPONSIBILITIES AND GUARANTEE

A. Provide a written warranty that all work executed under this section will be free from defects in materials, workmanship and free of leaks for a period of five (5) years from date of acceptance, unless resulting from structural defects or causes other than the work of this section. Said defects shall be remedied, by the applicator for the period of the warranty, without additional cost to the Owner. Warranty shall be submitted with the Shop Drawings.

1.06 ACCEPTABLE MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard materials of proven reliability and as manufactured by reputable manufacturers having experience in the production of such materials. The materials furnished shall be installed in accordance with the best practices and methods and shall perform satisfactorily when installed as specified herein and as per manufacturer's recommendations. The following manufacturers are approved for use.

1. Penetron International
2. Xypex Chemical Corporation
3. Vandex USA, LLC
4. Or equal.

B. Qualifications:

1. Manufacturer: Manufacturer shall have a minimum of five (5) year's experience in manufacturing the principal materials for the required work.

2. Applicator: Waterproofing applicator shall be a firm experienced in the installation of cementitious crystalline waterproofing as demonstrated by previous successful installations of similar nature, size, and scope. Waterproofing applicator shall be acceptable to the manufacturer and such acceptance shall be indicated in writing.

3. Application Supervisor: At least one person, thoroughly experienced in the installation of products specified herein, shall be present during execution of this portion of the Work and shall be responsible to direct all Work performed under this section.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers identified with name, brand, type, grade, class and all other qualifying information.

B. Store materials in dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have been damaged and remove from the job site.

PART 2 - PRODUCTS

2.01 GENERAL

A. All cementitious crystalline waterproofing materials used shall meet or exceed requirements of CRD C48-73 Permeability of Concrete, ASTM C 267-77 Chemical Resistance of Mortars and ASTM C 39-86 Compressive Strength of Cylindrical Concrete Specimens, as performed by an independent testing laboratory.

B. The crystalline waterproofing coating shall be consist of a mix of Portland cement and specially treated quartz / silica sand and needs only to be mixed with potable water prior to application. When mixed with water and applied as a cementitious coating this causes a catalytic reaction which generates a non-soluble crystalline formation of dendritic fibers within the pores and capillary tracts of concrete. This process shall cause concrete to become permanently sealed against the penetration of water or liquids from any direction.

C. The cementitious repair mortar or dry-pac shall be based on similar ingredients as the waterproofing coating. Patching material shall be used to patch, seal, and repair any structural damage on the concrete substrates. Against a direct flow of water (leakage) or where there is excess moisture due to seepage a plug shall be used in conjunction with the patching material.

D. The crystalline waterproofing materials shall be products of Penetron International, Xypex Chemical Corporation, Vandex USA or equal. The crystalline waterproofing materials specified herein shall be the end product of a single manufacturer in order to achieve standardization for installation, operation, maintenance, and manufacturer's services.
E. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the Contractor and subjected to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

2.02 MIXES

A. The acceptable crystalline waterproofing materials by Penetron, Xypex and Vandex shall be prepared according to the following mixing proportions or as recommended by the manufacturer.

<table>
<thead>
<tr>
<th>Table 1: Waterproofing Materials Mixing Proportions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Rate</td>
</tr>
<tr>
<td>(lbs/yd²)</td>
</tr>
<tr>
<td>Plug:</td>
</tr>
<tr>
<td>Peneplug</td>
</tr>
<tr>
<td>Xypex Patch’n’ Plug</td>
</tr>
<tr>
<td>Vandex Plug</td>
</tr>
<tr>
<td>Patching Material:</td>
</tr>
<tr>
<td>Penecrete Mortar</td>
</tr>
<tr>
<td>Xypex Dry-Pac</td>
</tr>
<tr>
<td>Vandex Mortar</td>
</tr>
<tr>
<td>Coating:</td>
</tr>
<tr>
<td>Penetron</td>
</tr>
<tr>
<td>Xypex Concentrate</td>
</tr>
<tr>
<td>Vandex Super (grey)</td>
</tr>
</tbody>
</table>

B. Waterproofing materials shall be mixed by volume with clean water, which is free from salt and deleterious materials.

C. Do not mix bonding agents or admixtures, with crystalline waterproofing materials.

D. Waterproofing Coating:
1. Mix waterproofing powder with water to a creamy consistency in quantities which can be applied within 20 to 30 minutes from the time of mixing. As mixture thickens, stir frequently, but do not add additional water. Follow proportions in Table 1 or as recommended by the manufacturer. Setting time is approximately 60 minutes.

2. **Brush application mix:** Measure dry powder and place in mixing container. Measure water and mix into powder with a paddle on a slow speed electric drill (250 RPM) or other type mixer which will ensure mixing and is acceptable to manufacturer.

3. **Spray application mix:** Mixing shall be same as specified for brush application, except that mix shall be thinner. Use proportions in Table 1 only as a guide. Adjust proportions in order to match type of equipment and pressures used as acceptable to manufacturer.

E. **Patching Material:**

1. Mechanically mix Xypex Dry-Pac in a trowel for 10 to 15 seconds. Lumps may be present in mixture and will be acceptable. Mix only as much as can be applied in 15 minutes. Mortar trowel applied or as recommended by manufacturer.

2. Mechanically mix Vandex Mortar in quantities which can be applied within 30 minutes from time of mixing. Frequently agitate mixture, but do not add additional water. Mortar trowel applied or as recommended by manufacturer. Setting time is approximately 120 minutes.

F. **Plugging Material:**

1. Mechanically mix plugging compound with water to the consistency of a stiff putty in proportions identified in Table 1 or as recommended by the manufacturer. Do not mix more than can be used in 3 minutes. For best results, water temperature should be approximately 60°F to 70°F (15°C to 20°C). Plugging material trowel applied or as recommended by manufacturer. Application time is about 30 seconds after mixing.

PART 3 - EXECUTION

3.01 **GENERAL**

A. Prior to start of waterproofing installation, Contractor shall arrange a visit to project site by waterproofing material manufacturer to inspect and certify the following:

1. Surfaces to which waterproofing is to be applied are in acceptable condition.

2. Surfaces are sound and clean.

3. Form release agents, methods, and materials used to cure concrete surfaces are compatible with waterproofing materials.

3.02 **PREPARATION**

A. Contractor shall sandblast all surfaces to be waterproofed by means of high pressure water jetting, wet sandblasting or other approved mechanical means. All surfaces to be
treated shall have an open capillary system, clean, free from scale, excess oil, dirt, film, paint, laitance, curing compounds, existing coatings, and foreign matter.

B. Examine surfaces to be waterproofed for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints, cracks, leaks, or other unsuitable conditions. These defects are to be treated with the waterproofing supplier’s approved repair patching material and plug.

C. Repair these defects in accordance with manufacturer's product data and as follows:

1. **Form Tie Holes, Faulty Construction Joints and Cracks:** Chip defective areas in a "U" shaped slot approximately ¾ - inch to 1 - inch wide and a minimum of 1 - inch deep. Clean cavity of debris and dust. Soak with water, remove surface water and prime area to be patched with a coat of waterproofing material. Fill cavity with approved patching material. Compress into cavity using pneumatic packer or block and hammer.

2. **Rock Pockets, Honeycombing or Other Defective Concrete:** Rout out defective areas to sound concrete. Remove loose materials and saturate with water. Remove surface water, apply one coat of waterproofing material and allow to dry for about ten (10) minutes. After coating has set, but while it is still "green", fill cavity to surface with approved patching material, level as necessary.

3. **Leaks:** Cut out the leak to sound concrete in a "U" shaped slot approximately ¼ - inch to 1 - inch wide and a minimum of 1½ - inch to 2 - inch deep. Clean cavity of debris and dust. Soak with water and remove surface water. Insert waterproofing approved plug, press plug into hole and maintain pressure until setting has taken place. Coat remaining cavity with waterproofing coating, after coating has set, but while it is still "green", fill cavity to surface with approved patching material, level as necessary.

D. Remove all protrusions and cut back to sound concrete. Remove any honeycombed, spalled or damaged areas.

E. As a minimum, the CONTRACTOR shall include in its base bid the patching of 1,750 square feet of existing interior filter wall surface (assumed depth of 2-inches on average), and repair of 80 linear feet of cracks. Amounts over or under these base assumptions will be addressed on a case by case basis in the field.

### 3.03 EXECUTION

A. Prior to applying waterproofing coating, concrete surfaces must be thoroughly saturated with clean water. Remove excess water before application of waterproofing coating. If concrete surface dries out before application, it must be re-wetted, surface should be damp not wet.

B. Do not apply waterproofing coatings under rainy conditions or when ambient temperature is below 40°F (4°C).

C. Waterproofing coatings shall be applied with brush or spray at the application rates listed in Table 1.
1. **Brush application:** Apply two (2) coats as a slurry with a stiff bristle brush. Spread the material evenly and work it well into the surface. Apply the second coat after the first coat has reached an initial set, but while it is still “green” (less than 48 hours).

2. **Spray application:** Apply two (2) coats using appropriate compressed air spray equipment such as a hoppergun. The required air pressure should be approximately 72.5 psi and the delivery of air 18ft³/min. Apply coats in circular movements, apply second coat after initial has set, but while it is still green.

### 3.04 CURING

A. Begin curing as soon as waterproofing materials have set up sufficiently so as not to be damaged by a fine spray. Fog-spray treated surfaces at least three (3) times a day or as required to keep the waterproofing material damp for a period of not less than five (5) days.

B. Treated surfaces can also be cured by covering with polyethylene sheeting or damp burlap for the prescribed period or as recommended by the manufacturer.

C. In warm climates, more than three (3) sprayings per day may be necessary to prevent excessive drying of coating.

D. Do not lay sheetings / mats directly on waterproofing coating as air contact is required for proper curing.

E. Cure waterproofing materials for the prescribed period and then allow to set for 14 days before filling filter basin with liquid.

F. If there is poor air circulation in treated areas, provide fans or blown air to aid in curing of waterproofing.

G. For horizontal surfaces begin curing as soon as the final set has occurred, but before surface starts to dry. Conventional moist procedures such as water spray, and wet burlap may be used. Cure for a minimum of 48 hours.

H. In hot dry sunny conditions, consult manufacturer's product data.

I. If moist curing is not possible, a chemical curing agent manufactured for or compatible with each approved waterproofing material shall be used as recommended by the waterproofing materials manufacturer. Chemical agent shall have at least two (2) years of successful field use to be eligible for acceptance.

J. Protect cured surfaces from damage to wind, sun, rain and temperatures below 36°F for a period of not less than 48 hours after application. If plastic sheeting is used as protection, it shall be raised off waterproofing coating to allow air circulation.

### 3.05 DISINFECTION AND TESTING

A. See the Sections entitled “Hydrostatic Testing of Structures” and “Disinfection and Bacteriological Testing”.

- END OF SECTION -
SECTION 13222 – FILTER MEDIA AND GRAVEL

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide all labor, materials, equipment and supervision required to furnish and install the filter material as shown on the Contract Drawings and as specified herein. This includes removal and off-site disposal of the existing filter material to an approved site, and replacement with gravel, anthracite coal and silica sand for four (4) filters.

B. All equipment and materials used in contact with water shall be certified as being in conformance with NSF Standard 61.

C. All testing shall conform to the requirements of the latest edition of ANSI/AWWA B100.

D. The materials covered by this specification are intended to be standard materials of proven performance as manufactured by reputable concerns.

E. The Contractor shall be responsible for coordinating all equipment, materials and services required under this Contract for proper installation and operation of the filters rehabilitated. Coordination will be required during demolition, construction, start-up, and / or testing.

F. Reference the Section entitled “Summary of Work” for construction sequencing restrictions applicable to this Work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals

B. Materials and Equipment

C. Filter Underdrains

D. Surface Wash Agitator System

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS


D. ANSI/AWWA C653 - Standard for Disinfection of Water Treatment Plants.

1.04 SUBMITTALS

A. The Contractor shall furnish complete shop drawings for materials and Work incorporating all information and data listed herein and required to evaluate the filter material's compliance with the Contract Documents in accordance with the Section entitled “Submittals”.

CITY OF NORTH MIAMI
WINSON WTP FILTER REHAB BP1
B. **Shop Drawings:** The Contractor shall submit a media and gravel submittal including technical information approved by a licensed engineer regularly employed by the filter media supplier. The engineer shall have at least 15 years experience in water treatment. Data to be submitted shall include, but not limited to the following:

1. Supplier's Name.
2. Resume of Engineer Providing Submittal.
4. Certification of compatibility of the underdrain system with the filter media specified.
5. Gradation of each media type.
6. Date of sampling / lot number.
7. Samples of each media type.
8. Representative sample analysis, (i.e. effective size, uniformity coefficient, specific gravity, acid solubility and moh hardness for Anthracite only).
10. Shipping Schedule.
11. Diagram with type of material and depth of each.
12. Media Loading Procedure.

C. **Quality Control Manual:** The Contractor shall submit a Quality Control Manual obtained from the filter media supplier that demonstrates the filter media and filter gravel to be furnished will comply with all applicable provisions of ANSI/AWWA B100 and the requirements of these specifications. Submittal shall include an Affidavit of Compliance for the filter materials including Certification of Compatibility of the underdrain system with the filter media specified. The Quality Control Manual will include the following:

1. Affidavit of Compliance / Certification of Compatibility.
2. Qualification of the raw feedstock.
3. Control procedures at the screening mill.
4. Independent testing laboratory report.
5. Packaging definition.
6. Purchase orders.
7. Storage procedures.

D. **Independent Testing Laboratory Report:** The Contractor shall submit laboratory reports obtained by the filter materials supplier and prepared by a licensed and recognized independent testing laboratory to analyze and report the physical and chemical characteristics, including grain size (mm), specific gravity, uniformity coefficient, acid
solubility and hardness (moh scale) for samples representative of the actual production “lot”. The production “lots” shall be included on the independent laboratory reports and labeled on the packaging containers for filter materials delivered to the jobsite. Anthracite report shall also include Hardgrove Grindability Index (HGI), percent volatiles (dry ash-free), ash percent (dry), carbon percent, and washability characteristics (percent material with specific gravity below 1.4) as required by the Owner.

E. **Samples:** Contractor shall submit samples of anthracite and filter sand following delivery of shipment. The Owner may, at its option, test samples in accordance with procedures specified in ANSI/AWWA B100. Sample size shall be approximately 500 grams, placed in a resealable plastic bag and properly labeled.

F. Approval of any sample shall not be construed as signifying that the material satisfies all indicated requirements. The Contractor shall be responsible for complying with all requirements in the Contract Document.

G. Contractor shall notify Engineer at least 48 hours prior to washing filter media to enable the Engineer to be present.

1.05 **MANUFACTURES SERVICE REPRESENTATIVE**

A. The services of a qualified filter supplier technical representative who shall adequately supervise the installation and testing of all materials and equipment furnished under this contract and instruct the Owner’s operating personnel in its maintenance and operation. The services of the manufacturer’s representative shall be provided for a period of not less than three (3) days as follows:

1. At least one (1) trip of one (1) day to supervise the onsite testing of the filter media and installation in at least one (1) filter including support gravel.

2. One (1) trip of one (1) day to supervise initial start-up and operation of at least one (1) filter, and instruct the Owner’s personnel in proper operation and maintenance of the equipment.

C. The times specified are exclusive of travel to and from the facility and shall not be construed as to relieve the filter supplier of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

D. Any additional time required to achieve successful installation shall be at the expense of the Contractor.

1.06 **MATERIAL DELIVERY, STORAGE, AND PROTECTION**

A. Filter materials will not be shipped until the submittal is approved by the Owner. Approval of the submittal, including the Quality Control Manual, samples and independent testing, shall constitute acceptance of the filter materials.

B. Filter material will be shipped in bags or semi-bulk containers in accordance with ANSI/AWWA B100. Delivery of "bulk" shipments will not be permitted unless the Contractor can demonstrate that the materials can be handled and stored without contamination and segregation.

C. Special care shall be taken in transporting and placing the filter materials to avoid contamination with dirt or organic matter. Any filter material which has become dirty, either
before or after it has been placed in the filters, shall be either washed or removed and
replaced by clean material at no additional cost to the Owner. All material which has been
contaminated by organic matter will be rejected and replaced at no additional cost to the
Owner.

D. The proper storage of all materials shall be the responsibility of the Contractor. The Owner
assumes no responsibility for materials which are not properly protected from the weather
by the Contractor. Paper bags (if used) shall be protected from moisture at all times.

1.07 CLEANUP

A. Each filter cell of the filter beds shall be cleaned thoroughly before any filter materials are
placed. During media and filter gravel placement, each cell of the filter beds shall be kept
clean throughout the placing operations.

PART 2 – PRODUCTS

2.01 GENERAL

A. Filter media, support gravel and filter media testing methods shall conform to the
requirements of ANSI/AWWA B100 - Standard for Granular Media, except as otherwise
indicated.

B. The filter media provided shall be equal in all respects to the approved samples, and a
similar sample for test purposes shall be furnished during the preparation and placement of
the filter materials.

2.02 FILTER MEDIA

A. Filter media shall consist of anthracite coal and graded silica sand to depths as listed in
Article 2.05 and shown in the Contract Drawings after all necessary washing and scraping
has been completed. A skimming allowance of at least 1-inch for each media type is
recommended.

B. The filter media shall have specific gravities as indicated in Article 2.05. The average
apparent specific gravity shall be determined by the procedure set forth in ASTM C128 –

C. Acid solubility shall not exceed five (5) percent in accordance with ANSI/AWWA B100.

D. The effective size and uniformity coefficient shall be as indicated in Article 2.05. The
particle size shall be determined by screening through standard sieves calibrated in
accordance with ASTME E 11 - Specification for Wire Cloth Sieves for Testing Purposes.
Effective size is defined as the theoretical size of the sieve (in millimeter) that will pass 10
percent (by dry weight) of the representative sample. The uniformity coefficient is defined
as the theoretical size of the sieve (in millimeters) that will pass 60 percent of the sample by
weight divided by the effective size.

1. SAND MEDIA: Silica sand shall be composed of hard, durable, clean siliceous
particles visibly free of clay, loam, dust, and other foreign matter.

2. ANTHRACITE MEDIA: The anthracite shall be composed of hard and durable grains
and shall be processed from anthracite coal. Blending of non-anthracite material to
meet any portion of the requirements is not acceptable. The anthracite shall be
visibly free of iron sulfides, clay, shale, dust or other foreign matter. The anthracite shall have a moh scale hardness of not less than 2.7. All test procedures shall be in accordance with the applicable portions of ANSI/AWWA B100.

2.03 FILTER GRAVEL

A. Silica gravel shall be to a depth as shown in the Contract Drawings after all necessary washing and scraping has been completed.

B. Silica gravel shall consist of hard, rounded stones with an average saturated-surface dry specific gravity of not less than 2.5. Not more than one (1) percent by weight of the material shall have a specific gravity of 2.25 or less.

C. The gravel shall contain not more than two (2) percent by weight of thin, flat or elongated pieces (pieces in which the largest dimension exceed five times the smallest dimension).

D. The silica gravel shall be free from shale, mica, clay, sand, loam and organic impurities of any kind. The gravel shall be screened to proper size and placed in the filter cell in layers. The gravel within each layer shall be uniformly graded. The gravel shall be furnished and installed in each of the filter units as indicated on the Contract Drawings.

2.04 MANUFACTURERS

A. The following manufacturers are approved for anthracite and gravel:
   1. Anthra Filter, Inc.
   2. F.B. Leopold Company, Inc.
   3. Roberts Water Technologies, Inc.
   4. Severn Trent Water Purification, Inc.,
   5. Or equal

B. The following manufacturers are approved for silica sand:
   1. Standard Silica and Sand, Florida
   2. F.B. Leopold Company, Inc.
   3. Roberts Water Technologies, Inc.
   4. Severn Trent Water Purification, Inc.,
   5. Or equal

2.05 FILTER MEDIA DESIGN

A. The filter bed shall meet the following criteria:

<table>
<thead>
<tr>
<th></th>
<th>Anthracite Layer</th>
<th>Sand Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Depth (inches)</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>2. Effective size (mm)</td>
<td>0.90± 0.05</td>
<td>0.50± 0.05</td>
</tr>
<tr>
<td>3. Uniformity coefficient</td>
<td>Less than 1.4</td>
<td>Less than 1.4</td>
</tr>
<tr>
<td>4. Specific gravity</td>
<td>1.65± 0.05</td>
<td>2.6±0.05</td>
</tr>
</tbody>
</table>
PART 3 – EXECUTION

3.01 INSTALLATION

A. The underdrain system shall be inspected and tested before the commencement of filter material placement.

B. Marks shall be placed on the inside of the filter designating the top elevation of each layer before any filter gravel or media are placed.

C. Workers are not permitted to stand or walk directly upon the filter materials. Workers must stand or walk on boards which will sustain their weight without displacing the gravel and media.

D. In placing each layer of gravel, sand and anthracite, extreme care shall be taken to avoid disturbing the previous layer. Complete the installation of each layer before the next layer above is started.

E. Each gravel layer shall be leveled by hand prior to placing the next layer. Before any filter sand or anthracite is placed, wash gravel bed at a maximum available rate of 25 gpm per square foot of filter area for five (5) minutes with the Engineer present. Replace disturbed gravel with clean material of the proper size and type to obtain the required depth.

F. Place the filter sand and anthracite in the order of their respective specific gravities. Place and level the filter sand first. Then backwash bed a minimum of three (3) times, with the Engineer present. Remove all fines, as required by scraping to the correct elevation. Place the filter anthracite and backwash the bed a minimum of three (3) times, with the Engineer present. Remove surface fines as required by scraping to the correct elevation. Sufficient quantities of filter sand and anthracite shall be furnished so that the finished depths correspond to the specifications once the filter beds have been backwashed and skimmed of fines.

G. For each separate and distinct washing, the washwater shall be initially applied at a rate not to exceed 2 gpm per square foot of filter area and shall be gradually increased to the rate that achieves fluidization as recommended by the filter media supplier and underdrain system manufacturer for a duration of at least five (5) minutes. If insufficient washwater is available to achieve these flow rates, contact the Engineer for an alternate procedure.

H. The filling of the filter with water shall only be permitted using the backwash supply. Extreme care shall be employed to ensure a slow removal of all entrained air from the filter bed prior to increasing the backwash rate to maximum. Once the air has been removed from the filter bed, the backwash rate can then be increased.

I. The filters shall be washed and tested one at a time. Contractor shall notify water plant operations personnel and Owner representative at least seven (7) days prior to when the filter gravel and filter media is ready for washing and scraping operations. All washing operations shall be conducted by the water plant staff. All scraping and media additions to filter media shall be conducted by the Contractor. The Contractor shall remove and dispose all skimmed filter media in accordance with applicable federal, state and local regulations. The Contractor shall not placed skimmed media into filter washwater trough or plant dumpster.
3.02 FILTER MEDIA ONSITE TESTING

A. The anthracite and sand media shall be tested immediately upon delivery and prior to acceptance by the Owner, to ensure that the physical characteristics of the media supplied are consistent with those specified. For both the sand and anthracite, a minimum of five (5) samples for each shall be drawn for testing from different batches. Testing shall be conducted to determine effective size, specific gravity, and uniformity coefficient for the samples drawn.

B. An independent local laboratory shall be retained by the Contractor to test the filter media prior to installation. The test results shall be acceptable to the filter manufacture. In the event that test results from any of the samples show non-compliance with the specified media parameters, the Contractor will be responsible to conduct five (5) additional tests at no additional cost to the Owner. Filter media that does not meet the applicable requirements and standards of the specifications upon testing shall be replaced at no cost to the Owner.

C. All laboratory costs, labor, power, equipment, water and incidentals required for tests shall be furnished by the Contractor.

3.03 DISINFECTION

A. Prior to placing the filter units in service the Contractor shall provide all labor and materials required to disinfect each filter bed in accordance with ANSI/AWWA C653 and the requirements of the Section entitled “Disinfection and Bacteriological Testing”.

- END OF SECTION -
SECTION 13223 – SURFACE WASH AGITATOR SYSTEM

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide all labor, materials and equipment required to furnish, install, test and place in satisfactory operation the surface wash agitator system for the four (4) filters as shown on the Drawings and specified herein. The surface wash agitator system shall include the surface wash supply pipe, surface wash agitators and all appurtenant materials required to restore the surface wash system to previous operating conditions.

B. All equipment and materials used in contact with water shall be certified as being in conformance with NSF Standard 61.

C. All of the equipment described in this section shall be supplied by a single manufacturer to ensure unit responsibility for the operability of the surface wash agitator system.

D. The agitator system shall be the product of a recognized manufacturer that has been regularly engaged in the design and manufacturing of filter surface wash systems for at least ten (10) years and can demonstrate at least fifty (50) installations.

E. The Contractor shall be responsible for coordinating all equipment, materials and services required under this Contract for proper installation and operation of the filters rehabilitated.

F. Reference the Section entitled “Summary of Work” for construction sequencing restrictions applicable to this Work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals

B. Filter Underdrains

C. Filter Media and Gravel

D. Stainless Steel Pipe

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. NSF Standard 61 – Drinking Water System Components - Health Effects

1.04 SUBMITTALS

A. The Contractor shall furnish complete shop drawings showing details of fabrication, design, materials of construction and installation details in accordance with the Section entitled “Submittals”.

1.05 MANUFACTURES SERVICE REPRESENTATIVE

A. The services of a qualified manufacturer's technical representative who shall supervise the installation and testing of the first set of new surface wash agitators furnished under
this Section. The services of the manufacturer’s representative shall be provided for a period of not less than two (2) days as follows:

1. At least one (1) trip of one (1) day to check and supervise the installation of the surface wash agitator system in the first filter basin rehabilitated.

2. One (1) trip of at least one (1) day to test and accept the surface wash agitator system(s) including supervising initial start-up and operations and instruct the Owner’s personnel in the proper operation and maintenance of the equipment after the four filter basins have been rehabilitated.

B. The times specified are exclusive of travel to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

C. Any additional time required to achieve successful installation shall be at the expense of the Contractor.

PART 2 -- PRODUCTS

2.01 SURFACE WASH AGITATORS

A. The surface wash agitators shall be of the self-propelled rotary type. Each agitator unit shall essentially consist of a drop pipe terminating into a center bearing assembly that is connected to rotating horizontal distributor arms fitted with water dispersion nozzles.

B. Each rotating agitator shall be capable of uniformly discharging water over its entire area of influence.

C. Surface wash agitators shall be:

1. Straight-Line type agitators manufactured by F.B. Leopold Company with QJ end caps, Severn Trent Water Purification, Inc., or equal.

2. The agitator diameter shall be as shown on the Drawings. The Contractor shall field measure to filter box dimensions to confirm dimensions shown on the Drawings.

3. Each agitator shall be designed to deliver an average flow of 61 gpm with a minimum operating pressure of 50 psi.

D. The center bearing assembly shall be suitable for connection to the surface wash supply pipe and shall be constructed of Type 316 stainless steel with a ball bearing type central housing stabilized for vertical and horizontal bearing pressure. The ball bearing assembly shall be easily disassembled to allow for maintenance when required.

E. Suspended from the center bearing assembly, the agitator unit shall consist of a single, continuous horizontal arm fabricated of a single section of 1½-inch diameter, Schedule 5 Type 316 stainless steel. The bottom of the ball bearing assembly shall be unitized to the horizontal arm. Units with arm assemblies of more than one piece or units requiring field assembly using tee type assemblies shall not be allowed. Units fabricated with screwed, press fit, pinned, or soldered arms shall not be allowed where the horizontal arm intersects the vertical centerline of the drop pipe.
F. The distributor arm shall be precision drilled to accept the insertion of dispersion nozzles which shall be the non-clogging type that are easily replaced. The nozzles shall be spaced so that the water distribution shall be substantially uniform over the entire area of influence of the rotary media agitator.

G. The rotating distributor arm shall extend outward from the vertical centerline of the bearing in a horizontal straight manner.

H. Nozzles shall be attached to the trailing edge of the straight portion of the lateral arms.

I. Nozzles shall be spaced on the distributor arm to most effectively distribute water to the filter media surface and shall be set 15 degrees downward from the horizontal plane. Nozzles shall be designed so that they can be easily replaced with common tools. Nozzles shall be color coded to distinguish orifice sizes.

J. Each distributor arm shall be fitted with an endcap assembly that remains in place under all operating conditions.

K. A minimum distance of 2-inch shall be provided between the top of the filter media and the centerline of the agitator distributor arm.

L. The rotation indicator “flag” shall be provided for each agitator to indicate movement.

2.02 SURFACE WASH SUPPLY PIPE

A. All surface wash supply piping and supports within the filter basin shall be constructed of Schedule 5 Type 316L stainless steel unless otherwise noted on the Contract Drawings.

B. The pipe sections shall be factory cut and welded to the required dimensions for field assembly. No pipe welding shall be permitted on the jobsite. Whenever pipe must be field connected, rolled grooves shall be provided and the sections joined together with Victaulic Style 475 flexible stainless steel coupling, Piedmont style K low pressure grooved-end flexible coupling, or equal.

C. The drop pipe that connects the main surface wash supply pipe to the individual agitator mechanisms shall be 2-inch diameter, Schedule 40 Type 316 stainless steel. Drop pipe connections to the agitator mechanism and agitator stabilizer shall be attached with stainless steel couplings as shown in the Contract Drawings.

D. Type 316L stainless steel agitator supply header support brackets and securement hardware shall be furnished for adequate support of the supply piping from the wash water troughs and from the filter walls as shown on the Contract Drawings. All structural members shall be 3/16 - inch minimum thickness and pipe support (clamp type) bolts for the pipe securement to support brackets shall be 3/8 - inch minimum diameter.

2.03 AGITATOR STABILIZERS

A. Furnish stabilizers for the agitator drop pipes. Furnish with all necessary angles, brackets, wedge type anchors, u-bolts, nuts and washers as required for a complete system. All materials for the stabilizers shall be Type 316 stainless steel. The surface wash agitator manufacturer is responsible for the design of the stabilizers.
PART 3 – EXECUTION

3.01 INSTALLATION

A. The surface wash agitator system including rotation indicator, supply pipe, drop pipe, agitator arm and applicable supports shall be installed as per the written instructions of the manufacturer.

B. The surface wash supply will provide a minimum of 60 psi for the proper operation of the agitators.

C. All surface wash agitators shall be installed level and plumb. All necessary precautions recommended by the manufacturer shall be followed to ensure that the distribution system and surface wash supply piping is completely clean and free of any debris, dirt, or other foreign materials which could clog the system or interfere with flow. All surface wash supply pipe and surface agitators shall be fabricated and installed in accordance with the manufacturer’s printed instructions.

3.02 TOOLS, SUPPLIES AND SPARE PARTS

A. 10% of each size surface wash dispersion nozzles shall be provided as spares.

B. One (1) surface sweep center bearing.

- END OF SECTION -
SECTION 15000 - PIPING, GENERAL

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, lining and coating, testing, disinfection, excavation, and backfill, to provide a functional installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Summary of Work
B. Concrete and Grout
C. Painting
D. Filter Underdrains
E. Surface Wash Agitator System
F. Pipe Supports
G. Pipeline Testing and Disinfection

1.03 SUBMITTALS

A. The Contractor shall submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in the Section entitled “Submittals”, and as specified in the individual piping sections.

B. Each shop drawing submittal shall be complete in all aspects incorporating all information and data listed herein and all additional information required to evaluate the proposed piping material's compliance with the Contract Documents. Partial or incomplete submissions will be returned to the Contractor without review.

C. Data to be submitted shall include, but not be limited to:

1. Catalog Data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various piping components and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete layout and installation drawings with clearly marked dimensions and elevations. Piece numbers which are coordinated with the tabulated pipe layout schedule shall be clearly marked. Piping layout drawings shall indicate the following additional information; pipe supports, location, support type, hanger rod size, insert type and the load on the hanger in pounds.
3. Weight of all component parts.

4. Design calculations when requested.

5. Tabulated pipe layout schedule which shall include the following information for all pipe and fittings: service, pipe size, working pressure, wall thickness and piece number.

D. **Certifications:** Prior to installation, the Contractor shall furnish an Affidavit of Compliance certified by the pipe manufacturer that the pipe, fittings and specials furnished under this Contract comply with all applicable provisions of AWWA and these specifications. No pipe or fittings will be accepted for use in the Work on this project until the affidavits have been submitted and accepted in accordance with the Section entitled “Submittals”.

E. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.04 **QUALITY ASSURANCE**

A. **Tests:** Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards.

B. **Welding Requirements:** All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

C. **Welder Qualifications:** All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, acceptable testing agency not more than 12 months prior to commencing work. Machines and electrodes similar to those used in the Work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders. Furnish welder’s qualification papers to the Engineer.

1.05 **MANUFACTURER’S SERVICE REPRESENTATIVE**

A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain correct pipe joints, supports, or special connections, the Contractor shall furnish such assistance at no additional cost to the Owner.

1.06 **MATERIAL DELIVERY, STORAGE, AND PROTECTION**

A. All piping materials, fittings, valves, and accessories shall be delivered in clean and undamaged conditions and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.07 **CLEANUP**
A. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.
PART 2 - PRODUCTS

2.01 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Division 2 - Sitework and Division 15 - Mechanical and furnished as specified herein.

B. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of the Section entitled “Pipe Supports”, and/or as shown.

C. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable Sections of Division 15 - Mechanical, unless otherwise specified. Pipes above ground or in structures shall be field painted in accordance with the Section entitled “Painting”.

2.02 PIPE FLANGES

A. Flanges: Where the design pressure is 125 psi or less, flanges shall conform to either ANSI/AWWA C115/A21.15 Class D or ANSI B16.1 125-lb class. Where the design pressure is greater than 150 psi, up to a maximum of 250 psi, flanges shall conform to either ANSI/AWWA C115/21.15 or ANSI B16.1 250-lb class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA 115/21.15. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12-inches and over shall be provided with lifting eyes in the form of welded or threaded eye bolts.

C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. Flange Bolts: If studs are required, they shall be in accordance with ASTM A307, Grade B, with heavy hex nuts. Machine bolts shall normally be used on all flanged connections and shall be in accordance with ASTM A307, Grade B, with heavy hex nuts. If studs are required, they shall extend through the nuts a minimum of ¼-inch. All bolts and nuts shall be hot dipped galvanized and shall conform to the Section entitled “Metal Fabrications”.

E. Flange Gaskets: Gaskets for flanged joints shall be of materials as specified in piping sections. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

F. Flange Gasket Suppliers shall be John Crane, or equal

2.03 GROOVED COUPLINGS
A. General: Mechanical-type couplings shall be provided where shown. Buried or submerged couplings shall have Type 316 stainless steel bolts and nuts conforming to the requirements of the Section entitled “Metal Fabrications”.

B. Stainless steel pipe couplings shall conform to Section entitled “Stainless Steel Pipe”.

2.04 MECHANICAL COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where shown, and shall be of similar material as the pipe, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. The middle ring shall be not less than ¼-inch in thickness and shall be either 5 or 7-inches long for standard steel couplings, and 16-inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of the Section entitled “Metal Fabrications”.

B. Pipe Preparation: The ends of the pipe, where specified or shown, shall be prepared for sleeve-type couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12-inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to an air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. The rubber in the gasket shall meet the following specifications:

1. Color - Jet Black
2. Surface - Nonblooming
3. Durometer Hardness - 74 ± 5
4. Tensile Strength - 1000 psi Minimum
5. Elongation - 175 percent Minimum

D. The gaskets shall be immune to attack by the material which is being transported. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above.

E. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

F. Restrained Joints: Where harnesses are required for sleeve-type couplings, they shall be in accordance with the requirements of the appropriate reference standard, or as shown.
G. Supplier shall be Rockwell (Smith-Blair), Style 411, Dresser, Style 38, Ford Meter Box Co., Inc., Style FC1 or FC3 or equal.
2.05 FLANGED COUPLING ADAPTERS

A. Reference Standards:

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AWWA C207 Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In.</td>
</tr>
<tr>
<td>2</td>
<td>AWWA C213 Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines</td>
</tr>
<tr>
<td>3</td>
<td>AWWA C219 Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe</td>
</tr>
<tr>
<td>4</td>
<td>ASTM A36 Standard Specification for Carbon Structural Steel</td>
</tr>
<tr>
<td>6</td>
<td>NSF 61 Drinking Water System Components - Health Effects</td>
</tr>
</tbody>
</table>

B. Product Standard: Flanged coupling adapters shall comply with AWWA C219.

C. Flange Dimensions: Flanges shall meet the requirements of AWWA C207. Flanges shall be Class D. Bolt circle dimensions shall be compatible with ANSI Class 125 and 150.

D. Pressure Capacity: 150 psi.

E. Materials:

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coupling Body and Flange</td>
<td>Carbon Steel</td>
</tr>
<tr>
<td>Follower (a.k.a. end ring)</td>
<td>Carbon Steel</td>
</tr>
<tr>
<td>Bolts and Nuts</td>
<td>316 Stainless Steel</td>
</tr>
<tr>
<td>Gasket</td>
<td>Material to be selected by manufacturer. Selected material shall be suitable for water service with chloramine residual of 2 mg/L</td>
</tr>
</tbody>
</table>

F. Factory Applied Exterior Coating: Fusion bonded epoxy per AWWA C213 with a minimum 12 mils dry film thickness (DFT). Coating shall be suitable for contact with potable water per NSF International Standard 61.

G. Factory Applied Interior Lining: The lining shall match the coating.

H. Harnessing: All flanged coupling adapters shall be harnessed to the wall of the filter by using 316 stainless steel tie rods, 316 stainless steel nuts and and 316 stainless steel tabs.

I. Manufacturer: Romac Style FC400, Dresser Style 128-W, Smith Blair Corporation, or equal.
2.06  RESTRAINED FLANGE ADAPTER

A. General: Restrained flange adapters shall be used where shown on the Drawings to connect existing plain end ductile iron pipe to proposed stainless steel flanged piping. The proposed stainless steel flanged piping shall have AWWA C107 Class D flanges.

B. Body Material: The restrained flange adapter ring body shall be made of ductile iron conforming to ASTM A536.

C. Gaskets: Sealing gaskets shall be EPDM.

D. Factory Applied Internal Lining: All internal surfaces of wetted parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to AWWA C213 titled “Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines”. Lining shall be suitable for contact with potable water per NSF International Standard 61.


F. Flange Bolt Pattern: The adapter shall have flange bolt circles that are compatible with AWWA C107 Class D flanges.

G. Restraint: Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.

H. Deflection Capability: Restrained flange adapters shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6” gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

I. Manufacturer: SERIES 2100 MEGAFLANGE, as produced by EBAA Iron, Inc., or equal.

2.07  SLEEVES

A. Pipe sleeves shall be provided where shown on the Drawings. All PVC pipe passing through cast-in-place concrete walls or slabs shall be provided with a sleeve whether or not shown on the Drawings.

B. Except for core drilled holes in existing concrete, sleeves shall be equipped with a waterstop centered in the wall penetration.

C. As a minimum, sleeves shall be of the same material as the pipe passing through it.

D. Sleeves shall be of sufficient size to pass the pipe and any required coverings of the pipe and shall extend two (2) inches above finished floor.

E. Sleeves shall be caulked with a fire retardant caulking compound at fire walls and a gas tight compound at gas tight walls.

F. All sleeves penetrating water/wastewater tanks or wet wells and all below grade walls or floors shall be provided with penetration seals, "Link Seal" as manufactured by Thunderline
Corporation, or equal. Penetration seals shall be covered with a two part polysulfide sealant on the earth or wet side of the sleeve and penetration seal as shown on the Drawings.

G. All sleeves in building interiors shall be sealed with foam sealant and caulking as shown on the Drawings.

2.08 WALL PIPES

A. Wall pipes shall be provided where shown on the Drawings. All wall pipes and castings shall be equipped with waterstops and shall be of the same material as the connecting piping. The wall pipes shall have the interior and exterior protection as specified for the connecting piping.

B. Wall pipes shall be of sufficient length to pass through the wall in accordance with the details on the Drawings and shall conform to the details shown on the Drawings. The end of the wall pipes shall be of a type consistent with the piping to be connected to them and shall conform to their standards and specifications.

2.08 WATERTIGHT LINK SEALS

A. Application Location: Furnish watertight link type seals where indicated on the Drawings.

B. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.

C. Materials: Assemble interconnected rubber links with Type 316 stainless steel bolts, nuts, and pressure plates. Elastomeric sealing material shall be as recommended by the manufacturer for the application.

D. Sizing Criteria: Size modular mechanical seals according to manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening or core drilled opening in existing walls (when sleeves are not indicated on the Drawings).

E. Manufacturers and Products (or Equal:
   1. Thunderline/LinkSeal, Div. Of PSI, Houston, TX; Link Seal;
   2. Calpico, Inc., South San Francisco, California; Sealing Linx;
   3. Advance Products and Systems, Lafayette, Louisiana; Innerlynx.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall furnish all labor, tools, materials, and equipment necessary for installation and jointing of the pipe. All piping shall be installed in accordance with the Drawings in a neat workmanlike manner and shall be set for accurate line and elevation. All piping shall be thoroughly cleaned before installation, and care shall be taken to keep the piping clean throughout the installation.
B. Before setting wall sleeves, pipes, castings and pipes to be cast in place, the Contractor shall check the Drawings and equipment manufacturer’s drawings which may have a direct bearing on the pipe locations. The Contractor shall verify existing piping tie-in connections and verify size, type, and location before fabricating new piping assemblies.

C. Piping shall be attached to pumps, valves, equipment, etc., in accordance with the respective manufacturers’ recommendations. This includes the use of flexible connectors as required.

D. For piping assembled with threaded, solvent cemented, welded or soldered joints, liberal use of unions shall be made. Unions shall be provided close to main pieces of equipment and in branch lines to permit ready dismantling of piping without disturbing main pipe lines or adjacent branch lines. A minimum of one union per straight run of pipe between fitting and/or valves with multiple lengths of pipe shall be used.

E. All changes in directions or elevations shall be made with fittings, unless otherwise shown.

3.02 SHIPPING, HANDLING AND STORAGE

A. Special care in handling shall be exercised during delivery, distribution and storage of pipe to avoid damage and setting up stresses. Damaged pipe will be rejected and shall be replaced at the Contractor’s expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.

B. No pipe shall be dropped from cars or trucks to the ground. All pipe shall be carefully lowered to the ground by mechanical means. In shipping, pipe and fittings shall be blocked in such manner as to prevent damage to castings or lining. Any broken or chipped lining shall be carefully patched. Where it is impossible to repair broken or damaged lining in pipe because of its size, the pipe shall be rejected as unfit for use.

C. All mechanical joint pipe shall be laid with 1/8-inch space between the spigot and shoulder of socket.

3.03 FLANGED JOINTS

A. Flanged joints shall be made up with full face gaskets as specified in the piping paragraphs. Flange faces shall have a uniform bearing on the gaskets. Flanges shall be drawn together uniformly until the joint is tight. No washers shall be permitted for the bolt and nut assemblies. The length of the bolts shall be uniform and in accordance with the standards specified herein. The bolt’s maximum projection beyond the end of the nut shall be 0.25-inch and shall not fall short of the end of the nut. All buried flanges shall be installed with Type 316 SS nuts and bolts.

3.04 WELDED JOINTS

A. Welded joints shall be in accordance with the requirements of the Section entitled “Stainless Steel Pipe”.

3.07 THRUST RERAINT

A. All sleeve type couplings shall be harnessed except where noted specifically on the Drawings. The harnessing shall be as shown on the Drawings or as specified herein.
B. Where the distance between adjacent flanges is in excess of ten feet or where a harness can not be used, the pipe supports adjacent to the coupling shall restrain the piping preventing any linear or angular movement resulting in the pipe separating from the coupling or misalignment in the joint.

C. Where expansion joints are used, control units shall be provided. All tie rods and control units shall be installed in accordance with manufacturer recommended procedures.

D. All tie rods and associated hardware shall be Type 316 stainless steel.

E. In general, all valves and fittings shall be restrained in an acceptable manner such that the unbalanced force developed at them shall be supported independent of the piping system.

3.08 PIPE SCHEDULE

A. The following abbreviations are used in the schedule:

1. Material
   316 SS - 316 Stainless Steel (non-welded joints) or
   316L Stainless Steel - low carbon (welded joints)

2. Wall Thickness
   Sch - Schedule

3. Fitting Type
   316 SS - 316 Stainless Steel (non-welded joints) or
   316L Stainless Steel - low carbon (welded joints)
## PIPE SCHEDULE

<table>
<thead>
<tr>
<th>Service</th>
<th>Nominal Pipe Diameter (Inches)</th>
<th>Material</th>
<th>Thickness Class or Schedule</th>
<th>Working Pressure (PSIG)</th>
<th>Type of Joints</th>
<th>Type of Fittings</th>
<th>Protective Coating</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Filter Surface Scour Supply Piping</td>
<td>All</td>
<td>316 SS</td>
<td>Sch 5S</td>
<td>100</td>
<td>Note 1</td>
<td>316 SS</td>
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<td>-</td>
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<td>Filter Feed, Backwash, Drain, Waste and Product Piping</td>
<td>All</td>
<td>316 SS</td>
<td>Sch 5S</td>
<td>100</td>
<td>Note 1</td>
<td>316 SS</td>
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</tr>
<tr>
<td>Sample Lines to Instruments</td>
<td>All</td>
<td>316L SS</td>
<td>-</td>
<td>-</td>
<td>Note 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Compressed Air Piping</td>
<td>3-inch and less</td>
<td>Galvanized Steel</td>
<td>Sch 80</td>
<td>100</td>
<td>Note 3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Potable Water Supply to Hose Bibbs (above ground mounted on existing filters)</td>
<td>3-inch and less</td>
<td>Galvanized Steel</td>
<td>Sch 80</td>
<td>100</td>
<td>Note 3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1 Refer to the Section entitled “Stainless Steel Pipe”
2 Refer to the Section entitled “Stainless Steel Tubing”
3 Refer to the Section entitled “Mill Piping, Exposed and Buried”

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, and test all exposed and buried mill piping as shown and specified, complete, including small steel pipe, black steel pipe, Alloy 20 pipe, copper tubing, fittings, gaskets, bolts, insulating connections, and such other specialties as required for a complete and operable piping system in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Piping, General
B. Pipe Supports
C. Piping and Equipment Identification System
D. Pipeline Testing and Disinfection

PART 2 – PRODUCTS

2.01 SMALL GALVANIZED STEEL PIPE

A. Unless otherwise specified, galvanized steel pipe in sizes 6-inches in diameter and smaller shall conform to the requirements of ASTM A53 or ASTM A120 as shown, and shall be Schedule 80. Galvanized steel pipe shall not be cement mortar lined unless otherwise shown. Fittings for galvanized steel pipe shall be of galvanized malleable iron, with NPT or grooved ends.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Small Steel Pipe: Buried galvanized pipe shall be coated with a primer coating and tape wrapped. The pipe surface shall be completely covered with a primer coating in accordance with the manufacturer's specifications. Primer coating shall be Polyken #1027 Pipeline Primer as manufactured by Corrosion Control Products Company. After the primer coating has been applied, the pipe shall be wrapped with Polyken #930 series wrapping tape as manufactured by Corrosion Control Products Company. The backing shall be low density Polyethylene and the adhesive shall be Butyl Rubber, Synthetic Resin. Wrapping tape thickness shall be 50 mils.

B. Drain Traps: Drain traps shall be installed at low points in all air and gas lines or elsewhere where shown. Liquid outlets shall be piped to the nearest floor drain or open sump, subject to Engineer comment and acceptance.

- END OF SECTION –
SECTION 15012 – STAINLESS-STEEL PIPE

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install stainless steel pipe and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

B. All filter gallery and surface wash piping shall be Type 316L Stainless Steel – Schedule 10S.

C. All piping shall have a working pressure of 100 psig.

D. Due to the limited clearances in the pipe gallery, piping and fittings shall be constructed by the Contractor to meet the general orientation of that shown on the drawings, in general compliance with AWWA C208-01, Felker Brother Corporation, J. F. Ahern Company, or equal.

E. Note that in cases where available clearances do not allow for standard fitting installation, the Contractor shall fabricate fittings with centerline to end dimensions equal to one times (1X) the pipe diameter. The Contractor shall field verify all clearances and submit a complete complete pipe layout drawing, illustrating dimensions needed to match the existing connection points as shown on the “Post-Demolition” drawings.

F. Reference the Section entitled “Summary of Work” for construction sequencing restrictions.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Summary of Work

B. Maintenance of Utility Operations During Construction

C. Filter Underdrains

D. Surface Wash Agitator System

E. Pipe Supports

F. Piping, General

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions.

B. Show material of construction, with ASTM reference and grade. Submit manufacturer's certificates of compliance with referenced pipe standards, e.g., ASTM A312, A403, A778, A774. Show wall thickness of steel cylinder.

C. Submit manufacturer’s catalog data for the flange gaskets.
PART 2 - PRODUCTS

2.01 Type 316 STAINLESS STEEL SCHEDULE 10S, 100 PSI CWP

A. Pipe, 1/4" through 24", Schedule 10S, stainless steel, welded seam, pickled and passivated; 1/4” through 12” annealed after welding.

B. Fittings, 2 1/2" through 24", Schedule 10S, wrought stainless steel, butt-weld, pickled and passivated; 2000 lb. socket-weld end for 2" and smaller (See Notes for outlets).

C. Flanges, 1/4" through 24", 316L stainless steel AWWA Class D ring or hub flanges, smooth face finish; alternatively, 4” through 24”, lapped with 304L stainless steel AWWA Class D ring back-up flange with stub end where raised face is compatible with mating flange. The ID of the stub end face shall not exceed the OD of the pipe by more than 0.5%.

D. Gaskets, 1/8”, full face EPDM or fluoroelastomer gaskets rated for 275 psig operating pressure.

E. Bolts and Nuts, stainless steel hex-head bolts and stainless steel heavy semi-finished hex nuts.

F. Arched band couplings, 8” through 24”, in accordance with this Section. Pipe end rings shall be of Type 316L stainless steel and shop welded by the pipe fabricator as required for the working pressure of the coupling.

G. Grooved-end couplings, 3/4” through 14”, galvanized ductile iron, EPDM gaskets, rolled groove, Victaulic Style 77 flexible coupling or style 89 rigid coupling, or equal.

H. Outlets shall be made by extrusion in accordance with ANSI B31.3 in pipe through 12”. Larger outlets may be fabricated with reinforcement as required for working pressure in accordance with ANSI B31.3.

I. Pipe components shall be manufactured in accordance with the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>ASTM</th>
<th>ANSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>A778, Gr TP 316L</td>
<td>B36.19</td>
</tr>
<tr>
<td>Fittings</td>
<td>A403, Gr CR 316L</td>
<td>B16.9</td>
</tr>
<tr>
<td>Fittings &gt;12’</td>
<td>A774, Gr CR316L</td>
<td>B16.9</td>
</tr>
<tr>
<td>Flanges</td>
<td>A240, 316L</td>
<td>B16.5</td>
</tr>
<tr>
<td>Gaskets</td>
<td>-----</td>
<td>B16.21</td>
</tr>
<tr>
<td>Bolts</td>
<td>F593, Grp. 2</td>
<td>B18.2.1</td>
</tr>
<tr>
<td>Nuts</td>
<td>F594; Grp. 2</td>
<td>B18.2.2</td>
</tr>
<tr>
<td>Bolt Length</td>
<td>-----</td>
<td>B16.5</td>
</tr>
<tr>
<td>Bolt and Nut</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Threads</td>
<td>-----</td>
<td>B1.20.1</td>
</tr>
<tr>
<td>Grooved-end Couplings</td>
<td>A536 Gr 65-45-12</td>
<td>-----</td>
</tr>
</tbody>
</table>

2.02 FINISH

44238-008-S15012.doc
A. Pipe and wrought fittings 14" through 24" shall have a hot rolled, No. 1 finish or better unless otherwise specified. Pipe and fittings 1/4" through 12" shall have a No. 2D finish or better unless otherwise specified.

2.03 ARCHED BAND COUPLINGS

A. Restrained and expansion arched band couplings 2" through 24" shall be as manufactured by Victaulic “Depend-O-Lok”, or equal.

B. Couplings shall be suitable for the same working pressure as that of the flanges specified for the piping system in which they are installed.

C. Couplings shall be bolted, split-sleeve type and shall consist of 4 component groups; one-piece housing, gaskets, bolts and nuts, and pipe end rings as required for pipe restraint.

D. Housing shall be manufactured from Type 316L stainless steel of the thickness required for coupling working pressure but not less than that of Schedule 10S piping of the same nominal diameter.

E. Pipe end rings shall be manufactured by the coupling manufacturer of Type 316L stainless steel of the dimensions required for coupling working pressure. Coupling manufacturer shall specify welding dimensions and procedures to be used by the pipe fabricator for welding the rings to the pipe.

F. Gaskets shall be EPDM. Bolts and nuts shall comply with the pipe component specification.

G. Expansion couplings shall be of sufficient width to accommodate 1.5 inches of axial pipe movement. Expansion couplings shall be located as shown on the Drawings. One end of each expansion coupling shall be located by pipe end rings.

H. Arched band couplings shall not be utilized where removal and replacement of coupling and gaskets in the completed piping system would not be feasible without cutting the pipe.

PART 3 -- EXECUTION

3.01 INSTALLING FLANGED PIPING

A. Set pipe with the flange bolt-holes straddling the pipe's horizontal and vertical centerline, springing, forcing, or stressing the connecting valves or equipment. Install pipe without pipe or any springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment. Avoid extra joints.

B. Lubricate bolts with graphite and oil prior to installation.

3.02 INSTALLING UNIONS

A. Provide unions on exposed piping 2 inches and smaller as follows:

1. At every change in direction (horizontal and vertical).

2. 6 to 12 inches downstream of valves.

3. Every 40 feet in straight piping runs.
4. Near threaded connections to mechanical equipment.
5. On both sides of threaded control valves and other in-line instruments.

3.03 FABRICATION, ASSEMBLY, AND ERECTION

A. Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Beveled ends shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding.

B. Fabrication shall comply with ANSI B31.3, Chapter V.

C. All welding of pipe, fittings and subassemblies shall be performed in the factory by qualified welders in accordance with ANSI B31.3 with standard procedures for the application.

D. The minimum number of passes for welded joints shall be as follows:

<table>
<thead>
<tr>
<th>Steel Cylinder Thickness (inch)</th>
<th>Minimum Number of Passes for Welds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.1875</td>
<td>1</td>
</tr>
<tr>
<td>0.1875 through 0.25</td>
<td>2</td>
</tr>
<tr>
<td>Greater than 0.25</td>
<td>3</td>
</tr>
</tbody>
</table>

E. Use the shielded metal arc welding (SMAW) or the tungsten inert gas (TIG) process for welding. Use the SMAW process for any pipe. Use the TIG process only on pipe having a maximum thickness of Schedule 10S.

F. Welding preparation shall comply with ANSI B31.3, paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Tables 341.3.2A and 341.3.2B, and paragraph 341.4 for visual examination.

G. Identify welds in accordance with ANSI B31.3, paragraph 328.5.

H. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush. All heat tint resulting from the welding operation shall be removed accordingly.

I. Welding electrodes shall comply with AWS AS.4. Bare wire shall comply with AWS A5.9.

J. At no time shall water be left standing inside completed pipe runs (except during testing after which the line shall be drained). Drain taps with valves shall be provided at all low points in piping systems.

3.04 ACID TREATMENT OF STAINLESS STEEL PIPE AND FITTINGS

A. After all fabrication is completed, all pipe spools shall be pickled and passivated by complete immersion in accordance to ASTM A-380. Alternative methods will not be allowed. All pipe spools shall be free of surface iron and have a uniform 2D finish throughout upon completion of the process.

3.05 HYDROSTATIC TESTING

A. See Section entitled “Pipeline Testing and Disinfection”. Test with potable water only.
3.06 INSTALLING ABOVEGROUND PIPE

A. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

B. Provide pipe hangers and supports as specified in Division 15.

- END OF SECTION -
SECTION 15013 – STAINLESS STEEL TUBING

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Where shown on the Drawings, furnish and install stainless steel tubing and compression fittings.

B. Furnish and install appropriate tubing supports as required for a complete installation. The Contractor is responsible for the design of tubing supports.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. Submit shop drawings in accordance with the Section entitled “Submittals”.

PART 2 - PRODUCTS

2.01 STAINLESS STEEL TUBING FOR WATER SERVICE

A. Tubing: All stainless steel tubing shall be seamless, annealed, Type 316L stainless steel per ASTM A269. Tubing nominal wall thickness shall be 0.035-inch for tubing with a nominal outside diameter of 3/8-inch.

B. Fittings: All fittings shall be Type 316 stainless steel compression type.

C. Tubing and Fittings Manufacturer: Swagelok, or equal.

PART 3 - EXECUTION

3.01 HYDROSTATIC TESTING

A. In accordance with the Section entitled “Pipeline Testing and Disinfection”.

B. Repair all leaks.

3.02 INSTALLING ABOVEGROUND PIPE

A. Install pipe without springing, forcing, or stressing the tubing or any adjacent connecting valves or equipment.

B. All tubing shall be installed in horizontal and vertical planes and shall be rigidly supported.

- END OF SECTION -
SECTION 15020 - PIPE SUPPORTS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, and installation of all pipe supports, hangers, guides, and anchors shown, specified, or required for a complete and operable piping system, in accordance with the requirements of the Contract Documents.

B. Where pipe supports are specifically shown and/or detailed on the drawings, they shall supersede the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Piping, General

B. Stainless Steel Pipe

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

   ANSI / ASME B31.3 Process Piping

1.04 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall furnish complete shop drawings of all pipe supports, hangers, anchors, and guides, as well as calculations for special supports and anchors, in accordance with the Section entitled “Submittals”.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The Contractor shall note that all pipe support locations are not shown on the Drawings and shall follow the Specifications herein in locating supports. Where deviations and modifications are required, they shall be made subject to review by the Engineer.

B. Code Compliance: All piping systems and pipe connections to equipment shall be properly supported, to prevent undue deflection, vibration, and stresses on piping, equipment and structures. All supports and parts thereof shall conform to the requirements of ANSI/ASME B31.1 and ANSI / ASME B31.3, except as supplemented or modified by these Specifications. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code, or local administration requirements.

C. All piping shall be rigidly supported from the building structure by approved hangers, inserts, or supports. No piping shall be supported from other piping or from metal stairs, ladders, and walkways unless specifically permitted by the Engineer.

D. Unless otherwise indicated on the Contract Drawings, piping supports shall consist of concrete piers or fabricated Type 316 Stainless Steel supports as specified below.
Materials and workmanship shall be in full compliance with Division 3 - Concrete of these Specifications.

E. Supporting appurtenances shall be arranged to prevent undue stress on equipment to which piping is connected. Supporting appurtenances shall provide the desired pitch as specified or required for proper drainage of the piping. The pipe suspension shall prevent excessive stress, excessive variation in supporting force, and possible resonance with imposed vibration while the system is in operation. All valves and valve operators shall be rigidly supported independently of the piping. Vertical runs of pipe shall be supported independently of the connected horizontal runs. All vertical pipes shall be supported at each floor or at intervals of at least 10 feet by approved pipe collars, clamps, brackets or wall rests. Supporting appurtenances, when used with copper piping, shall be copper, bronze or bronze plated. All piping shall be supported independently of the equipment to which it is connected. All in line devices (flowmeters, etc.) shall be removable without the need for temporary supports for adjacent and connecting piping.

F. In general, the type of pipe supports to be used shall be as follows unless otherwise shown on the Drawings:

<table>
<thead>
<tr>
<th>Height of Centerline of Pipe above Floor</th>
<th>Type of Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 feet or less</td>
<td>Concrete Pier</td>
</tr>
<tr>
<td>Greater than 6 feet</td>
<td>Adjustable Pipe Saddle, Bracket Supports or Hangers</td>
</tr>
</tbody>
</table>

G. Wall bracket supports shall be used where shown for pipe to be installed adjacent to a wall. Where it is not feasible to install hanger supports, adjustable pipe saddle supports may be used upon review and acceptance by the Engineer. The Contractor shall install pipe supports in conformance with these Specifications unless otherwise shown on the Contract Drawings. Where deviations and modifications are required, they shall be made only with the permission of the Engineer. A detailed layout of pipe supports for each building shall be submitted to the Engineer for review prior to pipe fabrication or installation.

H. For all couplings, supports shall be placed on each side and as close to the coupling as possible.

I. Structural Members: Wherever possible, pipes shall be attached to structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the Contractor at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction. Stainless steel and non-metallic piping installed in tanks, channels or conduits shall be supported by hangers, hanger rods, hardware and inserts fabricated of Type 316 stainless steel.

J. Freestanding pipe connections to equipment shall be firmly attached to fabricated Type 316 stainless steel frames made of angles, channels, or I-beams anchored to the structure. Exterior, freestanding overhead piping shall be supported on fabricated Type 316 stainless steel pipe stands, consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps, securing the pipes. All materials shall be Type 316 stainless steel.

K. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, fiber glass, and other plastic pipes, shall be supported on both sides, according to manufacturer's
recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on plastic and fiber glass piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. Where a specific pipe support is called for on the Drawings, this support shall be used as and where indicated for the specific application. In general, spacing of supports shall be as specified herein unless specifically modified by the Engineer.

M. All supports, saddles, bearing plates, and hangers, shall support by direct contact the pipe a minimum of 120 degrees around, except as specified herein.

N. Where continuous concrete inserts are used, the maximum concentrated load on the end two (2) inches of inserts, with laying lengths of eight (8) inches or longer, shall not be more than 50 percent of the maximum recommended loading of the channel. All pipe supports shall be positioned such that they will not interfere with the use of hoisting equipment, where provided.

O. Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints. They shall permit the piping to expand and contract freely in directions away from the anchored points and shall be structurally suitable to withstand all loads imposed. Pipes subject to thermal expansion shall be installed perfectly aligned and concentrically guided. These piping support systems shall be submitted to the Engineer for review. The submittal shall show location of anchors, concentric pipe guides and expansion couplings (single or double).

2.02 TYPE 316 STAINLESS STEEL CHANNEL SUPPORTS

A. Pipe supports shall be wall or slab mounted 1 5/8-inch X 1 5/8-inch UNISTRUT (or equal) Type 316 stainless steel channels with Type 316 stainless steel straps, and Type 316 stainless steel lock nuts. Supports shall be attached to walls and slabs by 3/8-inch diameter, 6-inch long Type 316 stainless steel anchor bolts with lock nuts. Bolt support spacing shall be maximum 12-inch O.C.

2.03 PIPE ROLLER SUPPORTS

A. The Contractor shall furnish and install self-lubricating roller supports where shown on the Contract Drawings and as specified herein. Roller supports shall be Anvil Figure No. 271 or equal. Assemblies shall include all directly connected or welded anchorage hardware.

B. Roller supports shall meet the loading requirements of the design and conforming to the details on the Drawings. The rollers shall have support section fabricated of the same material as is the pipe to be supported, a Type 316 series stainless steel slide plate, and a carbon steel base to which the Teflon is applied. The support plates at roller supports shall be stitch welded to stainless steel pipe at all roller support locations.

C. The roller supports shall be installed in the exact locations shown or indicated on the Contract Drawings, at required elevations, true to orientation and level, assuring that the correct half of each roller is in its proper position. The Contractor shall store the rollers to protect them from mechanical damage prior to installation, and shall protect the same during and after installation from contamination and damage due to placing of concrete and other materials. The Contractor shall clean the operation surfaces of rollers thoroughly before final assembly.
2.04 SPRING TYPE HANGERS

A. Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. All spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. The support shall be designed for a maximum variation in supporting effort of 25 percent for the total travel resulting from thermal movement.

2.05 PIPE SUPPORT SPACING

A. The distance between supports for each size of pipe shall not exceed those listed in the attached schedule. However, if the pipe size to be supported is not listed in the schedule, the next smaller nominal pipe size spacing shall be used. In all cases, there shall be a minimum of one support per laying length of pipe on uninterrupted horizontal runs. This support shall be placed within one (1) foot of the joint. If the pipe manufacturer recommends a smaller spacing interval than specified herein, then the manufacturer's spacing shall be used.

B. The distance between supports shall not exceed that listed in the following schedule unless otherwise indicated on the Contract Drawings:

<table>
<thead>
<tr>
<th>Nominal Pipe Size (inches)</th>
<th>Metallic Piping (feet)</th>
<th>Plastic, Fiberglass and Copper Piping (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>3/4 to 1-1/2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>2 to 3</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>6 and larger</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>

2.06 PIPE HANGERS AND HANGER RODS

A. Where pipe hangers are used, they shall be of the clevis or friction clamp type except where there is longitudinal movement due to temperature changes. Where longitudinal movement occurs, the adjustable yoke roller type hanger shall be used. See the hanger schedule below for location/type of hangers to be used. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.

B. All hangers shall have a means of vertical adjustment after erection. Hangers shall be designed so that they cannot become disengaged by any movement of the supported pipe. Hangers subject to shock, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors.

C. Hangers shall be designed so that they can not become disengaged by movements of the supported pipe. Lock nuts shall be used on all hangers. All piping systems shall be supported by means of hangers having an individual means of vertical adjustment for leveling of lines after piping is in place.
D. Spacing and arrangements shall conform to the requirements of Section 6, Chapter 1 of ANSI B31-1 code for pressure piping. Spacing indicated shall be the maximum spacing.

E. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing. Stainless steel hangers required in the pipe hanger schedule shall be supported by hanger rods, hardware and inserts fabricated of Type 316 stainless steel.

F. All other rods, hardware and inserts shall be fabricated of hot-dip galvanized steel. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than ½-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

G. All concrete inserts and/or expansion bolts shall be capable of supporting the maximum working load of the rod which is attached to it.

H. Sheet metal insulation protector saddle shall be used for all hot water piping, refrigerant piping, etc.

I. A neoprene isolation pad shall be provided between galvanized clevis and stainless steel piping. For hot air applications, a teflon pad shall be provided.

2.07 SADDLES

A. Pipe saddles shall be used to cradle horizontal piping when being supported from below except where expansion of pipe requires rollers. All saddles shall be capable of being adjusted after installation.

2.08 BASE ELBOWS, TEES AND CONCRETE PEDESTALS

A. Base elbows, tees and concrete pedestals shall be provided at the locations shown on the Drawings and as specified. All vertical runs of pipe shall be supported on a base elbow and/or concrete pedestal. After completion of curing of the concrete pedestal, the piping shall be adjusted to the proper grade.

2.09 HARNESSED PIPE SUPPORTS

A. Pipe harness straps shall be provided on concrete pedestal supports where shown on the Drawings and required by these Specifications.

B. Harness straps shall be 1/4-inch thick, Type 316 stainless steel and attached to the concrete pedestal supports by stainless steel anchors.

C. Unless otherwise indicated on the Contract Drawings, strap width shall be in accordance with the Table below:

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Strap Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inches and below</td>
<td>2 inches</td>
</tr>
<tr>
<td>6 inches and above</td>
<td>3 inches</td>
</tr>
</tbody>
</table>

2.10 METAL FRAMING SYSTEMS
A. A metal framing system as manufactured by Unistrut, Globe-Strut or approved equal may be used for supporting the piping system. The metal framing system shall be designed and installed according to manufacturer's recommended procedure and shall be capable of supporting the piping system as specified herein.

B. Channels, inserts and closure strips shall be cold formed mild steel conforming to ASTM A-245.

C. Fittings shall be Hot Rolled Steel conforming to ASTM A-307. Fasteners shall conform to ASTM A-307. All pieces shall be hot-dip galvanized after fabrication, unless otherwise noted on the Drawings.

2.11 THRUST RESTRAINT

A. Pipe anchors shall be spaced to divide pipe into sections. Anchors shall be located at valves, changes in direction of piping, and major branch connections. Anchors shall be of a type recommended by the pipe manufacturer and reviewed by the Engineer.

B. On all piping, where sleeve type couplings and flanged adapters are located near fittings or valves, tie rods shall span across the coupling as specified herein to restrain movements of the pipe along its axial direction. Such restraints can be deleted if both ends of the pipe are anchored in a concrete structure with no fitting or valve occurring within the span length, in the suction piping to a pump where the coupling is between the pump and valve, or when the water pressure measured at the crown of the pipe is less than five (5) feet.

C. All sleeve type couplings shall be harnessed except where noted. The harnessing shall be as shown on the drawings or as specified herein. Harnesses for steel pipe shall be in accordance with AWWA Manual M11 for the pipe size and pressure, working or test whichever is greater.

D. Harnesses shall be tie rods spanning between adjacent flanges. Friction clamps shall not be permitted. The size and number of tie rods shall be the same as for steel pipe for the same pressure and pipe size.

E. Where the distance between adjacent flanges is in excess of ten (10) feet or where a harness can not be used, the pipe supports adjacent to the coupling shall restrain the piping preventing any linear or angular movement resulting in the pipe separating from the coupling or misalignment in the joint.

F. Where expansion joints are used, control units shall be provided. All tie rods and control units shall be installed in accordance with the manufacturer's recommended procedures.

G. Tie rods and associated hardware shall be Type 316 stainless steel.

H. In general, all valves and fittings shall be restrained in an approved manner such that the unbalanced force developed at them shall be supported independent of the piping system.

2.12 MANUFACTURED SUPPORTS

A. **Stock Parts:** Where not specifically shown or detailed, designs, generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.
B. Suppliers or equal:

1. Basic Engineers, Pittsburgh, PA;
2. Bergen-Paterson Corp., Boston, MA;
3. Elcen Metal Products Company, Franklin Park, IL;
5. NPS Industries, Inc., Secaucus, NJ;
6. Unistrut Corp., Itasca, IL.

2.13 COATING

A. Galvanizing: All fabricated pipe supports, other than stainless steel or non-ferrous supports, shall be blast cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General: All pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ANSI/ASME B31.1 and ANSI / ASME B31.3. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. Appearance: Pipe supports and hangers shall be positioned in such a way as to produce an orderly, neat piping system. All hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other Work.

C. Pipe Support Spacing: The distance between supports for each size of pipe shall not exceed those specified in 2.05.

3.02 FABRICATION

A. Quality Control: Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Welding shall conform to the Section entitled “Metal Fabrications”. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

- END OF SECTION -
SECTION 15030 – PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all components of the system for identification of piping and equipment as specified hereinafter. The system shall include the application of color coding to all new and altered plant piping. The Contractor shall paint the equipment and piping of all Contracts in the colors selected by the Owner, and in accordance with the requirements of the Section entitled “Painting”.

1.02 SUBMITTALS

A. The Contractor shall submit shop drawings and manufacturer’s product literature in accordance with the Sections entitled “Submittals” and “Materials and Equipment”.

B. In addition, the Contractor shall submit with the shop drawings a schedule of the colors and designations proposed for each service. A minimum of four (4) color charts with cross references to the colors and services listed herein shall be included with the Submittal. The Owner shall select the final color for each service during shop drawing review.

PART 2 - PRODUCTS

2.01 PIPING BANDS AND STRIPES

A. All new and altered piping shall receive identification bands. Such bands shall be 6-inches wide, neatly made by masking, and spaced at intervals of 30-inches on centers regardless of the diameter of the pipe being painted. The Contractor may use approved precut and prefinished metal bands on piping, in lieu of the masked and painted bands, where approved by the Engineer. Banding colors shall be as indicated in Article 2.03.

B. Buried potable water piping shall be identified by continuous blue stripes in accordance with FDEP 62-555.

2.02 PIPING IDENTIFICATION LETTERING AND ARROWS

A. The Contractor shall apply identification lettering in the form of plain upper-case block lettering giving the name of the pipe contents and arrows indicating the direction of flow of liquids to all types and sections of piping.

B. All lettering and arrows shall be of the vinyl, self-adhesive tape type or the plastic snap-on/strap-on type with self gripping fasteners. Pipe-marking devices (i.e., tape or snap-on/strap-on type) shall be suitable for a 5 to 8 year outdoor life without discoloration. Pipe marking devices shall be as manufactured by Lab Safety Supply, or equal.

C. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located every ten feet and shall be properly inclined to the pipe axis to facilitate easy reading. Lettering shall also appear directly adjacent to each side of any wall or slab the pipeline passes through, with a minimum of two titles on each pipe in one structure. Identification lettering shall be located midway between color coding bands where possible.
D. Lettering, background and arrow colors shall be the manufacturer’s standard colors unless otherwise directed by the Engineer.

E. All lettering and arrows shall have an overall height in inches in accordance with Table 15030-1.

<table>
<thead>
<tr>
<th>Diameter of Pipe or Pipe Covering</th>
<th>Height of Lettering</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 to 1 1/4 inches</td>
<td>1/2 inch</td>
</tr>
<tr>
<td>1 1/2 to 2 inches</td>
<td>3/4 inches</td>
</tr>
<tr>
<td>2 1/2 to 6 inches</td>
<td>1 1/4 inches</td>
</tr>
<tr>
<td>8 to 10 inches</td>
<td>2 1/2 inches</td>
</tr>
<tr>
<td>Over 10 inches</td>
<td>3 1/2 inches</td>
</tr>
</tbody>
</table>

F. The manufacturer’s instructions shall be followed in respect to storage, surface preparation and application.

G. For piping less than 3/4-inch diameter, the Contractor shall furnish and attach corrosion resistant color tags with the required lettering.

2.03 PIPING AND EQUIPMENT IDENTIFICATION SCHEDULE

A. The Contractor shall provide the colors selected by the Owner from the painting manufacturer’s color charts during shop drawing review.

PART 3 – EXECUTION (Not Used)

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide all tools, supplies, materials, equipment, and labor necessary for furnishing, epoxy coating, installing, adjusting, and testing of all valves and appurtenant work, complete and operable, in accordance with the requirements of the Contract Documents. Where buried valves are shown, the Contractor shall furnish and install valve boxes to grade, with covers, extensions, and position indicators.

B. The provisions of this Section shall apply to all valves and valve operators specified in the various Sections of these Specifications except where otherwise specified in the Contract Documents. Valves and operators in particular locations may require a combination of units, sensors, limit switches, and controls specified in other sections of these Specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Painting

B. Equipment General Provisions

C. Piping, General

D. Division 16 - Electrical

E. Division 17 - Instrumentation

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are specified in the Section entitled "Reference Standards."

B. Commercial Standards:

- ANSI B16.1: Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
- ANSI B16.5: Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
- ANSI/ASME BI.20.1: General Purpose Pipe Threads (Inch)
- ANSI/ASME B31.1: Power Piping
- ASTM A 36: Specification for Structural Steel
- ASTM A 48: Specification for Gray Iron Castings
- ASTM A 536: Specification for Ductile Iron Castings
- ASTM B 61: Specification for Steam or Valve Bronze Castings
- ASTM B 62: Specification for Composition Bronze or Ounce Metal Castings
ASTM B 148  Specification for Aluminum-Bronze Castings
ASTM B 584  Specification for Copper Alloy Sand Castings for General Applications
ANSI/AWWA C500  Gate Valves for Water and Sewerage Systems
ANSI/AWWA C504  Rubber-Seated Butterfly Valves
AWWA C508  Swing-Check Valves for Waterworks Service, 2 Inches Through 24 Inches NPS
ANSI/AWWA C509  Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewage Systems
AWWA C550  Protective Interior Coatings for Valves and Hydrants

1.04 SUBMITTALS

A. Shop Drawing:  Shop drawings of all valves and operators including associated wiring diagrams and electrical data, shall be furnished as specified in the Section entitled "Submittals".

B. Valve Labeling:  The Contractor shall submit a schedule of valves to be labeled indicating in each case the valve location and the proposed wording for the label. Reference Article 2.01 Paragraph O below for further details

1.05 QUALITY ASSURANCE

A. Valve Testing:  Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

B. Bronze Parts:  Unless otherwise specified, all interior bronze parts of valves shall conform to the requirements of ASTM B62, or, where not subject to dezincification, to ASTM B584.

PART 2 – PRODUCTS

2.01 VALVES

A. General:  The Contractor shall furnish all valves, gates, valve-operating units, stem extensions, and other accessories as shown on the Contract Drawings and specified. A valve schedule is provided at the end of this section to complement the Contract Drawings and is not intended to be all inclusive. All valves and gates shall be new and of current manufacture. All shut-off valves, 6-inch and larger, shall have operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing position indicators, and valve extensions. Shut-off valves mounted higher than 6-feet above working level shall be provided with chain operators. All valves shall have a minimum design pressure rating of 150 psi and capable of a test pressure of 300 psi. For service applications with pressures in excess of 150 psi, valves shall have a minimum pressure rating in excess of the service application working pressure.

B. Cast iron parts of valves shall meet the requirements of ASTM A126, "Standard Specifications for Grey Iron Castings for Valves, Flanges and Pipe Fittings, Class 'B'." Flanged ends shall be flat-faced and have bolt circle and bolt patterns conforming to ANSI B16.1 Class 125 unless otherwise specified hereinafter.
C. All castings shall be clean and sound, without defects of any kind and no plugging, welding or repairing of defects will be permitted. All bolt heads and nuts shall be hexagonal conforming to ANSI B18.2. Gaskets shall be full face and made of natural or synthetic elastomers in conformance with ANSI B16.21 suitable for the service characteristics, especially chemical compatibility and temperature. Nonferrous alloys of various types shall be used for parts of valves as specified. Where no definite specification is given, the material shall be the recognized acceptable standard for that particular application.

D. All buried valves shall be provided with cast-iron valve boxes unless otherwise indicated. The boxes shall be asphalt varnished, or enameled cast iron, adjustable to grade, and installed perpendicularly, centered around and covering the upper portions of the valve or valve operator, or the pipe. The top of each valve box shall be placed flush with finish grade unless otherwise indicated on the Drawings. Valve boxes shall be as specified elsewhere in this section.

E. All buried valves and other valves located below the concrete operating deck or level, specified or noted to be key operated, shall have an operator to finish grade or deck level, a 2-inch square AWWA operating nut, and cover or box and cover, as may be required.

F. **Valve Flanges:** Flanges on valves shall be in accordance with the Section entitled “Piping, General.”

G. **Gate Valve Stems:** Where subject to dezincification, gate valve stems shall be of bronze to ASTM B 62, containing not more than 5 percent of zinc nor more than 2 percent of aluminum. Where dezincification is not a problem, bronze to ASTM B 584 may be used. For valve stems with a minimum tensile strength of 60,000 psi, minimum yield strength of 40,000 psi, and an elongation of at least 10 percent in 2 inches, as determined by a test coupon poured from the same ladle from which the valve stems to be furnished are poured.

H. **Protective Coating:** Except where otherwise specified, ferrous surfaces, exclusive of stainless steel surfaces, in the water passages of all valves 4-inch and larger, as well as the exterior surfaces of all submerged valves, shall receive a fusion-bonded epoxy coating in accordance with AWWA C550. Flange faces of valves shall not be epoxy coated. The Contractor, through the valve manufacturer, shall certify in writing that such coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications.

I. **Valve Operators:** Valves and gates shall be furnished with operators, provided by the valve or gate manufacturer. All operators of a given type shall be furnished by the same manufacturer. All valve operators, regardless of type, shall be installed, adjusted, and tested by the valve manufacturer at the manufacturing plant. Operator orientation shall be verified with the Engineer prior to installation. If this requirement is not met, changes to orientation shall be made at no additional cost.

J. All operators, unless otherwise specified, shall turn counter-clockwise to open. Operators shall have the open direction clearly and permanently marked. In addition, all valve operators shall be provided with the valve by the valve manufacturer. The Contractor, through the valve manufacturer, shall be solely responsible for the selection of the proper operator to meet the operating conditions specified herein. Field calibration and testing of the operators and valves to ensure a proper installation and an operating system shall be the responsibility of the Contractor.
K. All manual operators shall have levers or handwheels, unless otherwise shown. Where buried, the valves shall have extensions with square nuts or floor stands. Valves mounted higher than 6 feet above floor or operating level shall have chain operators. Unless otherwise shown or specified, valves of sizes 4-inch and larger shall have gear-assisted operators.

L. Operation of valves and gates shall be designed so that the effort required to operate the handwheel, lever or chain shall not exceed 40 pounds applied at the extremity of the wheel or lever. The handwheels on valves 14 inches and smaller shall not be less than 8 inches in diameter, and on valves larger than 14 inches the handwheel shall not be less than 12 inches in diameter.

M. Chainwheel operator shall be fabricated of malleable iron and pocketed type chain wheels with chain guards and guides. Chainwheel operators shall be marked with an arrow and the word "OPEN" indicating direction to open. The operators shall have galvanized smooth welded link type chain. Chain that is crimped or has links with exposed ends shall not be acceptable.

N. Floor Stands: Floor stands shall be cast iron, non-rising stem type with lockable hand wheel operator, valve position indicator and steel extension stem. Hand wheel shall be lockable in the full closed position. The floor stand shall be furnished with an armored padlock and six keys. Lock shall be as manufactured by Master, Schlage or equal. Floor stand shall be standard pattern type as manufactured by Clow Corporation, or equal.

O. Valve Labeling: A label shall be provided on all valves exclusive of hose bibbs. The label shall be of 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, and shall be permanently attached to the valve or on the wall adjacent to the valve or as indicated by the Engineer.

PART 3 – EXECUTION

3.01 VALVE INSTALLATION

A. General: All valves, gates, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer’s written instructions and as shown and specified. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.

C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified or shown on the drawings, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

-END OF SECTION-
PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install electric operators, for new and existing valves and gates complete and operable, including all controls, motors, gears, etc., as shown and as specified herein, all in accordance with the requirements of the Contract Documents.

B. Electric operators shall be designed to unseat, open or close, and seat the valves or gates under the most adverse operating condition to which the valves or gates will be subjected. The safety margin of motor power available for seating and unseating the valves or gates shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The capacity of the operator and/or actuator shall be adequate to drive the valves or gates under the differential pressure and flow as specified in this section.

C. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Engineer. There shall be no mounting restrictions on the electric valve operator. Operators shall be furnished with conservatively sized extension bonnets, extension stems, or torque tubes, and all required adapters and appurtenances required for a complete installation. Operators furnished with extension bonnets shall include stainless steel extension stems, or stainless steel torque tubes. The electric operators for new and existing valves and gates shall be the full and undivided responsibility of the valve and gate manufacturers in order to ensure complete coordination of the components and to provide unit responsibility.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Materials and Equipment

B. Equipment Testing and Startup

C. Valves, General

D. Butterfly Valves

E. Electric Motors

1.03 QUALITY ASSURANCE

A. For all electric motor operators the Contractor shall assign the valve (or gate) manufacturer the responsibility of any field adjustments to set or program the operator to provide the required control functions. All wires of motor operators shall be identified with a unique number.

B. All valve and gate electric operators shall be supplied by the same manufacturer for standardization and unit responsibilities purposes. Contractor shall coordinate requirements with all valve and gate suppliers and existing equipment to ensure proper sizing and operation of all new and existing valves and gates fitted with electric operators.
C. **Shop Testing:**

1. Conduct a complete functional check of each unit. Correct any deficiencies found in shop testing prior to shipment.

2. Submit written certification that:
   
   a. Shop tests for the electrical system and all controls were successfully conducted;
   
   b. Electrical system and all controls provide the functions specified and required for proper operation of the valve operator system.

3. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment shall simulate each typical valve load and the following parameters should be recorded:
   
   a. Current at maximum torque setting
   
   b. Torque at maximum torque setting
   
   c. Flash Test Voltage
   
   d. Actuator Output Speed or Operating Time
   
   e. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

D. **Service of Manufacturer's Representative:**

1. Provide the services of a representative of the manufacturer(s) in order to:
   
   a. Check out and certify the installation(s);
   
   b. Provide assistance during field-tests;
   
   c. Instruct the City's operating personnel in proper operation and maintenance procedures for valves, geared operators, and electric actuators.

1.04 **SUBMITTALS**

A. Shop drawings of all proposed operators, including associated specifications, wiring diagrams, programming, register addresses, data communications configurations and proposed diagnostic and programming software as well as electrical data shall be furnished as specified in the Section entitled "Submittals."

1.05 **TOOLS, SUPPLIES AND SPARE PARTS**

A. Tools, supplies and spare parts shall be provided as specified in the Contract Documents and specified herein for the operation, programming and maintenance of the valve and gate operators.
B. Provide programming and diagnostic software, cables and special tools, other than those normally found in an electronic technician's tool box, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble equipment for service and maintenance (i.e., special tools, programmers/calibrators, indicator lamp insertion and removal tools, etc.).

C. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, programming/calibration unit, charger, special tools, cord extenders, and related items which are not specified but are necessary for checking field operation of equipment supplied under this Division.

D. Provide the following spare parts:
   1. One main controller circuit board
   2. One DeviceNet communications board
   3. Three of each type of fuse

PART 2 -- PRODUCTS

2.01 ELECTRIC MOTOR OPERATORS

A. All motorized valves shall be furnished by the Contractor through the valve and gate manufacturers as a complete package. Electric motor driven valve and gate operators shall be furnished and installed in accordance with the applicable requirements shown on the process and instrumentation diagrams and electrical elementary diagrams. Operators shall comply with AWWA requirements for electric operators.

B. Electric operators including the motor, all required gearing, integral continuous duty rated solid state reversing starter, position encoder, electronic torque sensor, AC line surge suppressors, programmable electronic controls and local control switches shall be provided. Electric motor operators/controllers shall be Limitorque MX or QX (for open/close service) or QX (for modulating service); Rotork IQ or IQT (for open/close service) or IQTM (for modulating service); or equal.

C. Unless otherwise indicated, or specified, motor operators shall be furnished complete with motors, torque switches, transmitters, electronic controllers, starters, incoming AC line power lightning and surge suppression, fiber optic data link interface (where shown on Drawings), terminal blocks, gear reducers, handwheel, and incidental accessories as required.

D. Stem Nut: The actuator for other than quarter turn valves shall have a stem nut of iron per AWWA C 540-93. The nut arrangement, where possible, shall be of the two-piece type or shall be part of a separate sub assembly to simplify field replacement.

E. Manual Operation: A handwheel shall be provided for manual operation. The handwheel shall not relocate during hand operation nor shall a fused motor prevent manual operation.

F. When in manual operating position, the 460 volt motor driven unit will remain in this position until motor is energized at which time the valve operator will automatically return to electric operation and shall remain in motor position until handwheel operation is desired. This movement from motor operation to handwheel operation shall be accomplished by a
positive declutching knob or lever which will disengage motor and motor gearing mechanically but not electrically. Hand operation must be reasonably fast and require no more than 80 pounds of rim effort at the maximum required torque. It shall not be possible for the unit to be simultaneously in manual and motor operation.

G. All motors on valves with nominal pipe sizes 16 inches and larger, all gate operators, or where otherwise required to meet the specified torque requirements, shall be furnished with 460 volts, three phase, 60 Hz AC reversible squirrel cage induction type motors and shall be specifically designed for continuous duty service. Motors shall be totally enclosed, non-ventilated, with NEMA Class H (modulating service) or Class F (open/close service) insulation and a maximum continuous temperature rating of 120 degree C (rise plus ambient). The electric motor shall have a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator. The motor shall include single phase protection. The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve and when torque is exceeded during valve travel. Leads from the motor shall be brought to the limit switch compartment without external piping or conduit box. The motor and contactor shall be capable of up to 1200 start/stops per hour for modulating service operators with 60 starts per hour for open/close service operators without overheating. Motor bearings shall be permanently lubricated by premium lubricant. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits, connected to a tripping device. Fast acting fuses shall be provided to protect solid state components. Solid state reversing starters utilizing thyristors shall be provided. 480 VAC disconnect switch with locking disconnect handle (30 amp, 3 pole, 480 volt, un-fused, NEMA 4X SS enclosure) shall be provided mounted within 6 feet of the actuator control housing.

H. Gears shall be rated at twice the output torque of the operator. Heavy-duty grease shall protect gearing and sealed ball bearings of the main shaft for five years without changing. Power gearing shall consist of helical or spur type gears of alloy heat-treated steel. Worm gears shall be carburized and hardened alloy steel and ground after heat treatment. The worm gear pinion shall be alloy bronze. The gearing shall be designed to allow field repair and change in gear ratio. All gearing shall be designed for 100 percent overload. Unless otherwise specified, gear ratios for quarter-turn valves shall be selected to provide a minimum travel time of 45 seconds from full-closed to full-open. Gear ratios for linear gates and devices shall be selected to provide a minimum travel time of 60 seconds from full-closed to full-open.

I. Torque capacity of the actuators shall be sufficient to operate the valves and gates with the maximum pressure differential indicated in the associated valve schedule with a safety factor of 1.5. Over travel of the operator shall be prevented by internal mechanical stops cast into the operator. A local continuous position indicator shall be provided. Actuators shall be equipped with declutch mechanism and hand wheel operator for manual operation. When the actuator is set in the declutched position for hand wheel operation, it shall return automatically to electric operation when actuator motor is energized. The hand wheel shall not rotate during electric operation nor shall a fused motor prevent hand wheel operation. Actuators shall be self-locking with non-back driving stem nuts.

J. Actuators shall be capable of operating in ambient temperatures ranging from -22 degrees F to +158 degrees F.
K. Actuators shall be provided with individual compartments for the motor, gearing, wiring terminals, and control circuits, including auxiliary switches plus position sensing device. Compartments shall be provided with moisture and dust-proof rigid cast covers meeting NEMA 6, certified to 10 feet of water for 48 hours. Where explosion hazard areas are shown or specified, actuator enclosures shall be explosion proof. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The inner seal shall fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling or transported by conduit. Double cartridge shaft seals shall be provided on the hand wheel and output shafts for weatherproof protection. All external fasteners shall be Type 316 stainless steel.

L. All motorized operators for valves with nominal pipe sizes less than 16 inches, and all modulating duty (if torque requirements specified herein are met) shall be designed for 480 VAC power supply but may contain DC power transformers and DC motors.

M. Speed-torque curves for the motors and torque calculations for seating, unseating, and running conditions shall be submitted. The maximum valve torque (seating/unseating) shall be less than 50 percent of stall torque or starting torque potential of the motor whichever is greater.

N. Electronic Controller: The electronic controller assembly and related control devices shall include but not be limited to the following:

1. Valve position shall be sensed by a 15-bit, optical, incremental or absolute position encoder or magnetic pulse system. Open and closed positions shall be stored in permanent, non-volatile memory. The controller shall measure and visually indicate valve position at all times, including during both motor and handwheel operation. Position indication shall be accomplished by integral LCD display and manual position indicator (a manual indicator is not required if a separate backup battery power supply is furnished for the LCD display).

2. An electronic torque sensor shall be included. The torque limit may be adjusted from 40-100% of rating in 1% increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a "Jammed Valve" protection feature, with automatic retry sequence, shall be incorporated to de-energize the motor if no movement occurs.

3. The control module shall include power and logic circuit boards, control transformer, and protection fuses. The module shall be easily removed through the use of plug-in connectors. The module shall also include a solid-state reversing starter, local control switches, LCD, and LED indicators. All internal wiring shall be flame-resistant, rated 105 degrees C, and UL listed.

4. The reversing starter shall be mechanically interlocked to prevent simultaneous energizing of the open and close coils. The control module shall also include an auto reversal delay to inhibit high current surges caused by rapid motor reversals. The control transformer shall include vacuum-impregnated coils and dual primary fuses. A phase correction circuit shall be included to correct motor rotation faults caused by incorrect site wiring. The phase correction circuit shall also detect the loss of a phase and disable operation to prevent motor damage.
5. A dedicated circuit to prevent undesired valve operation in the event of an internal circuit fault or erratic command signal shall be included. In the event of an internal circuit fault, an alarm shall be signaled by tripping the Monitor Relay providing a fault output through the data link and through the local LCD indication.

6. A monitor relay shall be included and shall trip when the actuator is not available for remote operation.

7. A Liquid Crystal Display (LCD) shall be included to display valve position as a percent of open, 0-100%, and current actuator status. "STATUS OK" shall be displayed for an operable actuator. If the actuator is not operable, the appropriate alarm shall be displayed. The alarm shall be continuously displayed until the actuator is operable. Red, green, and yellow LEDs shall be included for open, close, stopped, and moving indication.

8. All calibration shall be possible without removing any covers. A configurable password shall be available to prevent unauthorized changes.

9. The actuator shall be coated with a high-solids epoxy E-coat primer, and then finish-coated with a polymer powder coat. External fasteners shall be Type 316 stainless steel.

10. Diagnostic and programming facilities shall be included to program the unit as well as to accumulate and report the performance of the motor, position encoder or magnetic pulse system, cycle time, handwheel operations, actuator ID, and output turns. In addition, a torque profile of the reference baseline valve stroke and the last valve stroke shall be included. All diagnostic information shall be displayed on the LCD or through hand held infrared programming tool. Programming tool and accessories shall be provided.

11. A control station shall be incorporated integrally within the electronic controller housing to provide open/stop/close control and remote/local control of the operator with a locking facility. An auxiliary control station shall be provided for each actuator that is not accessible to the operator without a ladder (as shown on Drawings). Remote controls shall utilize a DeviceNet control data link interface. The DeviceNet data link shall provide for valve monitoring and control via the control system specified in Division 17.

12. Wiring terminals shall be embedded in a terminal block of high tracking-resistance compound. The power terminals shall be shrouded from the control terminals by an insulating cover. The terminal compartment shall be separated from the inner electronic controller compartment of the actuator by means of a watertight seal.

13. Controller shall be 'O' ring sealed, watertight, and dustproof to NEMA 6 minimum standard. The control modules shall have an inner watertight and dustproof 'o' ring seal between the terminal compartment and the internal electrical elements of the actuator, fully protecting the switch mechanism, and other internal electrical elements from moisture, and dust, when the terminal compartment cover is removed on site for cabling. Where explosion hazard areas are shown or specified, actuator enclosures shall be explosion proof. In explosion hazard areas, FM approval shall be to 3600 and 3615 Class 1 Div 1 Groups C&D. Class 2 Div 1E, F&G.
14. Incoming AC power lightning/surge protection shall be provided through a surge protection device mounted on the exterior of the case (screw in type) or in a separate adjacent enclosure. Protection device shall be Phoenix Contact VALVETRAB, or equal.

15. DeviceNet port lightning/surge protection shall be provided through a surge protection device mounted on the exterior of the case (screw in type) or in a separate adjacent enclosure specifically design for DeviceNet applications. Protection device shall be Phoenix Contact PLUGTRAB, or equal.

O. Local and remote commands, controls and status indication shall be provided as described herein.

1. Full open or full close service.
   a. Local operation
      LOCAL/REMOTE signal selector switch
      OPEN/CLOSE pushbuttons and status lights
      Fault indication
      0-100% position indication
   b. Remote operation
      Full OPEN status to control system
      Full CLOSED status to control system
      OPEN command (momentary discrete) from control system
      CLOSE command (momentary discrete) from control system

2. Modulating service
   a. Local operation
      LOCAL/REMOTE signal selector switch
      OPEN/STOP/CLOSE pushbuttons and status lights
      Fault indication
      0-100% position indication
   b. Remote operation
      0-100% position to control system
      0-100% position setpoint from control system

3. All service conditions remote monitoring
   a. In Remote status
   b. In Local status
   c. Actuator opening
   d. Actuator closing
   e. Battery low
   f. Electronic Fault
   g. Current actuator torque value
h. High torque FAULT  
i. Motor Overload  
j. Power Failure  
k. Lost Phase  

P. Controller programming, DeviceNet controller addressing, and signal data table addresses shall be coordinated with the Instrumentation and Control System Subcontractor.

Q. Actuators with the specified control interface shall be manufacturer’s standard design with a minimum of five years successful operating history. A minimum of ten installation references (with contact and phone number) shall be provided with the submittals.

2.02 MANUAL OPERATORS

A. Refer to the Section entitled "Valves, General".

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Valve and gate operators shall be installed in accordance with the Section entitled "Valves, General".

B. The Contractor shall coordinate electronic configuration and settings of each motorized operator to function with plant control systems and all applicable control strategies. Contractor shall coordinate with Instrumentation and Control System Subcontractor to determine optimal actuator settings for smooth and stable process control while minimizing actuator movements. As a minimum, the following actuator settings shall be configured (default values are given in parenthesis), subject to review by the Instrumentation and Control System Subcontractor and the Engineer during control system testing:

1. Action on loss of control signal (stay in last position)
2. Action on motorized operator failure (stay in last position)
3. Action on return of power following a power failure (do not fault, resume normal operations)
4. Control deadband (1%)
5. Minimum delay between valve movements (5 seconds)
6. Limits of valve or gate travel (adjusted by valve supplier)
7. Torque alarm limit (75%)
### Electric Operator Schedule

<table>
<thead>
<tr>
<th>ID Number</th>
<th>Service</th>
<th>Valve Type</th>
<th>Action Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOV 30000</td>
<td>Surface Scour Supply Throttling Valve</td>
<td>Butterfly</td>
<td>Modulating</td>
</tr>
<tr>
<td>MOV 31006</td>
<td>Filter No. 1 Flow Control Valve</td>
<td>Butterfly</td>
<td>Modulating</td>
</tr>
<tr>
<td>MOV 32006</td>
<td>Filter No. 2 Flow Control Valve</td>
<td>Butterfly</td>
<td>Modulating</td>
</tr>
<tr>
<td>MOV 33006</td>
<td>Filter No. 3 Flow Control Valve</td>
<td>Butterfly</td>
<td>Modulating</td>
</tr>
<tr>
<td>MOV 34006</td>
<td>Filter No. 4 Flow Control Valve</td>
<td>Butterfly</td>
<td>Modulating</td>
</tr>
<tr>
<td>MOV 30001</td>
<td>Backwash Supply Isolation Valve</td>
<td>(Existing Gate)</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 31001</td>
<td>Filter No. 1 Influent Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 31002</td>
<td>Filter No. 1 Backwash Supply Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 31003</td>
<td>Filter No. 1 Drain Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 31004</td>
<td>Filter No. 1 Waste Backwash Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 31005</td>
<td>Filter No. 1 Surface Wash Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 32001</td>
<td>Filter No. 2 Influent Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 32002</td>
<td>Filter No. 2 Backwash Supply Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 32003</td>
<td>Filter No. 2 Drain Valve</td>
<td>Butterfly</td>
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<td>MOV 32004</td>
<td>Filter No. 2 Waste Backwash Valve</td>
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<tr>
<td>MOV 32005</td>
<td>Filter No. 2 Surface Wash Valve</td>
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<td>Open / Close</td>
</tr>
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<td>MOV 33001</td>
<td>Filter No. 3 Influent Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 33002</td>
<td>Filter No. 3 Backwash Supply Valve</td>
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<td>Open / Close</td>
</tr>
<tr>
<td>MOV 33003</td>
<td>Filter No. 3 Drain Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 33004</td>
<td>Filter No. 3 Waste Backwash Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 33005</td>
<td>Filter No. 3 Surface Wash Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
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<td>MOV 34001</td>
<td>Filter No. 4 Influent Valve</td>
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<td>Open / Close</td>
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<td>MOV 34002</td>
<td>Filter No. 4 Backwash Supply Valve</td>
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<td>Open / Close</td>
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<tr>
<td>MOV 34003</td>
<td>Filter No. 4 Drain Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 34004</td>
<td>Filter No. 4 Waste Backwash Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
<tr>
<td>MOV 34005</td>
<td>Filter No. 4 Surface Wash Valve</td>
<td>Butterfly</td>
<td>Open / Close</td>
</tr>
</tbody>
</table>

1 Contractor/Supplier shall field verify existing valve conditions and furnish all requisite equipment, materials and labor as necessary to install a new operator on the existing valve.

- END OF SECTION -
SECTION 15106 - BALL VALVES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install ball valves, complete and operable, as shown and specified herein, including epoxy coating, appurtenances, operators, and accessories, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals

B. Valves, General

1.03 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with the Section entitled “Submittals.” The shop drawings shall include the following:

1. Manufacturer’s standard literature.

2. Dimension drawings for all valves to be supplied.

3. Valve manufacture’s recommended instructions for joining the valves and piping.

B. Operation and Maintenance Manuals: Submit shop drawings in accordance with the Section entitled “Submittals.” The shop drawings shall include the following:

1. Manufacturer’s standard literature.

2. Dimension drawings for all valves to be supplied.

3. Valve manufacture’s recommended instructions for joining the valves and piping.

PART 2 – PRODUCTS

2.01 STAINLESS STEEL BALL VALVES

A. Materials: Ball valves for use with stainless steel piping systems, including instrument isolation, air lines, and moisture drains and at all other locations shown on the drawings shall be 316 stainless steel body and trim.

B. Body Type: two or three piece design

C. Ends: flanged or threaded connections as indicated or as required to suit the intended service.

D. Seats and seals: Teflon

E. Ball: No internal ring for the ball shall be acceptable
F. **Class:** 150

G. Manually operated valves of 4-inch size and larger shall have right-angle gear type operators with handwheel. Manually operated valves of 2-inch size and larger that require proximity position switches shall have right-angle gear operators except that such valves may have lever operators through 3-inch size where the valve manufacturer offers compatible valve, operator and proximity switch units. The mounting of right-angle gear operators shall conform to ISO 5211.

H. **Manufacturers:**

1. ‘Apollo’ Valves manufactured by Conbraco Industries, Inc.
2. NIBCO
3. Valen Inc.
4. FNW Valve (Ferguson Enterprises, Inc.)
5. Jamesbury Corporation

I. **Spare Parts:** Furnish two (2) valves of each size installed as spare parts.

**PART 3 - EXECUTION**

3.01 **GENERAL**

A. All valves shall be installed in accordance with provisions of section entitled "Valves and Appurtenances". Care shall be taken that all valves in plastic lines are well supported on each end of the valve.

B. All valves shall be tested for unidirectional or bi-directional shut-off as required by service conditions.

- END OF SECTION -
SECTION 15110 - BUTTERFLY VALVES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Valves, General

B. Electric Operators

1.03 REFERENCE STANDARDS

A. ASME B16.1 Cast Iron Flanges and Flange Fitting

B. AWWA C504 Standard for Rubber Seated Butterfly Valves

PART 2 - PRODUCTS

2.01 BUTTERFLY VALVES (AWWA)

A. General: Butterfly valves for water working pressures up to 150 psi shall conform to ANSI/AWWA C504 Class 150B – Rubber Seated Butterfly Valves, subject to the following requirements. Valves shall be of the size and class indicated. Flanged valves shall have ANSI 125-lb flanges. Shaft seals shall be designed for use with standard split-V type packing or other acceptable seal. The interior passage of butterfly valves shall not have any obstructions or stops. The seats shall be positively clamped or bonded on body of the valve, but cartridge-type seats which rely on a high coefficient of friction for retention shall not be acceptable. Where rubber-lined bodies are required, the lining shall wrap around to cover the flange sealing face.

C. Manual Actuators: All manually-actuated valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator.

D. Electric Actuators: Actuators shall conform to the Section entitled “Electric Operators”

E. End Connections: End connections shall be flanged or mechanical joint as indicated on the Drawings.

F. Valve Body Material: Cast Iron ASTM A126 Class B or Ductile Iron ASTM A536 grade 65-45-12 per AWWA C504.

G. Shaft Material: Type 316 Stainless Steel, ASTM A276, Type 316.


I. Disk Material: Type 316 Stainless Steel, ASTM A743, Type CF8M

J. Disk Seating Edge Material (valves 3 to 20-inches): Type 316 Stainless Steel, ASTM A276, Type 316.
K. **Disk Seating Edge Material (valves 24-inches and Larger):** Type 316 Stainless Steel, ASTM A240, Type 316.

L. Manufacturers shall be DeZurik Corporation, Mueller Company, or equal.

**PART 3 - EXECUTION**

3.01 **INSTALLATION**

A. All exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. The installation shall be in accordance with the Section entitled “Valves, General”.

3.02 **PROTECTIVE COATINGS**

A. **Exterior Coatings for Aboveground Service:** Valve exterior shall be factory coated with a red phenolic primer paint. Primer shall be suitable for contact with potable water and shall meet the requirements of ANSI/NSF Standard 61: Drinking Water System Components. Primer shall be compatible with the finish coating specified in the Section entitled “Painting”.

B. **Interior Coatings for Aboveground Service:** Interior ferrous surfaces of valves that will be in contact with water shall receive a thermosetting epoxy coating conforming to AWWA C550. Coating shall be suitable for contact with potable water and shall meet the requirements of ANSI/NSF Standard 61: Drinking Water System Components.

- END OF SECTION -
SECTION 15114 - MISCELLANEOUS VALVES AND APPURTEINANCES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install miscellaneous valves as shown and as specified herein, complete and operable including protective coatings, appurtenant work and operators, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals
B. Painting
C. Valves, General

1.03 SUBMITTALS

A. Submit shop drawings and Operation and Maintenance Manual all in accordance with the Sections entitled “Submittals” and “Equipment General Provisions”.

PART 2 – PRODUCTS

2.01 AIR RELEASE VALVES (WATER SERVICE)

A. The internal mechanism shall be the compound lever type to permit the valve to open under pressure in order to vent pockets of entrapped air as they accumulate. The compound mechanism shall be activated by a stainless steel float to lift the Buna-N needle to shut off the air release orifice.

B. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. Manufacturers, Or Equal:
   1. APCO Valve and Primer Corporation
   2. Crispin (Multiplex Manufacturing Company)
   3. Golden-Anderson
   4. Val-Matic (Valve and Manufacturing Corporation)

PART 3 - EXECUTION

3.01 INSTALLATION

A. All valves shall be installed in accordance with the manufacturer's printed recommendations and the requirements of the Section entitled “Valves, General”.
SECTION 15800 – EXHAUST FAN

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, equipment and material for the complete installation of the exhaust fan as indicated on the Drawings and specified herein.

B. Work Included Under Other Sections:

1. Control and power wiring and conduit under Division 16, Electrical.

2. Motor starters under Division 16, Electrical, unless factory mounted and wired by equipment manufacturer.

1.02 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of the Section entitled “Submittals”.

B. Data to be submitted shall include but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.

3. Weight of all component parts and assembled weight.

4. Electrical characteristics, wiring, diagrams, etc.

5. Sample data sheet of equipment nameplate(s) including information contained thereon.

6. Details of special fasteners and accessories.

7. Type of adhesives, binders, joint cement, mastics.

8. Proposed insulation procedures and installation methods.

9. Spare parts list.

10. Special tools list.

11. Controls:

a. Wiring schematics indicating factory installed wiring as well as field
installed interconnection wiring between control panels, remote mounted starters, and remote mounted equipment.

b. Catalog data for all control panel components including but not limited to enclosures, controllers, starters, pilot lights, selector switches, pushbuttons, etc.

c. Control panel layout drawings.

C. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment.

1. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.

2. In addition to a full set of manuals with closeout documentation, each unit shall ship with its own manual in a watertight enclosure.

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.04 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers’ data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Submit all instruction books and manuals in accordance with Division 1.
PART 2 – PRODUCTS

2.01 GENERAL

A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.

B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.

C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial commercial grade.

D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located otherwise it shall cut all new openings required at its own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.

E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.

G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

2.02 EXHAUST FANS

A. Product and Manufacturer: Greenheck Company, Loren Cook Company, or approved equal.

B. General:

1. Discharge air directly away from the mounting surface

2. Sidewall mounted applications

3. Performance capabilities up to 6,400 cubic feet per minute (cfm) and static pressure to 2.25 inches of water gauge

4. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

5. Comply with the National Electrical Manufacturers Association (NEMA),
standards for motors and electrical accessories.

C. Wheel:

1. Material type: aluminum
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and

D. Motor:

1. Type: Single speed.
2. Enclosure: Totally enclosed, fan cooled (TEFC), solid shaft, ball bearing, energy efficient type (for motors 3/4 horsepower and larger).
3. Motor to be non-overloading at any point on operating curve of exhauster.
4. Mounting: Motor to be mounted on adjustable or slotted face plates with rubber or neoprene cushions.
5. Disconnects: Provide factory mounted factory wired, un-fused disconnects for all motors.
6. Overload Protection: Provide integral overload protection on all single phase motors.
8. Power Supply: As noted on Drawings.
9. Motor shall be in accordance with all current applicable standards to NEMA, IEEE, AFBMA, NEC and ANSI.
10. Motor efficiencies shall be determined in accordance with NEMA Standard.
11. Motor shall be premium efficiency supplied with Class F insulation and rated for continuous duty at 40 C ambient temperatures and 80 C (Class B) temperature rise at a 1.15 service factor.
12. Contractor to coordinate electrical conduit installation to fan motor.

E. Sequence of Operation: Fan shall operate through an ON/OFF switch with running pilot light.

1. In the “ON” position, fan shall run continuously and the running pilot light shall be illuminated.
2. In the “OFF” position, the fan shall not operate.
F. Disconnect Switches:
   1. NEMA Rating: 4X.
   2. Positive electrical shut-off
   3. Wired from fan motor to junction box installed within motor compartment

G. Bird Screen
   1. Material: Aluminum
   2. Protects fan discharge

H. Coatings: Hi-Pro Polyester

2.03 DAMPERS

A. General: All fans shall be installed with dampers whether shown on the Drawings or not. Dampers shall prevent outside air from entering back into the building when the fan is off.

B. Type: Counterbalanced, Gravity Operated, Industrial Grade

C. Frame Material: 316 Stainless Steel

D. Frame Type: Flanged Channel

E. Frame Gauge: 0.125 inches

F. Frame Depth: 8-inches (minimum)

G. Flange Width: 2-inches (minimum)

H. Mounting Hole Spacing on Flange: 6-inches on center (unless shown differently on the Drawings)

I. Mounting Hole Diameter: ½-inch (unless shown differently on the Drawings)

J. Blade Material: Aluminum

K. Axle Bearing: Acetal with Type 316 stainless steel ball

L. Axle Diameter: manufacturer’s standard

M. Axle Material: Type 316 stainless steel

N. Linkage Material: Type 316 stainless steel

O. Flow Direction: Horizontal

P. Factory Coatings: Hi Pro Polyester

Q. Basis of Design: Greenheck Model HB-110.
R. Balancing: Dampers shall be balanced for minimal resistance to flow.

2.04 NAME PLATES

A. White laminated phenolic plastic with minimum 3/16-inch high black engravings if viewing distance is less than 24-inches, ½-inch high lettering for distances up to 72-inches, and proportionately larger lettering for greater distances.

B. Nameplates shall be affixed with weatherproof adhesive.

C. Nameplates shall be provided at all thermostats, control switches, panels, or any other device providing information on equipment being controlled. Nameplates shall be provided on all HVAC equipment matching equipment scheduled identification numbering.

PART 3 – EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions.

3.02 EXAMINATION

A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.03 PREPARATION

A. Ensure openings are square, accurately aligned, correctly located, and in tolerance.

3.04 INSTALLATION

A. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings

B. Install fans in accordance with manufacturer's instructions.

3.05 ADJUSTING

A. Adjust exhaust fans to function properly

B. Adjust Belt Tension

C. Lubricate bearings

D. Adjust drive for final system balancing

E. Check wheel overlap

-END OF SECTION-
SECTION 15995 - PIPELINE TESTING AND DISINFECTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform flushing and testing of all pipelines and appurtenant piping, complete, including conveyance of test water from Owner designated source to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

B. Reference the Section entitled “Summary of Work” for construction sequencing restrictions.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards
   ANSI/AWWA B300 Hypochlorites
   ANSI/AWWA B301 Liquid Chlorine
   ANSI/AWWA C651 Disinfecting Water Mains
   ANSI/AWWA C600 Installation of Ductile Iron Water Mains and their Appurtenances

1.03 SUBMITTALS

A. A pumping and transmission equipment, testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval a minimum of 48 hours before testing on any particular pipeline is to commence.

PART 2 -- PRODUCTS

2.01 MATERIALS REQUIREMENTS

A. All test equipment, temporary valves or bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

PART 3 -- EXECUTION

3.01 GENERAL

A. Unless otherwise provided herein, water for testing pipelines will be from a Owner furnished source; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

B. All pressure and gravity pipelines shall be tested. All testing operations shall be performed in the presence of the Engineer.
3.02 TESTING OF PIPELINE

A. All equipment, including, but not limited to, pumps, gauges, and special fittings required to perform the testing shall be provided by the Contractor. The Contractor shall perform all excavation and other work required to locate and repair leaks and correct other defects which may be disclosed or develop under tests. The Contractor shall replace all coating, painting, backfill, or other permanent work removed in locating or repairing leaks and correcting defective piping. All gauges and control devices connected to lines being tested must be disconnected for the duration of the test. Water shall not be used in testing air lines, chlorine gas lines, or other gas carrying pipes. All tests shall be witnessed by the Engineer.

B. Prior to testing, all pipelines shall be flushed or blown out as appropriate. The Contractor shall test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of fourteen days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Care shall be taken to see that all air vents are open during filling.

C. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least twenty-four hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

D. Gravity sewer pipe or other pipe having free surface flow shall be given a water exfiltration test as specified herein. The Contractor has the option of using a low pressure air test in lieu of the water exfiltration test. If excessive groundwater is present which precludes use of the exfiltration test, the Contractor shall use either the low pressure air test or infiltration test.

E. Water lines, sewage force mains and other pressure piping carrying liquids having bell and spigot gasketed joints shall be given a pressure and leakage test in accordance with AWWA C-600 unless specifically modified herein.

F. PVC, steel, ductile iron or other pipe material, with solvent welded, welded, threaded, flanged, grooved end or flexible couplings and joints shall be pressure tested as specified above. No leakage shall be permitted.

G. No special pressure or leakage testing is required for gravity storm drain pipes. Leakage shall be minimized by installation in a workmanlike manner with no visible sources of leakage in accordance with the manufacturer’s recommendations.

H. Pressure air and gas piping carrying air or other gasses under pressure shall be given a pressure test as specified herein. No leakage is permitted. Low pressure air piping shall be tested pneumatically. Air pressure of 20 pounds per square inch shall be applied to piping and fittings. High pressure air piping shall be tested to 200 psi unless otherwise specified. There shall be no drop in pressure in a 24-hour period. Leaks shall be
located and repaired to the satisfaction of the Engineer. Pressure drops due to thermal contraction are acceptable if the pressure returns to the original test pressure after 24 hours.

I. Vent piping shall be filled with water to the top of the system for a period of 24 hours with no measurable leakage.

J. Pressure Tests

1. All pressure piping carrying liquids, including valves, shall be field-tested at a hydrostatic pressure equal to the pipe pressure class, corrected to the elevations of the test gauge, with duration of two hours minimum, for each pressure test, unless code requirements dictate a longer duration. Air piping shall be tested using air or nitrogen. Pressure tests shall be recorded by the Contractor. Copies of all test report forms shall be forwarded to the Engineer.

2. Temporary or permanent thrust blocks or bulkheads or restrained joints shall be placed as required prior to tests, and the Contractor shall provide all necessary braces, plugs, thrust blocks, caps, flanges, and other materials to permit proper performance of the pressure testing; tests shall not be conducted until it concrete thrust blocks are capable of withstanding the loads produced.

K. Leakage Tests: Leakage tests shall be conducted concurrently with the pressure test. The allowable leakage shall be determined in accordance with AWWA C-600. The duration of the test shall be not less than two hours. Measurement shall be made by means of a calibrated suction tank showing the amount of water required by the test pump to accurately maintain the specified test pressure. Tests shall be performed only in the presence of the Engineer, or, if scheduling of tests is such that the Engineer cannot attend due to conflicting commitment, tests may be performed without the Engineer’s presence if the Contractor obtains written permission to do so from the Engineer prior to initiation of testing. No test report will be accepted unless proof of compliance with the foregoing requirement accompanies the test report. Low pressure air test shall be conducted in conformance with ASTM C-828.

L. In the case of pipelines that fail to pass the prescribed leakage test, the Contractor shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall repeat the test until the testing requirements are met.

3.03 FLUSHING

A. All piping shall be flushed clean of all dirt and foreign material following completion of the hydrostatic and leakage test. Air and gas piping shall be purged with air or nitrogen gas as directed by the Engineer.

B. Equipment and Supplies. The Contractor shall provide all equipment, and supplies for performing the work, and shall waste the water at locations or by procedures approved by the Engineer.

3.04 DISINFECTION

A. Disinfection of potable water lines shall be performed in accordance with AWWA Standard C-651, State of Florida and local applicable regulations. The Contractor shall provide a Disinfection Plant to the Engineer for approval. The Contractor shall be
responsible for furnishing fittings and all special pipe taps required by the pipe disinfection work.

3.05 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

B. Prior to actual connections to the existing potable water system, record drawings, hydrostatic pressure test results, and bacterial test results shall be submitted to the Engineer. Upon approval from the Miami-Dade County Department of Health, the connection can be constructed.

-END OF SECTION-
SECTION 16010 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.02 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall be fungus-resistant.

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.03 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:

1. Local Laws and Ordinances.


4. State Fire Marshal.

5. Underwriters' Laboratories (UL).


8. National Electrical Manufacturer's Association (NEMA).


10. Institute of Electrical and Electronics Engineers (IEEE).

11. Insulated Cable Engineers Association (ICEA).

12. Occupational Safety and Health Act (OSHA).


15. Florida Building Code
B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the Engineer.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

1.04 ELECTRICAL COORDINATION

A. Work Provided Under this Contract:

1. Install new electrical service to rehabilitated filter gallery, including lighting, ventilation and power to new electric valve operators.

2. Install branch circuit for new air compressor.

3. Provide and install all conduit and conductors required for power, control and instrumentation systems.

4. Terminate power field wiring within the existing Electrical Room.

5. Terminate control and instrumentation field wiring within the existing Control Room at the upper level of the Filter Building.

6. Install new ground bus for instrumentation devices.

7. Coordinate power shutdowns with Owner and Engineer.

1.05 SUBMITTALS

A. Quality Control Submittals:

1. Voltage Field Test Results


4. Factory test certification and reports for all major electrical equipment.

5. Site test certification and reports as specified in other Division 16, ELECTRICAL sections.

6. As part of the electrical submittal, the Contractor shall provide a minimum of $\frac{1}{4}$"=1'-0" scaled layout of the electrical equipment in the electrical room or major electrical
equipment in a mechanical room showing sizes of all equipment and their spatial relationship. Non-electrical equipment shall be approved before finalizing the electrical layout in mechanical rooms.

B. The following information shall be provided for all electrical equipment:

1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.

2. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.

1.06 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be corrosive areas.

B. Electrical equipment in rooms designated as Classified by NFPA 70 (national electrical code) as Division 1 or Division 2 shall meet all requirements set forth for that classification as described in NEC article 500.

C. All indoor chemical and process equipment areas shall be considered wet locations.

1.07 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the Owner. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the Contractor's failure to fulfill this requirement.

1.08 RESPONSIBILITY

A. The Contractor shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions that affect the work covered under Division 16, ELECTRICAL.
3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

1.09 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.

B. All new electrical equipment sizes, characteristics, facilities and room layouts are based on manufacturer Cutler-Hammer. If the Contractor chooses to, and is allowed to substitute, the Contractor shall be responsible for fitting all the equipment in the available space as shown on the drawings or shall re-design the facilities at no additional cost to the owner. Re-design shall be submitted to the Engineer for review and approval. Any expenses associated with the review and approval of the redesign shall be the responsibility of the Contractor

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:
   1. Provide manufacturers' standard finish and color, except where specific color is indicated.
   2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 - EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.
C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.

2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

3. Record supply voltage (all three phases simultaneously on the same graph) for 24 hours during normal working day.
   a. Submit Voltage Field Test Report within 5 days of test.

4. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
   b. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.

2. Make line current check after Power Company has made final adjustments to supply voltage magnitude or balance.

3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

C. Startup:

1. Demonstrate satisfactory operation of all electrical equipment. Participate with other trades in all startup activities.

2. Assist the Instrumentation and Control (I&C) Contractor in verifying signal integrity of all control and instrumentation signals.

- END OF SECTION -
PART 1 - GENERAL

1.01 THE REQUIREMENT
   
   A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein, all in accordance with the requirements of the Contract Documents.

1.02 APPLICATIONS
   
   A. All exposed raceways shall be in rigid aluminum conduit except in concrete duct banks and in corrosive locations as described herein.
   
   B. Electrical metallic tubing conduit shall not be used on this project.
   
   C. PVC Schedule 40 conduit shall be used in concrete encasement.
   
   D. PVC coated aluminum conduit shall be used in all exposed corrosive locations.
   
   E. All instrumentation raceways for exposed installations shall be rigid aluminum conduits unless otherwise noted on the Drawings.
   
   F. Outlet, switch, pull and junction boxes for flush-mounting in general purpose locations shall be one-piece, galvanized, pressed steel. Ceiling boxes for flush-mounting in concrete shall be galvanized, pressed steel.
   
   G. Outlet, switch, pull and junction boxes where surface mounted in exposed locations shall be cast ferrous boxes with mounting lugs, zinc or cadmium plating, and enamel finish. Surface mounted boxes in concealed locations may be pressed steel.
   
   H. Outlet, switch, pull and junction boxes, including covers, for installation in corrosive locations shall meet the NEMA 4X requirements and shall be Type 316 stainless steel or fiber glass-reinforced polyester and shall be furnished with mounting lugs.
   
   I. All fittings, elbows, couplings, etc. shall be of similar material to the conduits for which they are to be used.

PART 2 -- PRODUCTS

2.01 GENERAL
   
   A. All conduit of a given type shall be the product of a single manufacturer.

2.02 RIGID CONDUIT
   
   A. Steel conduit shall be hot-dipped galvanized as manufactured by the Youngstown Sheet and Tube Company, Allied Tube and Conduit Corporation, Wheeling-Pittsburgh Steel Corporation, or equal.
   
   B. PVC conduit shall be rigid polyvinyl chloride type as manufactured by Carlon, Phillips Petroleum Company, Triangle Pipe and Tube Company, Inc., or equal.
2.03 PVC COATED GALVANIZED RIGID CONDUIT

A. PVC Coated Rigid Steel conduit shall be hot-dipped galvanized as manufactured by Robroy Industries, or equal.

2.04 RIGID ALUMINUM CONDUIT

A. Rigid Aluminum Conduit shall be manufactured of 6063 alloy in temper designation T-1. The fittings shall be the same alloy.

B. Rigid Aluminum Conduit shall be listed by Underwriters’ Laboratories to U.L. 6, “Standard for Rigid Metal Conduit” and shall be manufactured to ANSI C80.5. (Federal specification).

C. Underwriters’ Laboratories Electrical Construction Equipment Directory (UL Green Book) states that aluminum conduit used in concrete or in contact with soil requires supplementary corrosion protection. Examples are paints approved for the purpose (bitumastic paint, for example), tape wraps approved for the purpose, or PVC coated conduit.

D. Rigid aluminum conduit shall be as manufactured by Allied TUBE & CONDUIT, or equal.

2.05 LIQUID TIGHT, FLEXIBLE METAL CONDUIT, COUPLINGS AND FITTINGS

A. Liquid tight, flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Division, Anaconda American Brass Company, American Flexible Conduit Company, Inc., Universal Metal Hose Company, or equal.

B. Fittings used with flexible conduit shall be of the screw-in type as manufactured by the Thomas and Betts Company, Crouse-Hinds Company, or equal.

C. In Class I Division I or Division 2 areas flexible explosion proof fitting shall be used.

2.06 FLEXIBLE COUPLINGS

A. Flexible couplings shall be as manufactured by the Crouse-Hinds Company, Appleton Electric Company, or equal.

2.07 BOXES AND FITTINGS

A. Pressed steel switch and outlet boxes shall be hot-dipped galvanized as manufactured by the Raco Manufacturing Company, Adalet Company, O.Z. Manufacturing Company, or equal. To be used only with concealed, in walls, locations that require flush covers.

B. Cast iron boxes and fittings shall be galvanized with cast galvanized covers and corrosion-proof screws as manufactured by the Crouse-Hinds Company, Appleton Electric Company, or equal. To be used for all exterior mounted box locations.

C. Conduit hubs shall be as manufactured by Meyers Electric Products, Inc., Raco Division, Appleton Electric Company, or equal.

D. Conduit wall seals shall be Type WSK as manufactured by the O.Z. Electrical Manufacturing Company, or equal.
E. Combination expansion-deflection fittings shall be Type XD as manufactured by the Crouse-Hinds Company, or equal.

F. PVC conduit shall be rigid polyvinyl chloride type as manufactured by Carlon, Phillips

PART 3 - EXECUTION

3.01 INSTALLATION

Note: PVC conduit shall be used only for fiber optic cables on this project.

A. Minimum conduit size shall be 3/4 inch electrical trade size. Conduit runs shall be limited to three (3) 90 degree bends or maximum of 270 degrees in any one run. Pull boxes shall be provided as required.

B. An equipment grounding conductor sized per article 250-95 of the NEC shall be installed in every raceway whether or not shown on the Drawings.

C. All underground conduit shall be buried at least 24 inches below grade. All joints shall be sealed with plastic tape. Twelve (12) inch minimum separation shall be maintained between shielded instrumentation wiring and all other conduits. This applies to exposed as well as buried installations.

D. A three (3) inch wide warning tape, yellow with black stenciled letters "CAUTION - CAUTION - CAUTION ELECTRICAL LINE BURIED BELOW" shall be installed at least 12 inches above, and along the entire length of all underground conduit.

E. No wire shall be pulled until the conduit system is complete in all details, or in the case of concealed work, until all rough plastering or masonry has been completed.

F. The ends of all conduits shall be tightly plugged to exclude dust and moisture while the buildings are under construction.

G. Conduit supports shall be spaced, as a minimum, at intervals as required by N.E.C. to obtain rigid construction.

H. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with Type 316 stainless steel horizontal members and threaded Type 316 stainless steel hanger rods. The rods shall be not less than 1/4 inch diameter.

I. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the wedge type shall be used. Tapcon type fasteners shall not be used.

J. All conduits on exposed work shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run straight and true.

K. No unbroken run shall exceed 500 feet in length. This length shall be reduced by 75 feet for each 90 degree elbow.
L. Liquid tight flexible metal conduit (between 18 inches and 3 feet in length) shall be used for all motor terminations and for terminating other equipment where vibration is present. All flexible conduits shall use a bonding wire unless a ground wire is included.

M. Flexible couplings shall be used in all locations for all motor terminations and other equipment where vibration is present.

N. Conduit wall seals shall be used for all conduits penetrating walls.

O. Both ends of all conduits terminating in panels, cabinets, and equipment in air-conditioned rooms shall be filled with closed cell foam. Filling shall be done after the cable has been pulled in order to prevent moisture condensation in the terminating enclosure.

P. Conduit stub outs for future construction shall be provided with threaded PVC end caps at each end.

Q. PVC Coated Galvanized steel conduit entering manholes and below grade pull boxes shall be terminated with grounding type bushings and connected to a 5/8" x 10' ground rod with a #6 bare copper wire.

R. Metallic raceways installed below-grade in outdoor locations, or in concrete shall be made up with a conductive waterproof compound applied to threaded joints. Compound shall be Zinc Clad Primer Coatings No.B69A45, HTL-4 by Crouse-Hinds, Kopr Shield by Thomas & Betts, or equal.

S. Erickson couplings shall be used at all points of union between ends of rigid steel conduits which cannot be coupled. Running threads and threadless couplings shall not be used. Couplings shall be 3-piece type such as Appleton Type EC, equivalent types such as manufactured by T&B, Steel City, Efcor, O-Z/Gedney, or equal.

T. All conduits terminating through concrete shall be PVC Coated hot-dipped galvanized steel to 6 inches above slab and shall be embedded in a 4-inch high housekeeping pad.

U. All pull boxes, junction boxes, etc., with 277 Volts to ground or higher and larger than 6"x6" shall be provided with a warning sticker that reads "DANGER HIGH VOLTAGE".

V. Conduit shall be terminated with flush couplings at exposed concrete surfaces. Conduit stubbed up for floor-standing equipment shall be placed in accordance with approved shop drawings.

W. Conduit may be cast integral with horizontal and vertical concrete slabs, providing one-inch clearance is maintained between conduit surface and concrete surface. If said clearance cannot be maintained, the conduit shall be installed exposed outside elevated slabs. Conduit shall be installed at least 12" below the slab on grade.

X. Where a run of concealed PVC conduit becomes exposed, a transition to rigid coated aluminum conduit is required. Such transition shall be accomplished by means of a factory elbow or a minimum 3-foot length of rigid steel conduit, either terminating at the exposed concrete surface with a flush coupling. Piercing of concrete walls by non-metallic runs shall be accomplished by means of a short steel nipple terminating with flush couplings.

Y. Expansion fittings shall be installed wherever a raceway crosses a structural expansion.
joint. Such fittings shall be expansion and deflection type and shall accommodate lateral and transverse movement. Fittings shall be O-Z/Gedney type “DX", Crouse Hinds "XD", or equal. These fittings are required in metallic and non-metallic raceway installations. When the installation is in a non-metallic run, a 3-ft length of rigid conduit shall be used to connect the non-metallic conduit to the fitting.

Z. Conduit penetrations on walls and concrete structures shall be performed in accordance with the following:

1. Seal all raceways entering structures at the first box or outlet with suitable fire retardant plastic expandable compound to prevent the entrance into the structure of gases, liquids, or rodents.

2. Dry pack with non-shrink grout around raceways that penetrate concrete walls, floors, or ceilings above ground, or use one of the methods specified for underground penetrations.

3. Where an underground conduit enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide an acceptable, malleable iron, watertight, entrance sealing device. When there is no raceway concrete encasement specified or indicated, provide such device having a gland type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement specified or indicated, provide such a device with a gland type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.

4. Where an underground raceway without concrete encasement enters a structure through a non-waterproofed wall or floor, install a sleeve made of Schedule 40 galvanized pipe. Fill the space between the conduit and sleeve with a suitable plastic expandable compound, on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device as specified may be used in lieu of the sleeve.

- END OF SECTION -
SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Furnish, install, and test all wire, cable, and appurtenances as shown on the Drawings and as specified herein, all in accordance with the requirements of the Contract Documents.

1.02 SUBMITTALS

A. Submit shop drawings for the following if applicable for project:

1. All wires and cables.
2. Cable lubricants.
3. Wire and cable tags.

PART 2 - PRODUCTS

2.01 GENERAL

A. All wires and cables shall be manufactured by the American Insulated Wire Company, Belden Corporation, Cable Continental, Pirelli Cable Corporation, Southwire Company, the Okonite Company, Rome Cable Corporation, or equal.

2.02 GENERAL USE WIRES

A. Wires for general use shall be rated 600 volts and shall meet the following requirements:

1. Conductors shall be Class B stranded, annealed, uncoated copper.
2. Insulation shall be type XHHW rated 75 degrees C in damp or wet locations and 90 degrees C in dry locations.
3. No wire smaller than No.12 AWG shall be used, for power, unless specifically indicated.

2.03 INDIVIDUAL OR MULTI-CONDUCTOR CONTROL CABLES

A. All control cables shall be rated 600 volts and shall meet the following requirements:

1. Conductors shall be rated No.14 AWG, Class B Stranded, annealed, uncoated copper.
2. Insulation shall be type XHHW rated 75 degrees C in wet locations and 90 degrees C in dry locations.
3. The overall jacket (for multi-conductor cables) shall be flame retardant PVC U.L. listed for cable tray installation.

2.04 INDIVIDUAL SHIELDED INSTRUMENTATION CABLES

A. Shielded instrumentation cables shall be rated 600 volts and shall meet the following requirements:
1. Individual shielded cable shall consist of 2 or 3 twisted, No.16 AWG, Class B stranded, annealed, uncoated, copper conductors.

2. Insulation shall be PVC/Nylon rated 75 degrees C in wet locations and 90 degrees C in dry locations.

3. Individual twisted pairs or triads shall be shielded with an aluminum foil/polyester tape shield with an individual No.18 AWG, stranded, tinned copper drain wire.

4. The overall jacket shall be flame retardant PVC U.L. listed for cable tray installation. A ripcord shall be laid longitudinally under the jacket to facilitate its removal.

5. The cable shall be rated for installation in underground conduit.

6. Cable shall be Belden 9342, or equal.

2.05 RTD CABLE

A. RTD cable shall be rated 300 volts and shall meet the following requirements:

1. Three (3) tinned copper 16 gage conductors with bedfoil aluminum shield, 18 AWG stranded copper drain wire.

2. The cable shall be rated for installation in underground conduit.

3. The contractor shall verify the type of cable required for the RTD with the RTD supplier prior to purchasing the cable and provide the correct cable.

2.06 CABLE TRAY CABLE

A. Cable shall be rated for 600 volts. Power and control tray cable shall be type TC, U.L. listed. Grounding conductor shall be installed as specified on the Drawings. Number and size of conductors shall be as indicated on the Drawings. The cable shall meet the following standards:


2. The conductors shall be stranded copper. Insulation shall be rated 90 degrees C dry, 75 degrees C wet. Each insulated conductor shall be sheathed with clear nylon jacket.

3. The PVC insulation shall be coded in accordance with NEMA WC-30 Color Code K 2. Each cable shall have a 90 degree C rated PVC jacket over the taped assembly. The jacket shall be abrasion, oil and chemical resistant and highly flame retardant.

4. Cable shall be Okonite FMR Okolon type, or equal.

2.07 TERMINATIONS

A. Cable terminations shall be as follows:

1. Compression connectors shall be Burndy "Hi Lug", Thomas & Betts "Shure Stake", or equal. Threaded connectors shall be split bolt type of high strength copper alloy.

2. Spring connectors (wire nuts) shall be 3M "Scotch Lok," "Ideal Wing Nuts", or equal.
3. Pre-insulated fork tongue lugs shall be "Thomas & Betts" RC Series, Burndy, or equal.

4. General purpose insulating tape shall be Scotch No. 33, Plymouth "Slip-knot", or equal. High temperature tape shall be polyvinyl by Plymouth, 3M, or equal.

5. Epoxy resin splicing kits shall be 3m Scotchcoat 82 Series, Burndy Hy Seal, or equal.

6. 5KV cables shall be terminated with stress cone terminators.

2.08 ACCESSORIES

A. Wire and cable accessories shall meet or exceed the level of quality provided by the manufacturers below:

1. Spring connectors (wing nuts): 3M, or equal.

2. Insulated fork compression terminals: 3M, Thomas & Betts, or equal.

3. Compression connectors: Burndy, Thomas & Betts, or equal.

4. Split bolt connectors: Burndy, Thomas & Betts, or equal.

5. General purpose tape: Scotch Brand, or equal.

6. High temperature (fireproofing) tape: Scotch Brand, or equal.

7. Glass cloth tape: Scotch Brand, or equal.

8. Low voltage splice Kits: Raychem (heat shrink types), or equal.

9. Low voltage motor terminations: Raychem (heat shrink types), or equal.

10. Identification devices shall be either imprinted plastic-coated cloth marking devices as manufactured by Thomas & Betts, or equal, shall be heat-shrink plastic tubing.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Conductors shall not be pulled into raceways until the raceway system has been inspected and approved by the Engineer, has been cleared of all moisture and debris, and all plastering and concrete work has been completed in the affected areas.

B. Conductors shall be installed in a manner such that the installed conductors will be free of kinks or other insulation damage.

C. Cable lubricants shall be used to facilitate wire pulling. Lubricants shall be U.L. listed for the type of insulation to which they are applied. Lubricants shall also be approved by the manufacturer of the cable to which they are applied.

D. Steel fish tapes or steel pulling cables shall not be used in PVC conduit runs.

E. Shielding on instrumentation wire shall be grounded at the transmitter end only, or as directed by the supplier of the instrumentation equipment.
F. Shielded instrumentation wire shall be installed from terminal to terminal with no splicing at any intermediate point.

G. Cable pulling tensions shall not exceed the maximum pulling tension specified by the cable manufacturer. The Contractor shall require the cable supplier to calculate all pulling tensions in duct banks. Maximum allowable limit calculations and results shall be submitted for engineers review. In case pulling tension would exceed the supplier units, recommendation shall be made to the engineer for solution.

H. Where exposed in manholes and pull boxes, medium voltage cables shall be fireproofed for their entire length by using electrical fireproofing tape anchored by an outer wrapping of glass cloth tape. All wrappings shall be made using 50 percent lap.

I. Splicing of cables will not be approved unless the length of the conduit run exceeds the manufacturer's standard shipping length of cable. The Engineer's written approval shall be obtained by the Contractor prior to any proposed splicing of cables. Splicing required due to incorrectly purchased cable length will not be approved.

3.02 TERMINATIONS AND SPLICES (LOW VOLTAGE)

A. Termination of power cable shall be by means of U.L. approved connectors. All connectors shall be compatible with the conductor material.

B. Terminate all control and instrumentation cable with insulated fork compression terminals.

C. All branch circuit wiring except motor branch circuit conductors may be spliced in suitable fittings at locations determined by the Contractor. Motor branch circuit conductors shall not be spliced.

D. Where splicing is allowed, splices shall be made with U.L. approved compression connectors, and splices shall be made waterproof except in indoor, above grade locations.

E. Terminations to motor leads in motor terminal boxes shall be made using Raychem's MCK-V motor connection kit, or equal, where applicable. All other motor terminations shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of two layers of varnished cambric tape with a minimum of two layers of high temperature tape.

3.03 TESTING

A. General

1. All field testing shall be performed after the cables are installed in the raceways and prior to connection to equipment.

2. Field testing shall be an independent, certified testing organization approved by the Engineer. The testing organization and test set operator shall have at least two (2) years of experience in testing low and medium voltage cables. Certification of experience shall be submitted to the Engineer at least 30 days prior to cable testing.

3. Field test results shall be submitted to the Engineer for approval prior to cable energization.

4. Cables which fail any part of their field tests shall be replaced with new cable and retested.

B. Low Voltage Wire and Cable Test Requirements:
1. All 600 volt power wire and cable shall be tested for insulation resistance between each phase to ground using a megohmmeter. If insulation resistance values are found to be less than the values recommended by IPCEA then the cables shall have failed this test. Branch circuit wiring for all but motor branch circuits are exempt from this testing requirement.

2. All control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and point of origination.

3.04 IDENTIFICATION

A. Each wire or cable in manholes, pull boxes, wireways, cabinets, panels, switchgear, and other similar accessible locations shall have attached a means of permanent identification in accordance with the cable and conduit schedules on the Drawings. Provide permanent, waterproof, non-metallic (paper is unacceptable) tags indicating the circuit numbers in 3/16 inch letters. Circuit numbers shall be protected with clear, shrinkable tubing.

B. All 208Y/120 volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A-black, Phase B-red, Phase C-blue, and Neutral-white. The 480Y/277 volt system conductors shall be color coded as follows: Phase A-brown, Phase B-purple, Phase C-yellow, and Neutral-gray. Color coding tape shall be used where colored insulation is not provided. Branch circuit switch legs shall be yellow, insulated ground wires shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the site. Bus bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs.

C. The Contractor shall assign to each control and instrumentation wire and cable a unique identification number. Said numbers shall be assigned to all conductors having common terminals and shall be shown on all shop drawings. Identification numbers shall appear within three (3) inches of conductor terminals. "Control" shall be defined as any conductor used for alarm, annunciator, or signal purposes.

1. Multi-conductor control and instrumentation cable shall be assigned a number which shall form a part of the individual wire number. The instrumentation cable numbers shall incorporate the loop numbers shown on the Drawings.

2. General purpose ac control cables shall be pink. General purpose dc control cables shall be blue.

3. All spare cables shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

4. Terminal strips shall be identified by imprinted, varnished, marker strips attached under the terminal strip.

- END OF SECTION -
SECTION 16440 - DISCONNECT SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install separately mounted, individual disconnect switches as specified herein and indicated on the Drawings.

B. Reference the Section entitled “Basic Electrical Requirements”.

1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests
   a. None required.

2. Field Tests
   a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications as referenced in Section 16000, Basic Electrical Requirements.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the Section entitled “Submittals”, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.
2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.

3. Assembled weight of each unit.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.05 TOOLS, SUPPLIES, AND SPARE PARTS

A. The equipment shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment, and with all spare parts as recommended by the equipment manufacturer.

B. One (1) complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.

C. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

D. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size switch shall have the same parts number.

1.06 IDENTIFICATION

A. Each equipment item shall be identified with a nameplate plus all other required safety labeling. The nameplate shall be engraved indicating the circuit number and equipment name with which it is associated.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Switches shall be manufactured by the Eaton Corporation, Square D Company, or the General Electric Company.

2.02 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Drawings and as required by the NEC. Handles shall be lockable.

B. Switches shall be NEMA Type HD, single-throw, externally operated, fused or non-fused as required. Switches of the poles, voltage, and ampere ratings shown shall be furnished in
NEMA 1A (gasketed) enclosures in indoor dry areas, and in NEMA 4X Type 316 stainless steel enclosures for damp/wet indoor process areas. Enclosures for outdoor applications shall be NEMA 4X aluminum or Type 316 stainless steel. Switches located in hazardous areas shall be suitable for the Class, Division, and Group to suit the application.

C. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.

D. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.

E. Fused disconnect switches shall be furnished for all motor operated valve and gate actuators unless otherwise noted. The Contractor shall coordinate the supply of these fused switches with the specific requirements of the actuator. Fuses with fast fault clearing times may be required for modulating valve actuators.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All disconnect switches shall be mounted with the top of disconnect at 66" above the floor unless otherwise indicated or if conditions suggest that a different height is more appropriate.

B. The Contractor shall furnish and install fuses of various types as required with the continuous ampere ratings as required or shown on the Drawings.

- END OF SECTION -
SECTION 16450 - GROUNDING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this Section:


B. Submittals

1. Shop Drawings:
   a. Product Data:
      1) Exothermic weld connectors.
      2) Mechanical connectors.
      3) Compression connectors.

C. UL Compliance

1. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 - PRODUCTS

2.01 GROUND ROD

A. Material: Copper clad.
B. Diameter: Minimum 5/8 inch.
C. Length: 20 feet.

2.02 GROUND CONDUCTORS

A. As specified in the Section entitled “Conductors”.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Use low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.; Cadweld and Cadweld Exolon
b. Thermoweld

B. Compression Type:
   1. Compress deforming type; wrought copper extrusion material
   2. Single indentation for conductors 6 AWG and smaller
   3. Double indentation with extended barrel for conductors 4 AWG and larger
   4. Barrels pre-filled with oxide inhibiting and anti-seizing compound and sealed
   5. Manufacturers:
      a. Burndy Corp
      b. Thomas and Betts Co
      c. Ilso Corp

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
   1. Manufacturers:
      a. Burndy Corp.
      b. Thomas and Betts Co.

2.04 GROUNDING WELLS
A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:

PART 3 - EXECUTION
3.01 GENERAL
A. Grounding shall comply with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:
   1. Ground shield to ground bus at power supply for analog signal.
   2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
   3. Do not ground control cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.
3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:
   1. Above grade Connections: Use exothermic weld, mechanical, or compression-type connectors.
   2. Below grade Connections: Install exothermic weld type connectors.
   3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
   4. Notify Engineer before backfilling ground connections.

B. Exothermic Weld Type:
   1. Wire brush or file contact point to bare metal surface.
   2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
   3. Avoid using badly worn molds.
   4. Mold to be completely filled with metal when making welds.
   5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:
   1. Install in accordance with connector manufacturer's recommendations.
   2. Install connectors of proper size for grounding conductors and ground rods specified.
   3. Install using connector manufacturer's compression tool having proper sized dies and proof of calibration within the last 12 months.
D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.
B. Bond electrical equipment supported by metal platforms to the platforms.
C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.
B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.
C. Make connections of grounding conductors fully visible and accessible.
D. Connect all non current-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.
B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.
C. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.11 INSTRUMENT GROUND - SURGE SUPPRESSION

A. Connect all instrument surge protection with #6 insulated copper groundwire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:
B. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.

C. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.

D. Provide air terminals as required.

E. Bond steel columns or major framing members to grounding system per National Electrical Code.

F. Bond each main down conductor to grounding system.

G. All conduits terminations in panels shall be grounded using appropriate ground bushing and conductor to nearest ground point.

3.13 GROUNDING SYSTEM

A. Grounding Conductor:

B. Completely encircle building structure.

C. Bury minimum 30” below finished grade.

D. Minimum 2 feet distance from foundation walls.

E. Interconnect ground rods by direct-buried copper cables.

F. Connections:
   1. Install ground cables continuous between connections.
   2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and non-accessible connections.
   3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
   4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
   5. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.
   6. Provide electric service arrestor ground wire to building water main.

- END OF SECTION -
SECTION 16461 - DRY TYPE DISTRIBUTION TRANSFORMERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, and test transformers for power and lighting distribution systems as specified herein, as indicated on the Drawings, and as required to complete the electrical installations.

B. All equipment specified in this Section shall be furnished by the transformer manufacturer who shall be responsible for the suitability and compatibility of all included equipment.

C. Reference the Section entitled “Basic Electrical Requirements”.

1.02 CODES AND STANDARDS

A. Transformers shall conform to all applicable Federal, UL, and NEMA standards. Materials and components shall be new and conform to grades, qualities and standards as specified herein and shown on the Drawings.

B. Transformers shall comply with the following industry standards:
   1. UL Listing/Approval
   2. NEMA Standard TP-1-2002
   3. National Electrical Code

1.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

   1. Witnessed Shop Tests
      a. None required.
   2. Certified Shop Tests
      a. The transformers shall be given routine factory tests in accordance with the requirements of the ANSI and NEMA standards. Temperature rises may be certified from basic design.
      b. As a minimum, the following tests shall be made on all transformers:
         i. Ratio tests on the rated voltage connection and on all tap connections.
         ii. Polarity and phase-relation tests on the rated voltage connection.
         iii. Applied potential tests.
         iv. Induced potential tests.
         v. No-load and excitation current at rated voltage on the rated voltage connection.
3. **Field Tests**
   
   a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.
   
   b. After installation, the transformers shall be subjected to routine insulation resistance tests. The tests shall be made by the Contractor who shall also furnish the required testing equipment.

1.04 **SUBMITTALS**

A. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.
2. Operation and Maintenance Manuals.
3. Spare Parts List.
4. Special Tools List.
5. Reports of Certified Shop Tests.

B. Each submittal shall be identified by the applicable specification section.

1.05 **SHOP DRAWINGS**

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein, and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.
2. Drawings showing clearly marked dimensions and weight for each transformer.
3. Sample equipment nameplate diagram.

D. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings.

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.06 **OPERATION AND MAINTENANCE MANUALS**
A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.07 TOOLS, SUPPLIES AND SPARE PARTS

A. The transformers shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

B. Spare parts lists, included with the Shop Drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.08 IDENTIFICATION

A. Each transformer shall be identified with the equipment item number indicated on the Contract Drawings and the accepted Shop Drawings. A nameplate shall be securely affixed in a conspicuous place on each transformer.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Dry type distribution transformers shall be Energy Star compliant and manufactured by the Square D Company, the General Electric Company, or Eaton Corporation.

2.02 DRY TYPE TRANSFORMERS

A. Furnish and install single-phase and three-phase general purpose, dry-type transformers, as specified herein and indicated on the Drawings. The transformers shall be 60 Hz, self-cooled, quiet-design insulated of the two winding type.

B. The transformers shall be Underwriters Laboratories, Inc. listed and shall bear the UL label.

C. The primary windings shall be rated 480 VAC for use on 3-phase systems and connected delta unless indicated otherwise on the Drawings. KVA ratings shall be as shown on the Drawings. Furnish transformers with two 2-1/2% primary taps above, and four 2-1/2% primary taps below rated voltage for transformers 15 KVA and above, and two 2-1/2% primary taps above, and two 2-1/2% primary taps below rated voltage for transformers less than 15 kVA. All taps shall be full capacity rated.

D. The ratings of the secondary windings shall be as indicated on the Drawings.

E. Transformers shall be designed for continuous operation at rated KVA, 24 hours a day, 365 days a year, with normal life expectancy as defined in IEEE 65 and ANSI C57.96. This
performance shall be obtainable without exceeding 150 degrees Celsius average temperature rise by resistance or 180 degrees Celsius hot spot temperature rise in a 40 degrees Celsius maximum ambient and 30 degrees Celsius average ambient. The maximum coil hot spot temperature shall not exceed 220 degrees Celsius. All insulating materials shall be flame retardant and shall not support combustion as defined in ASTM Standard Test Method D 635. All insulating materials shall be in accordance with NEMA ST 20 Standard for a 220 degrees Celsius UL component recognized insulation system.

F. Transformer coils shall be of the continuous wound copper construction and shall be impregnated with nonhygroscopic, thermosetting varnish.

G. Transformers shall have copper windings.

H. All cores are to be constructed of high grade, nonaging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current loses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be tightly clamped and compressed with structural steel angles. The completed core and coil shall then be bolted to the base by means of vibration-absorbing mounts to minimize sound transmission. There shall be no metal-to-metal contact between the core and coil assembly and the enclosure.

I. The enclosure shall be made of heavy gauge Type 316 stainless steel.

J. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees Celsius. Transformers shall be furnished with lugs of the size and quantity required and suitable for termination of the field wiring.

K. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.

L. Transformers shall have core and coil assemblies mounted on rubber isolation pads to minimize the sound levels. The transformers shall not exceed the following ANSI sound levels:

- 0 to 9 kVA 40 dB
- 10 to 50 kVA 45 dB
- 51 to 150 kVA 50 dB
- 151 to 300 kVA 55 dB
- 301 to 500 kVA 60 dB

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The transformers shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.

B. Conduit routed to and from the transformer shall be arranged for easy removal of the transformer.

-END OF SECTION-
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install panelboards of voltage and current ratings as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles and locations conforming to the panelboard schedules on the Drawings.

B. Reference the Section entitled “Basic Electrical Requirements”.

1.02 CODES AND STANDARDS

A. Panelboards shall conform to all applicable Federal, UL, and NEMA standards. Materials and components shall be new and conform to grades, qualities and standards as specified herein and shown on the Drawings.

B. Panelboards shall comply with the following industry standards:

1. UL Listing/Approval
2. UL Standards
   a. Panelboards - UL 67
   b. Cabinets and Boxes - UL 50
3. National Electrical Code
4. NEMA Standard - PB1

1.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests
   a. None required

2. Field Tests
   a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and the Section entitled “Basic Electrical Requirements”.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the Section entitled “Submittals”, the Contractor shall obtain from the equipment manufacturer and submit the following:
1. Shop Drawings.
2. Reports of Certified Shop Tests.
3. Spare Parts List.
4. Operation and Maintenance Manuals.

B. Each submittal shall be identified by the applicable specification section.

1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:
   1. Product data sheets.
   2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.
   3. Complete panelboard schedules indicating circuit designations and connected loads as shown on the Drawings for each panelboard.

D. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings.

1.06 TOOLS, SUPPLIES AND SPARE PARTS

A. The panelboards and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer. All spaces in the panelboards shall be furnished with a spare breaker as indicated in the panelboard schedules shown on the Drawings.

B. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.07 IDENTIFICATION

A. Each panelboard shall be identified with the identification number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard. Nameplates shall be laminated white plastic engraved to a black core with ¼-inch lettering.
PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 CONDUCTORS (MAIN BUS AND BRANCH CONNECTORS)

A. All main bus shall be copper sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above a maximum ambient temperature of 40 degrees C.

2.03 LIGHTING PANELBOARDS

A. General

1. Lighting panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal-overload, branch circuit breakers. Panelboards shall be of the configuration and rating as specified herein and indicated on the Drawings. Panelboards shall be service entrance rated where indicated on the Drawings.

2. Lighting panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers, as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting. Some panelboards shall be furnished and installed within motor control center structures as shown on the Drawings.

3. Lighting panelboards shall be fully rated and shall have a minimum short circuit rating of 10,000 amperes symmetrical, unless otherwise indicated on the Drawings.

4. Lighting panelboards shall be Eaton Corporation Pow-R-Line Series, the Square D Company equivalent, or the General Electric Company equivalent.

B. Enclosures

1. Except for lighting panelboards installed in motor control centers, the enclosure shall be NEMA 4X, constructed of Type 316 stainless steel unless otherwise indicated on the Drawings. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. All locks shall be keyed alike. The enclosure shall have wiring gutters on sides and shall be at least 5-3/4 inches deep. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

2. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet.

C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full
capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.

2. Solid neutral bus bars are required. Ratings shall be in accordance with applicable standards.

3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.

4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.

5. All bus shall be tin plated copper and shall extend the entire useable length of the panelboard, including spaces.

D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type conforming to NEMA Standard AB 1. All circuit breakers shall have quick-make, quick-break, and toggle mechanism for manual as well as automatic operation. Tandem or half-size circuit breakers are not acceptable. Branch circuit breakers used for control, instrumentation, telephone, fire alarm, or auxiliary equipment circuits requiring continuous operation shall be provided with a lock-on device.

2. Where indicated, or where required by Code, circuit breakers for receptacle circuits shall be equipped with integrally mounted ground fault interrupters complete with "TEST" push button and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.

3. Circuit breaker voltage ratings shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 240 VAC that matches the panelboard short circuit rating.

E. Directories

1. Approved directories with glass or noncombustible plastic cover and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

F. Surge Protective Devices

1. The lightning panelboards shall be furnished with integrated Type II surge protective devices (SPD). SPDs shall be provided in the location and quantity as shown on the Drawings.
2. The SPD shall be rated, designed, tested, listed, and labeled in accordance with UL-1449, third edition. Products labeled in accordance with previous editions of UL-1449 are not acceptable.

3. The SPD shall be factory installed by the lightning panelboard manufacturer using a direct bus connection. There shall be no cable connection between the bus bar and the SPD device.

4. The SPD shall have a fault current rating equal to or greater than that of the fault current rating of the lightning panelboard. The SPD shall employ metal-oxide varistor (MOV) technology. If integral fusing is used, the fuses shall allow the maximum rated surge current to pass without fuse operation.

5. The SPD shall have a maximum continuous operating voltage (MCOV) of at least 115% of the nominal voltage of the switchgear. The Voltage Protection Rating (VPR) of the SPD shall be submitted for Engineer review.

6. The Nominal Discharge Current (In) of the SPD shall be 20kA, minimum. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.

7. The SPD shall provide ten modes of protection for Wye connected systems, and seven modes of protection for Delta connected systems.

8. The SPD shall be furnished with an audible alarm and silence pushbutton, integral SPD status LEDs (one per phase), and a Form C dry contact for remote indication of alarm. A surge counter shall also be provided.

9. The SPD equipment shall be Clipper Power System by Eaton Corporation, SurgeLogic by the Square D Company, or Tranquell by the General Electric Company.

2.04 POWER DISTRIBUTION PANELBOARDS

A. General

1. Power distribution panelboards shall be of the configuration and rating as specified herein and as indicated on the Drawings. The panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal overload branch circuit breakers. Panelboards shall be service entrance rated where indicated on the Drawings.

2. Power panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting. Some panelboards shall be furnished and installed within motor control center structures as shown on the Drawings.

3. Power distribution panelboards shall be fully rated and shall have a minimum short circuit rating of 65,000 amperes symmetrical unless otherwise indicated on the Drawings.

4. Power distribution panelboards shall be Eaton Corporation Pow-R-Line Series, the Square D Company equivalent, or the General Electric Company equivalent.
B. Enclosures

1. Except for power panelboards installed in motor control centers, the enclosures shall be NEMA 4X constructed of Type 316 stainless steel unless otherwise indicated on the Drawings. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. All locks shall be keyed alike. The enclosure shall have wiring gutters on sides and shall be at least 5¾-inches deep. The panel shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

2. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet.

C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1,000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.

2. Solid neutral bus bars, where required, shall be provided. Ratings shall be in accordance with applicable standards.

3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.

4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.

5. All bus shall be tin plated copper and shall extend the entire useable length of the panelboard, including spaces.

D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type conforming to NEMA Standard AB 1. All circuit breakers shall have quick-make, quick-break, and toggle mechanism for manual as well as automatic operation.

2. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked “SWD” where required by Article 440 by the NEC. Circuit breakers installed for air conditioning units shall be HACR type.

3. Circuit breaker voltage rating shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A, unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 480 VAC that matches the panelboard short circuit rating.

E. Directories

1. Approved directories with glass or noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be provided in each panel. The
Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

F. Surge Protective Devices

1. The power panelboards shall be furnished with integrated Type II surge protective devices (SPD). SPDs shall be provided in the location and quantity as shown on the Drawings.

2. The SPD shall be rated, designed, tested, listed, and labeled in accordance with UL-1449, third edition. Products labeled in accordance with previous editions of UL-1449 are not acceptable.

3. The SPD shall be factory installed by the power panelboard manufacturer using a direct bus connection. There shall be no cable connection between the bus bar and the SPD device.

4. The SPD shall have a fault current rating equal to or greater than that of the fault current rating of the power panelboard. The SPD shall employ metal-oxide varistor (MOV) technology. If integral fusing is used, the fuses shall allow the maximum rated surge current to pass without fuse operation.

5. The SPD shall have a maximum continuous operating voltage (MCOV) of at least 115% of the nominal voltage of the switchgear. The Voltage Protection Rating (VPR) of the SPD shall be submitted for Engineer review.

6. The Nominal Discharge Current (In) of the SPD shall be 20kA, minimum. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.

7. The SPD shall provide ten modes of protection for Wye connected systems, and seven modes of protection for Delta connected systems.

8. The SPD shall be furnished with an audible alarm and silence pushbutton, integral SPD status LEDs (one per phase), and a Form C dry contact for remote indication of alarm. A surge counter shall also be provided.

9. The SPD equipment shall be Clipper Power System by Eaton Corporation, SurgeLogic by the Square D Company, or Tranquell by the General Electric Company.

2.05 COMBINATION POWER UNITS

A. The Contractor shall furnish and install a combination power unit as specified herein and indicated on the Drawings. The unit shall be a combination of a dry type transformer and a lighting panelboard. Transformer rating and panelboard bus rating shall be as indicated on the Drawings. The transformer and panelboard shall meet the requirements for these products as specified herein and elsewhere in these Specifications. Combination power units located outdoors shall be suitable for outdoor use and rated NEMA 3R.
B. The combination power unit shall be a Mini-Power Zone as manufactured by the Square D Company, a Mini-Power Center as manufactured by Cutler-Hammer, Servicecenter as manufactured by General Electric Company, or Siemens Energy and Automation, Inc. equivalent.

PART 3 -- EXECUTION

3.01 MOUNTING

A. Panelboards and combination power units shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.

B. Panelboards shall be set true and plumb in locations as shown on the Drawings. The top of panelboard enclosure shall not exceed six feet above finished floor elevation.

C. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.

D. The Contractor shall not use factory furnished knockouts with surface back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush back boxes with manufacturer's standard pattern of knockouts. The Contractor shall equip cabinet doors exceeding 40 inches in height with vertical bolt three point locking mechanism.

E. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.

F. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.02 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each panelboard. The mat shall be long enough to cover the full length of each panelboard. The mat shall be located so as not to obstruct the movement of the panel door. The mat shall be 1/4 inch thick with beveled edges, canvas back, sold type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes, or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION -
SECTION 17000 - CONTROL AND INFORMATION SYSTEM, GENERAL

PART 1 -- GENERAL

1.01 SCOPE

A. The Contractor shall provide, through the services of the instrumentation and control system subcontractor, all components, system installation services, as well as all required and specified ancillary services in connection with the Instrumentation, Control and Information System. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified. The system shall include all measuring elements, signal converters, transmitters, control panels, cabinets, digital hardware and software, operator interface terminals, signal and data transmission systems, interconnecting wiring, brackets, supports, piping, tubing, valves, mounting hardware, and such accessories as shown, specified, and/or required to provide the functions indicated.

B. The general scope of work to be performed under this Division includes, but is not limited to, the following:

1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.

2. Furnish and install process instrumentation and associated taps, nipples, valves, tubing, and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.

3. Furnish and install control equipment, operator interfaces, field panels and associated cabinets and control panels as shown on the drawings and as specified in this Division.

4. Furnish and install digital control system hardware and software as specified in this Division, including but not limited to:
   a. Programmable logic controller and appurtenances.
   b. DeviceNet networks and appurtenances.
   c. Ethernet switch, cables, and appurtenances.
   d. Operator interface terminal, control panel and appurtenances.

5. Final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under this Division.

6. Furnish and install transient voltage surge suppression systems for all digital equipment, data communications equipment, local control panels, and field instruments provided under this Division, including connections to grounding system(s) provided under Division 16.

7. Coordinate grounding requirements with the electrical subcontractor for all digital equipment, local control panels, and field instrumentation provided under this
Division. Terminate grounding system cables at all equipment provided under this Division.

8. Provide system testing, calibration, training and startup services as specified herein and as required to make all systems fully operational.

9. Furnish and install embedded supports, instrument stands, brackets, mounting hardware, piping, tubing, isolation valves and related items required for instrumentation and equipment furnished under Division 17.

10. The Contractor shall coordinate all work specified herein with related work specified in other Divisions, and shall schedule the work to minimize downtime of plant equipment and controls as described in Section 01520 Maintenance of Utility Operations During Construction. The Contractor shall provide temporary equipment and interconnecting cables as described herein and as shown on the Drawings.

C. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

A. Field mounted switches, torque switches, limit switches, valve and gate operator position transmitters, sump pump controls and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested and calibrated as specified under other Divisions.

B. Additional and related work performed under Division 16 includes the following:

1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, UPS and A.C. power supplies for all equipment, control panels and accessories furnished under Division 17.

2. Conduit and raceways for all instrumentation and control system signal wiring, grounding systems, special cables and data highway cables.

3. Instrumentation and control system signal wiring. See termination requirements below.

4. Install (pull in conduit system) data highway network, profibus, and other copper and fiber optic data communications cables.

5. Furnish and install grounding systems for all digital equipment, local control panels, and field instrumentation provided under Division 17. Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor.

6. Termination of all instrumentation and control system grounding, signal and data communications cables, wiring and surge suppression devices at the equipment end of all equipment furnished under other Divisions of the Specifications. Wiring
systems shall be installed complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor.

7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g. panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.

B. In order to centralize responsibility, it is required that all equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.

C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems and shall provide for the services of a qualified installation engineer to supervise all activities required to place the completed facility in stable operation under full digital control.

D. The instrumentation and control system shall be capable of simultaneously implementing all real-time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of any system component. It shall also be possible to simultaneously generate displays on all workstations and print out data on all printers without degradation of system performance.

E. Control system inputs and outputs are listed in the Input/Output Schedule. This information, together with the control strategy descriptions, process and instrumentation diagrams, and electrical control schematics, describes the real-time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.

F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field-mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under
other Divisions of the Specifications to determine all requirements to interface same with the control and information system. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.

G. The instrumentation subcontractor shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the Electrical Contractor for suitability for use with the associated cable system.

H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the Electrical Contractor and to the instrumentation subcontractor furnishing the equipment under this Division.

I. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

J. The Owner shall have the right of access to the subcontractor's facility and the facilities of its equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The instrumentation subcontractor and its equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

K. The terms "Instrumentation", "Instrumentation and Control System", and "Instrumentation, Control and Information System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the Specifications.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for municipal water treatment facilities. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. The instrumentation and control system subcontractor shall have completed at least one project within the past five years that included the installation and programming of Allen Bradley CompactLogix Series PLCs for automated process controls. As used herein, the term “completed” shall mean that a project has been brought to final completion and final payment has been made. Any instrumentation and control system subcontractor that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five calendar years shall not be acceptable.

1.05 DEFINITIONS

A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical
relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.

B. **Bit or Data Bit:** Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.

C. **Integrated Circuit:** Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

D. **Mean Time Between Failures (MTBF):** The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.

E. **Mean Time to Repair (MTTR):** The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.

F. **Availability:** The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

\[
A = 100 \times \frac{MTBF}{MTBF + MTTR} \text{ Percent}
\]

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

\[
A = A_2 + 1 - ((1-A_1) \times (1-A_1))
\]

where:

\[
A_1 = \text{availability of non-redundant device or system}
\]

\[
A_2 = \text{availability of device or system provided with an automatically switched backup device or system}
\]
G. **Abbreviations:** Specification abbreviations include the following:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Availability</td>
</tr>
<tr>
<td>ADC</td>
<td>Analog to Digital Converter</td>
</tr>
<tr>
<td>AVAIL</td>
<td>Available</td>
</tr>
<tr>
<td>ATA</td>
<td>Advanced Technology Attachment</td>
</tr>
<tr>
<td>BCD</td>
<td>Binary Coded Decimal</td>
</tr>
<tr>
<td>CSMA/CD</td>
<td>Carrier Sense Multiple Access/Collision Detect</td>
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<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>CRC</td>
<td>Cyclic Redundancy Check</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
</tr>
<tr>
<td>CS</td>
<td>Control Strategy</td>
</tr>
<tr>
<td>DAC</td>
<td>Digital to Analog Converter</td>
</tr>
<tr>
<td>DBMS</td>
<td>Data Base Management System</td>
</tr>
<tr>
<td>DDR</td>
<td>Double Data Rate</td>
</tr>
<tr>
<td>DIMM</td>
<td>Dual In-line Memory Module</td>
</tr>
<tr>
<td>DMA</td>
<td>Direct Memory Access</td>
</tr>
<tr>
<td>DPDT</td>
<td>Double Pole, Double Throw</td>
</tr>
<tr>
<td>DVD</td>
<td>Digital Video Disc</td>
</tr>
<tr>
<td>DVE</td>
<td>Digital to Video Electronics</td>
</tr>
<tr>
<td>ECC</td>
<td>Error Correction Coding</td>
</tr>
<tr>
<td>EPROM</td>
<td>Erasable Programmable Read Only Memory</td>
</tr>
<tr>
<td>FDM</td>
<td>Frequency Division Multiplexing</td>
</tr>
<tr>
<td>FSK</td>
<td>Frequency Shift Keyed</td>
</tr>
<tr>
<td>GB</td>
<td>Gigabyte</td>
</tr>
<tr>
<td>Gbps</td>
<td>Gigabits per second</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>MB</td>
<td>Megabyte</td>
</tr>
<tr>
<td>Mbps</td>
<td>Megabits per second</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Center</td>
</tr>
<tr>
<td>MTBF</td>
<td>Mean Time Between Failures</td>
</tr>
<tr>
<td>MTTR</td>
<td>Mean Time To Repair</td>
</tr>
</tbody>
</table>
OS - Operating System
OIT - Operator Interface Terminal
PCB - Printed Circuit Board
PLC - Programmable Logic Controller
RAID - Redundant Array of Inexpensive Discs
PROM - Programmable Read Only Memory
RAM - Random Access Memory
RMSS - Root Mean Square Summation
ROM - Read Only Memory
RTU - Remote Telemetry Unit
SATA - Serial ATA
SCADA - Supervisory Control and Data Acquisition
SDRAM - Synchronous Dynamic Random Access Memory
SIMM - Single In-line Memory Module
SPDT - Single Pole, Double Throw
TB - Terabyte
TDM - Time Division Multiplexing
TFT - Thin Film Transistor
USB - Universal Serial Bus
UPS - Uninterruptible Power Supply
WAN - Wide Area Network

H. To minimize the number of characters in words used in textual descriptions on displays, printouts and nameplates, abbreviations may be used subject to Engineer approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.06 ENVIRONMENTAL CONDITIONS

A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.

B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees Celsius; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees Celsius with relative humidity between 40 and 95 percent.
D. Outdoor equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees Celsius and relative humidity from 10 to 100 percent. All supports, brackets and interconnecting hardware shall be aluminum or Type 316 stainless steel as shown on the installation detail drawings.

PART 2 -- PRODUCTS

2.01 NAMEPLATES

A. All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to Engineer approval.

B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.

C. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

PART 3 -- EXECUTION

3.01 SCHEDULE OF PAYMENT

A. Payment to the Contractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System including, but not necessarily limited to, the following items:

1. Mobilization
2. Shop Drawing Submittals
3. Process Instrumentation
4. Control Panels
5. PLC Programming
6. OIT Programming
7. Process Instrumentation Testing and Startup
8. Control Panel Loop Testing


10. Training

11. Final System Acceptance Testing

12. Final Acceptance

B. Requests for payment for materials and equipment that are not installed on site, but are required for shop fabrication and testing (e.g., PLC hardware), or are properly stored as described in the Contract Documents and herein, shall be accompanied by invoices from the original supplier to the Contractor or instrumentation subcontractor substantiating the cost of the materials or equipment.

C. No payment for PLC or OIT programming shall be paid prior to approval of associated shop drawings. Upon approval of programming shop drawings, up to 50% of programming shall be payable. Upon completion of on-site PLC loop checkout, up to 70% of programming shall be payable. Upon completion of functional tests, up to 90% of programming shall be payable. The remaining 10% shall be payable upon completion of the Final Acceptance Test.

D. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance Test.

3.02 CLEANING

A. The Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials.

B. Upon completion of the instrumentation and control work, the Contractor shall remove all surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.03 FINAL ACCEPTANCE

A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:

1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.

2. Completion of the Availability Demonstration of the System as a whole.

3. Completion of all punch-list items.

B. Refer to Section 01700 entitled “Project Closeout” for additional requirements.

- END OF SECTION -
SECTION 17030 - CONTROL AND INFORMATION SYSTEM SUBMITTALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall submit complete Shop Drawings for all equipment in accordance with the General Conditions and Division 1 of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals

B. Control and Information System

1.03 DIGITAL HARDWARE SUBMITTALS

A. Submit system block diagram(s) showing:
   1. All equipment to be provided.
   2. All interconnecting cable.
   3. Equipment names, manufacturer, and model numbers.
   4. Equipment locations.

B. Submit information for all digital equipment including, but not limited to, the following:
   1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
   2. Catalog cuts, including complete part number breakdown information.
   3. Complete technical, material and environmental specifications.
   4. Assembly drawings.
   5. Mounting requirements.
   6. Color samples.
   7. Nameplates.
   8. Environmental requirements during storage and operation.

1.04 SOFTWARE SUBMITTALS

A. Software submittals shall include the following as a minimum:
1. Bill of materials with software names, vendors, and complete listings of included software modules.

2. Standard manufacturer’s literature describing the products.

3. Description of function of software in Control and Information System.

4. Limitations or constraints of software.

5. Minimum system (processor and memory) requirements.

6. Operation and maintenance requirements.

B. Submit information on the following software:

1. Third-party software, including:
   a. Operating system.
   b. Programmable controller programming software (where applicable).

2. Software configuration, including:
   a. Graphic display organization.
   b. Database configuration.
   c. Trends.
   d. System security.
   e. Formats for all reports, including all required calculations.
   f. Intercommunications between software products required to implement system functions.
   g. Equipment backup configuration and requirements.

C. Control Strategies

1. Provide control strategy documentation that includes control strategy diagrams (block oriented logic and ladder logic diagrams, as appropriate) to describe the control of all processes. The written description shall follow the format of the functional control descriptions contained herein. The control strategy submittals shall contain the following as a minimum:
   a. An overall description of the program structure and how it will meet the specified control requirements.
   b. A listing of the program.
   c. Extensive comments in the listings to describe program steps.
d. Equation and ladder program derivations for all specified control routines.

e. Resource (processor and memory) requirements.

f. A listing of inputs and outputs to the control strategy.

D. Application Software

1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include VBASIC and C programs, and any other add-in custom software.

E. Graphic Displays

1. Submit all graphic displays required to perform the control and operator interface functions specified herein.

2. Submit graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.

3. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.

4. Two of the required submittals in each revision cycle shall be full color prints of the entire set of displays. Additional sets may be in black-and-white or gray-scale.

5. Displays shall be printouts of actual process graphics implemented in the system.

1.05 CONTROL PANEL SUBMITTALS

A. Submittals shall be provided for all control panels, and shall include:

1. Exterior panel drawings with front and side views, to scale.

2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.

3. Panel area reserved for cable access and conduit entry.

4. Location plans showing each panel in its assigned location.
B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
2. Catalog cuts, including complete part number breakdown information.
3. Complete technical, material and environmental specifications.
4. Assembly drawings.
5. Mounting requirements.
6. Color samples.
7. Nameplates.
8. Environmental requirements during storage and operation.

C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

1.06 INSTRUMENT SUBMITTALS

A. Submit information on all field instruments, including but not limited to the following:

1. Product (item) name and tag number used herein and on the Contract Drawings.
2. Catalog cuts, including complete part number breakdown information.
3. Manufacturer's complete model number.
4. Location of the device.
5. Input - output characteristics.
6. Range, size, and graduations.
7. Physical size with dimensions, NEMA enclosure classification and mounting details.
8. Materials of construction of all enclosures, wetted parts and major components.
9. Instrument or control device sizing calculations where applicable.
10. Certified calibration data on all flow metering devices.
11. Environmental requirements during storage and operation.
1.07 WIRING AND LOOP DIAGRAMS

A. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.

B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11-inch by 17-inch reproducible prints.

C. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4, Figures 1-3, Minimum Required Items.

D. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.

1.09 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall deliver equipment operation and maintenance manuals in compliance with Section 01300 - Submittals. Operation and maintenance (O&M) manuals shall consist of two basic parts:

1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.

2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.

B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.

1. A comprehensive index.
2. A functional description of the entire system, with references to drawings and instructions.

3. A complete "as-built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

5. Full specifications on each item.

6. Detailed service, maintenance, and operation instructions for each item supplied.

7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

9. References to manufacturers' standard literature where applicable.

10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

D. The operating instructions shall clearly describe the step-by-step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.

F. The hardware maintenance documentation shall include, as a minimum, the following information:

1. Operation Information - This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

2. Preventive-Maintenance Instructions - These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.

3. Corrective-Maintenance Instructions - These instructions shall include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.
4. Parts Information - This information shall include the identification of each replaceable or field-repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between equipment numbers and manufacturer's part numbers shall be provided.

G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:

1. A program abstract that includes:
   a. Program Name - The symbolic alphanumeric program name.
   b. Program Title - English text identification.
   c. Program Synopsis - A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by nonsoftware oriented readers.

2. A program description that shall include, but not be limited to, the following:
   a. Applicable Documents - List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.
   b. Input - Output - Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.
   c. Processing - This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.
   d. System Configuration - Describe in detail the system configuration or status required for program implementation, if appropriate.
   e. Limitations and Constraints - Summarize all known or anticipated limitations of the program, if appropriate.
f. Storage - Define program storage requirements in terms of disk or RAM memory allocation.

g. Verification - Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.

h. Diagnostics - Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.

i. Malfunction Procedures - Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.
1.10 FINAL SYSTEM DOCUMENTATION

A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.

B. If any documentation or other technical information submitted is considered proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary will be used only for the construction, operation, or maintenance of the System and, to the extent permitted by law, will not be published or otherwise disclosed.

C. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11-inch by 17-inch original reproducible prints. All diagrams shall be corrected so as to describe final "as-built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.

D. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as-built software configurations.

E. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

F. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.

G. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.

H. The Owner recognizes the fact that not all possible problems related to real-time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

1.11 PROGRAMS AND SOURCE LISTINGS

A. Provide one copy of all standard, of-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.

B. Provide one copy of source listings on DVD media for all custom software written specifically for this facility, all database files configured for this facility, and all control
strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

1.12 SUBMITTAL/DOCUMENTATION FORMAT

A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.

B. All textual-type submittals and documentation shall be rendered and submitted in machine-readable Adobe Portable Document Format (.pdf).

1.13 ELECTRONIC O&M MANUALS

A. Subject to acceptance by the Owner and Engineer, the O&M information may be submitted in part or in whole in an electronic format on optical media.

B. Electronic O&M manuals shall contain information in machine-readable Adobe Portable Document Format (.pdf).

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17040 - CONTROL AND INFORMATION SYSTEM TRAINING REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. To familiarize the Owner's personnel with the process control system and field instrumentation, training shall be provided as detailed hereunder.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

1.03 SUBMITTALS

A. A minimum of 60 days prior to beginning training, submit a detailed training plan describing the following:

1. A listing of all courses to be conducted.
2. Course content.
3. Applicability of each course to management, operations, maintenance, laboratory, etc., personnel.
4. Course schedules.
5. Qualifications and experience of individual(s) providing training.

B. A minimum of 14 days prior to beginning each training course, submit documentation for use by the Owner's personnel during training. The training documentation shall be specific to the particular course, and shall include the following:

1. A listing of all subjects to be covered.
2. Course schedule.
3. Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.

1.04 GENERAL REQUIREMENTS

A. All costs of providing the training courses shall be borne by the Contractor.

B. As used herein, the term "day" shall mean an eight-hour day, and the term "week" shall mean a five day, 40 hour week.

C. Training courses, especially those for operator training, may be required to be scheduled during non-standard business hours (i.e., not between the hours of 8:00 am and 5:00
pm) to accommodate the working schedule of the Owner’s personnel. No additional compensation will be awarded to the Contractor for training at non-standard hours.

D. All training courses shall complement the experience and skill levels of the Owner’s personnel.

E. Training courses shall be structured in order of increasing capability or security levels. The purpose of this requirement is to allow personnel with lesser training requirements or security password levels to drop out of the training at certain times while the training continues for personnel with greater requirements or higher security levels.

F. All training courses shall include lecture as well as "hands on" experience for each of the attending personnel. The Contractor shall provide sufficient equipment for this to be accomplished. For example, training in which the instructor uses the computer and the Owner's personnel passively observe as the instructor demonstrates system functions shall not be acceptable.

G. Unless otherwise specified, all training courses shall be conducted in the Owner's facilities.

H. All training shall be completed prior to system acceptance.

I. Standard manufacturer training courses are acceptable pending approval by the Engineer and Owner.

1.05 OPERATOR TRAINING

A. Two 4-hour courses comprised of daily half-day (four-hour) sessions for up to ten persons each shall be conducted to provide instruction in the use of the Control and Information System to monitor and control the facility.

B. Operator training shall include familiarization training covering the Control and Information System. Operators shall be instructed in the names, locations, functions, and basic operation of all items of digital equipment and associated software.

C. Operator training shall cover process and equipment operation both individually and collectively as an operating system. Normal as well as abnormal operating conditions shall be covered, including the response to failure occurrences and system alarms. All operator/system interactions shall be described.

D. Operators shall be trained to instruct other operators and shall be provided with all course materials.

1.06 MAINTENANCE TRAINING

A. Two 4-hour courses shall be conducted for at least six persons prior to the start-up of digital equipment at the Owner's plant. Instruction shall be provided in the following:

1. Operating all digital equipment, including system start-up and shutdown procedures.

2. The use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to
the circuit board or module level and to implement repairs by replacing failed
circuit boards or modules.

3. Calibration and routine maintenance procedures for all analog and digital
equipment.

B. Step by step written procedures shall be provided for all preventive maintenance tasks
and for identifying hardware faults to the circuit board or module level for all items of
digital equipment.

C. All digital equipment preventive and corrective maintenance training activities shall be
limited to the use of commercially available off-the-shelf test equipment and to the use of
diagnostic routines and hardware items which are the same as those to be provided as
part of the system.

1.07 INSTRUMENT TRAINING

A. Two 4-hour courses shall be provided at the Owner's facilities no more than three
months prior to system start-up to instruct a minimum of five persons each in the
calibration and preventive maintenance of the field instruments provided under this
Contract.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17050 - TOOLS, SUPPLIES AND SPARE PARTS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide tools, supplies, and spare parts as specified herein for the operation and maintenance of the Control and Information System.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals

B. Control and Information System

PART 2 -- PRODUCTS

2.01 TOOLS

A. Provide special tools, other than those normally found in an electronic technician's tool box, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance. This shall include, but not be limited to, the following: connector pin insertion and removal tools, wire crimping tools, special wrenches, special instrument calibrators, indicator lamp insertion and removal tools, etc.

B. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Division.

C. One (1) Portable graphical multimeter with rechargeable battery, test leads, industrial lead set, and carrying case, Fluke Model 289, Simpson, or equal.

D. Furnish one portable calibrator capable of measuring DC volts, mV, mA, ohms, frequency, T/C, peak detect and trip detect on its input and simultaneously generate on its output all of the preceding signals plus two-wire simulation, ramp functions, up/down stepping and 10 point programmability. The calibrator shall be furnished complete with 24 VDC integral battery pack, spare battery pack, test leads, external charger, fuse pack, carrying case and appurtenances. It shall be possible to store and use automatic instrument calibration procedures that are downloaded from Windows-based instrument management software. Calibrator shall be Fluke 789 ProcessMeter, Ametek CL-9000, or equal.

E. A complete computer technician kit in an injection molded or high density polyethylene case. The kit shall be Model JTK-49 Workstation Kit by Stanley Supply Services of Phoenix, AZ, or a computer technician kit of equivalent equipment and value.

2.02 SUPPLIES

A. The Contractor shall provide supplies as specifically required in other Sections of Division 17
2.03 SPARE PARTS

A. Provide spare parts for items of control and instrumentation equipment as recommended by the manufacturer and in accordance with the Contract Documents.

B. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.

C. The Contractor shall replace all spare parts consumed during installation, testing, start-up, the system availability demonstration, and the guarantee period.

D. Refer to individual digital hardware and instrument sections for additional requirements specific to those devices.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17060 - SIGNAL COORDINATION REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall conform to the signal coordination requirements specified herein.

B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, and the instrumentation subcontractor.

C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLC's and Control System PLC's.

D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLC's, the Control System, etc.

1.02 ANALOG SIGNAL TRANSMISSION

A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 volts D.C.

B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.

C. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.

D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.

E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliamper signal.

F. The Contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.

G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.

H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third
element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

1.03 DISCRETE INPUTS

A. All discrete inputs to equipment and Control and Information System PLC’s, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLC’s, unless specified otherwise.

B. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC.

1.04 DISCRETE OUTPUTS

A. All discrete outputs from local control panels and Control and Information System PLC’s to field devices, starters, panels, etc., shall be 24 VDC powered (sourced) from the PLC panel.

B. PLC powered discrete outputs shall energize 24 VDC pilot relay coils in the field devices, starters, panels, etc. which in turn open or close contacts in the associated control circuit. The 24 VDC relay coil, contacts, and associated control circuitry shall be furnished integral with the field device, starter, panel, etc. by the supplier and contractor furnishing the field device, starter, or panel.

C. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC’s to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.

D. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

1.05 OTHER DISCRETE SIGNALS

A. Discrete signals between starters, panels, etc. where no 24 VDC power supply is available may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.

B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.

C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.

D. The above requirements shall apply to all starters and panels, regardless of supplier.

PART 2 -- PRODUCTS

2.01 PILOT RELAYS

A. Pilot relays shall be supplied with the following:

1. 24 VDC or 120 VAC coils, as required.
2. At a minimum, DPDT contacts rated at 5 A, 120 VAC or 28 VDC.

3. Sockets for 24 VDC and 120 VAC relays shall be of different configurations.

4. Clips for attachment to sockets.

5. Indicator lights that glow when the relay coil is powered.

B. Pilot relays shall be as manufactured by Square D, Allen Bradley, Potter & Brumfield, or equal.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall test the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Field Testing
C. Final Acceptance Test

1.03 SUBMITTALS

A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:

1. A schedule of all testing to be conducted.
2. A brief description of the testing to be performed
3. Test objectives.
4. Testing criteria per the Specifications.
5. Check lists and procedures for performing each of the specified tests.
6. Sample test result documentation.
7. Requirements for other parties.

1.04 GENERAL REQUIREMENTS

A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.

B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.

C. The Contractor (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and
space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinafore.

D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.

E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION - 17072 FIELD TESTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Control and Information System Testing, General
C. Final Acceptance Test

1.03 GENERAL REQUIREMENTS

A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:

1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in applicable Section of Division 17.

2. Each final control element shall be individually tested as specified hereinafter.

3. Each control loop shall be tested as specified hereinafter.

4. Each control strategy shall be tested under automatic digital control as specified hereinafter.

5. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.

B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.

C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

1.04 CONTRACTOR’S RESPONSIBILITIES

A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function
as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.

C. The Contractor shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.

1.05 FINAL CONTROL ELEMENT TESTING

A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.

B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD's, that require turndown limits shall be initially set during this test.

C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

1.06 LOOP CHECKOUT

A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.

B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.

C. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.

D. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.

E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
1.07 CONTROL SYSTEM STARTUP AND TESTING

A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.

B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.

C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.

D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.

E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.

F. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.

G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.

H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.08 FACILITY STARTUP COORDINATION

A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.

B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to
satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.

C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.

D. At least one qualified control systems technician shall be provided for control system startup and test activities (at least two when loop checkout is being performed).

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform the Final Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

B. Control and Information System Testing, General

1.03 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE

A. Upon completion of each construction phase the associated field testing shall be individually completed and accepted. However, prior to final acceptance of the system as a whole, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail-over, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. The Owner shall be given two (2) week notice of the starting date of the 30-day availability test of the entire control system.

B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.

1. Downtime of any LAN connected device that is automatically backed up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.

2. Downtime of a PLC that is not automatically backed up shall be considered a system failure if the downtime of the failed controller exceeds one (1) hour.

3. Downtime of a portion of the system resulting from failure of any field instrument shall not be considered a system failure provided that the system operates as specified under this condition.

4. An erroneous command to the process that can be specifically related to a software fault shall be considered as one (1) hour of downtime.

5. The inoperability of any subsystem resulting from a software fault shall be considered a system failure.

6. The failure of the same component more than one time during the 30-day test shall be considered a system failure.

C. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored.
D. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met. This shall include alarm histories, system logs, and historical process data to show that all equipment and process controls properly functioned during the 30-day test.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17080 - QUALITY ASSURANCE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. It is the intent of these Specifications and Drawings to secure high quality in all materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Contractor shall provide equipment and services to meet this intent.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. All work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State, local and other applicable codes.

1.03 QUALITY ASSURANCE - GENERAL

A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.

B. For uniformity, only one manufacturer will be accepted for each type of product.

C. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.

D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble-free service.

E. Electronic components shall be de-rated to assure dependability and long-term stability.

F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.

G. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers.

H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

1.05 OPTIONAL EQUIPMENT

A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for
approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

1.06 GUARANTEE

A. The instrumentation subcontractor through the Contractor shall install, maintain and guarantee the Instrumentation, Control and Information System as specified under the General Conditions and Division 1 of the Specifications. Maintenance personnel provided by the instrumentation subcontractor shall instruct the Owner's personnel in the operation, adjustment, calibration and repair of the equipment being serviced. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed and list materials used. A copy of all service reports shall be delivered to the Owner on the day the work is performed.

B. The instrumentation subcontractor shall provide the services of factory-trained service technician(s) at least twice during the guarantee period, for the purpose of performing preventive hardware maintenance.

C. Corrective hardware and software maintenance during the guarantee period shall be performed in accordance with the requirements of Division 1 and, in addition, shall meet the following requirements:

1. Corrective hardware maintenance shall be performed by factory-trained service technician(s) specifically trained to service the digital equipment provided. Technicians possessing suitable training and experience shall be provided to perform corrective maintenance on all other equipment. The hardware service technician(s) shall be available on-site within 24 working hours after notification by the Owner.

2. Corrective software maintenance shall be performed for software provided by the instrumentation subcontractor and incorporated into the system prior to the completion of system commissioning. Software service programmer(s) shall be available for consultation within four business hours and, if required, on-site within 16 business hours after notification by the Owner. Corrective software maintenance shall include the supply, installation and startup of all application software upgrades released during the guarantee period.

3. Corrective hardware and software maintenance performed during the guarantee period shall be performed at no cost to the Owner.

4. As used herein, the term "working hours" shall be defined as those of the treatment facility (seven days per week, 24 hours per day). The term "business hours" shall be defined as the hours between 8:00 a.m. and 5:00 p.m., local time, Monday through Friday; excluding holidays.

5. The guarantee period shall commence upon final acceptance of the completed treatment facility in accordance with the provisions of the Contract Documents.

D. The instrumentation subcontractor shall submit to the Owner a proposed maintenance agreement incorporating the following features:
1. Extension of preventive hardware maintenance services as described above for a period of up to five years from the expiration of the warranty period.

2. Provisions for corrective hardware and/or software maintenance work on a will-call basis for a period of up to five years from the expiration of the warranty period. Corrective maintenance work shall be performed by properly trained personnel as described above.

E. The proposed agreement shall include provisions for payment based upon an annual fee for preventive maintenance and cost plus expenses for corrective maintenance work. The portion dealing with corrective maintenance shall be written to include corrective maintenance caused by actions of the Owner during the warranty period and shall contain clauses for re-negotiation of contract prices based upon changes in recognized economic indicators published by the United States Department of Commerce.

1.07 SHIPPING HANDLING AND STORAGE

A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract Documents, air conditioning/heating shall be provided for storage of all field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

1.08 FABRICATION

A. Fabrication of all equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. The Contractor shall provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.

C. Equipment approval at the factory only allows the equipment to be shipped to the project site. The Contractor shall provide for the proper storage, installation and satisfactory start-up and operation of the equipment to the satisfaction of the equipment manufacturer, the instrumentation subcontractor, and the Engineer.

1.09 INSTALLATION

A. All instrumentation and control system installation work, whether new construction or modifications to existing equipment/panels/structures, shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The instrumentation subcontractor shall assign a competent representative who shall provide full time coordination and supervision of all on-site instrumentation and control system construction work from commencement of construction through completion and final acceptance.
C. All labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.

D. All equipment and materials shall fit properly in their installations. Any required work to correct improperly fit installations shall be performed at no additional expense to the Owner.

E. All work shall be performed in a neat and workmanlike manner. All hardware and instrumentation shall be installed in accordance with requirements specified herein, in accordance with industry best practices, in accordance with manufacturers’ recommendations, and in a manner suitable for ease of operation, inspection, and maintenance. All wiring shall be neatly bundled, run in wireway, and terminated. All spare wiring shall be neatly coiled and clearly labeled at both ends for future use by the Owner. Any work not meeting these requirements shall be corrected at no expense to the Owner.

F. Sufficient common-mode and differential-mode noise rejection shall be provided to insure operation of the plant process control system to meet all specification requirements. General practice shall include:

1. Maintaining crossings between noisy wires and signal wires at right angles.
2. Maintaining separation between noisy wires and signal wires as wide as practical.
3. Grounding all signals, shields and power supplies at the process control unit or local control panel.
4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.
5. Eliminating cable splices. All splices in instrumentation and control system signal and network cables shall be approved in advance by the Engineer.
6. Providing a floating output for transmitters that have their own power sources.

G. DC and AC power grounding shall be performed in accordance with the digital hardware manufacturer's recommendations as well as all applicable code requirements.

H. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.

I. Power wires shall be separated from parallel-running signal wires by the following minimum spacing:

<table>
<thead>
<tr>
<th>CIRCUIT VOLTAGE (VAC)</th>
<th>MINIMUM SPACING (IN.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>12</td>
</tr>
<tr>
<td>240</td>
<td>18</td>
</tr>
<tr>
<td>480</td>
<td>18</td>
</tr>
</tbody>
</table>
J. The Contractor shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.

K. Following acceptance of the factory tests by the Engineer, and in accordance with the construction schedule, the Contractor shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical work has been completed in the equipment rooms, MCCs, control rooms and all structural and/or mechanical work has been completed within 50 feet of equipment locations.

L. Upon completion of the above construction work, the Contractor shall request an inspection of the above named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17100 - CONTROL AND INFORMATION SYSTEM HARDWARE, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The process control system is physically and functionally distributed between PLC equipped control panels, motor control panels, field panels, and appurtenances.

B. Although manual control facilities shall be provided adjacent to each final control element or in local control panels, such facilities are for testing, maintenance and local monitoring purposes only and shall not be regarded as backup to the PLC based control system.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Programmable Logic Controllers

B. Operator Interface Terminals

1.03 DIGITAL HARDWARE CONFIGURATIONS

A. The digital hardware configuration shown on the Control System Block Diagram depicts overall system configuration requirements. System design shall be based upon this concept and shall provide an overall digital system availability of 99.8 percent under the conditions specified in the Section entitled “Final Acceptance Test”. Unless otherwise specified, designs that vary from this concept will be rejected.

B. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level.

PART 2 -- PRODUCTS

2.01 GENERAL SYSTEM HARDWARE REQUIREMENTS

A. Large scale integrated (LSI) circuit construction shall be employed unless otherwise specified.

B. Modular construction shall be employed to simplify maintenance and to provide for future hardware expansion. Plug-in, modular PCB's or modules shall be employed for easy removal to permit exposure of circuit wiring, components and test points. Extender boards shall be provided if necessary to permit PCB's to be completely exposed for testing purposes.

C. Keying schemes shall be used to prevent PCB misplacement.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTIONS 17120 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all programmable logic controllers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Signal Coordination Requirements
C. Uninterruptible Power Systems
D. Enclosures, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies, and Spare Parts. In addition, the following specific spare parts items shall be provided:

1. One of each type of CPU and network module for PLC equipment furnished under this Contract.
2. One of each type of input/output and data link communications module for PLC equipment furnished under this Contract.
3. One of each type and size of PLC power supply, loop power supply and panel equipment power supply furnished under this Contract.

PART 2 -- PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS - GENERAL

A. The Instrumentation Subcontractor shall furnish programmable controllers (PLC's) as specified herein and as shown on the Drawings. PLC's shall be provided complete with power supply, I/O cards, special function cards, instructions, memory, input/output capacity, and appurtenances to provide all features and functions as described herein.

B. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.
C. The programmable controller shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0 - 60 degrees Celsius and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.

D. Memory, communications, I/O modules, and processor shall be adequate for all control functions specified. PLC's shall be Allen-Bradley CompactLogix 1769-L4x as manufactured by Rockwell Automation, no substitution.

2.02 PROCESSORS

A. The processor and its associated memory shall be enclosed in a modular enclosure. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Memory shall consist of battery-backed RAM which shall retain the control program indefinitely as long as AC power is supplied. Batteries shall maintain processor RAM memory for at least 21 days in the event of power loss. Visual indication shall be provided if battery charge is insufficient to maintain the program in RAM memory for at least two weeks. Non-volatile memory shall be provided to store a backup of the user program and a default set of user adjustable parameters such as setpoints, timer values, mode selections, etc. such that the PLC shall return to an operable state upon loading the backup program. The PLC shall load the backup program and data to RAM upon power up following a power failure and loss of charge of the RAM batteries.

B. PLC shall meet the following minimum requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O Module Capacity</td>
<td>30</td>
</tr>
<tr>
<td>Communication</td>
<td>Ethernet/IP</td>
</tr>
<tr>
<td>User Memory</td>
<td>1.5 MB (minimum)</td>
</tr>
<tr>
<td>Non-Volatile Memory</td>
<td>64 MB (minimum)</td>
</tr>
</tbody>
</table>

C. The instruction set for the PLC shall include the following, as a minimum:

1. Relay type instructions
2. Counter and timer instructions
3. Comparison instructions (equal, greater than, limit tests, etc.)
4. Integer and floating point mathematical instructions
5. Advanced math and trigonometric functions
6. Statistical instructions
7. Matrix and array instructions
8. Logical instructions (and, not, or, etc.)
9. BCD conversion instructions
10. Bit modification, moving, and shift instructions
11. File instructions (search, copy, fill, etc.)
12. Diagnostic instructions
13. Sequencer instructions
14. Program control instructions (jump, goto, subroutine, etc.)
15. PID control loops
16. Block read and write capability
17. Send/receive messages
18. Immediate I/O and communications update instructions

D. Additional PLC processors or modules may be necessary and shall be furnished as required to meet the minimum instruction set and control strategy requirements specified.

2.03 COMMUNICATIONS

A. Provide communication ports, adapters, accessories, and software drivers as required to facilitate the following communication links shown on the Control System Block Diagram:

1. Ethernet/IP between PLC and OIT
2. RS-485 Modbus between PLC and motorized valve actuators.

2.04 INPUT/OUTPUT SUBSYSTEMS

A. Input/output hardware shall be Allen Bradley 1769 series DIN mountable modules. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active prewired spares for each I/O type furnished.

B. Discrete inputs shall be 24 VDC signal (integral to PLC) from dry field contacts. Discrete outputs shall be 24 VDC outputs from the PLC or dry relay contacts (2A minimum) as required. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 17550. Lightning/surge protection shall be provided as specified in the Section entitled “Transient Voltage Surge Suppression Devices”. Electrical isolation shall be provided where required.
C. Analog input circuits shall be the differential 15-bit resolution bipolar type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15 degrees C and be capable of accepting a 100 ohm Platinum RTD. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Lightning/surge protection shall be provided as specified in the Section entitled “Transient Voltage Surge Suppression Devices”. Maximum density for analog I/O modules shall be 8 per module.

D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms which can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All circuits extending beyond the control panel shall include individual fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed in the non-conducting mode, or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

E. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one loop or piece of equipment.

F. External power supplies shall be provided with the PLC as required to meet 150% of the specified installed I/O power requirements plus spares under full load conditions. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC. Power supplies shall be furnished with isolated lightning/surge protection systems as specified in the Section entitled “Transient Voltage Surge Suppression Devices”.

2.05 ACCESSORIES

A. Manufactured PLC cabling systems shall be used for wiring of I/O to terminal blocks. Cabling system shall consist of a I/O module connector, multi-conductor cable, and an interface module consisting of terminals. The terminals shall accept 24-12 AWG wire and be rated for the signals carried. If required, an interface module may consist of components (fuses, relays, surge protection, etc.) and terminals. Components shall be as specified elsewhere in Division 17. PLC cabling systems shall be as manufactured by Phoenix Contact, Weidmüller, Allen Bradley or equal.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17125 - OPERATOR INTERFACE TERMINALS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all Operator Interface Terminals, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATE WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Programmable Logic Controllers
C. Functional Control Descriptions

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in the Section entitled “Tools, Supplies, and Spare Parts, General”.

B. In addition, one of operator interface terminal loaded with the final version of all applications programming provided under this Contract.

PART 2 – PRODUCTS

2.01 OPERATOR INTERFACE TERMINALS

A. Operator Interface Terminals (OITs) shall be the 8-wire analog resistive color touch screen type with field replaceable backlights. The screen shall be 15 inches diagonal size and 1024x768 pixel resolution. The OIT shall be panel mounted and shall not change the NEMA rating of the enclosure to which it is mounted. OITs shall be supplied with all required power supplies, PLC communication cables and software, memory, or other accessories as required for a complete installation. Communications shall be via Ethernet/IP to the host PLC. The OIT shall be equipped with an SDHC card interface, a USB 2.0 interface, and a PCI interface.

B. The operator interface terminals shall be Allen Bradley PanelView Plus 6 1500 Color.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. The OIT shall be configured to provide complete monitoring and control functionality as specified in the Section entitled “Functional Control Descriptions”. Process status, operating values and operator-entered setpoints shall be displayed with associated units and service descriptions. Menus shall be provided to navigate between screens of different equipment items or process loops. OIT controls shall be designed for touch input and shall not require an external keyboard, mouse, or keypad. On screen keyboards shall be provided where any text or numeric input is required from the operator.
B. Configure the OIT with password login security to prevent unauthorized use. The OIT shall automatically logout after 30 minutes of inactivity. Provide PLC programming as necessary to work in conjunction with the OIT to achieve these security features.

C. Furnish a 32 GB SD card with the OIT for logging historical data. The SD card shall be compatible with the OIT SDHC card slot, and shall be capable of 45 MB/s read and write transfer rates. Configure the OIT to log all PLC inputs and outputs (hardwired and data links), all process control setpoints, and all alarms to the SD card. A minimum of 2 months of continuous data logging shall be saved to the SD card. Data older than 2 months (or more depending on how much data can be stored to the card) shall be automatically purged from the SD card at regular intervals. Configure the following full screen historical trend line graphs:

1. Filter System – 8 hour default duration; plot filter influent level, total filter flow rate, finished water turbidity, and surface scour flow rate.

2. Filter (typical for each filter) – 8 hour default duration; plot filter flow rate, headloss, turbidity, and level.

END OF SECTION
SECTION 17190 - UNINTERRUPTIBLE POWER SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

B. All UPS's shall be mounted within consoles or control panels containing the associated digital equipment unless otherwise specified or shown on the Drawings.

C. One UPS shall be provided for each control panel containing PLC, remote I/O, or operator workstation digital hardware provided under this Contract.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

1.03 SUBMITTALS

A. The Contractor shall submit UPS sizing calculations for all UPS’s furnished under this Contract in accordance with the Section entitled “Control and Information System Submittals”.

PART 2 -- EQUIPMENT

2.01 UNINTERRUPTIBLE POWER SYSTEMS

A. Each UPS shall consist of a tower style UPS module and battery modules as required to meet backup run time requirements for the connected equipment. Each UPS shall be sized for 150% of the connected loads, but not less than 1000 VA.

B. UPS's shall be the true on-line, double conversion type. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.

C. An automatic bypass switch shall be provided. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.

D. Each UPS shall meet the following requirements:

1. Input voltage shall be 117 VAC, single phase, 60 Hz.

2. Voltage regulation shall be +/-2 percent for line and load changes with less than 3% THD.
3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.

4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type. The battery modules shall have a minimum full load backup time of 30 minutes.

5. A status monitoring and control panel shall be provided and shall include the following:
   a. Status indicating lights for both normal and abnormal conditions.
   b. Alarm dry contact output shall close upon UPS fault.
   c. Battery and AC output volt meters.
   d. Circuit breakers for the charger AC input and the inverter input.

6. Sound absorbing enclosure.

7. EMI/RF noise filtering.

8. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.

E. UPS systems shall be APC Smart-UPS RT, Powerware 9120, Liebert GXT2, or equal.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17500 - ENCLOSURES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

B. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

B. Control and Information System Hardware, General

C. Cabinets and Panels

D. Panel Instruments and Accessories

E. Transient Voltage Surge Suppression Devices

F. Unpowered Instruments, General

G. Powered Instruments, General

H. Analytical Instruments, General

I. Refer to Division 16 for additional requirements for cable, circuit breakers, disconnect switches, etc.

1.03 GENERAL INFORMATION AND DESCRIPTION

A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.

B. Either manufacturer-standard or custom cabinetry may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.

C. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor shall examine plans and/or field inspect new and existing structures as required to determine installation requirements, and shall coordinate
the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in the Section entitled “Tools, Supplies and Spare Parts”. In addition, the spare parts items shall be provided as specified in the individual cabinet and panel specification Sections.

PART 2 -- PRODUCTS

2.01 TERMINAL BLOCKS

A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Wieland, Square D, or equal.

B. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30 amps.

C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top (NEMA 12 cabinets only).

2. Thermostatically controlled, low noise internal air blowers (initial setpoint 75°F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature.
E. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor’s pre-engineered and prefabricated wiring termination system will be acceptable.

F. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16 of the specifications. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

G. Separate terminal strips shall be provided for each type of power and signal used within each cabinet.

H. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

I. A copper 120 VAC ground bus shall be installed in each cabinet, and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.

J. Interior panel wiring and field wiring shall be tagged at all terminations with machine-printed plastic sleeves. The wire numbering system and identification tags shall be as specified in Division 16. Where applicable, the wire number shall be the ID number listed in the input/output schedules.

K. Wires shall be color coded as follows:

- Equipment Ground - GREEN
- 120 VAC Power - BLACK
- 120 VAC Power Neutral - WHITE
- 120 VAC Control (Internally Powered) - RED
- 120 VAC Control (Externally Powered) - YELLOW
- 24 VAC Control - ORANGE
- DC Power (+) - RED
- DC Power (-) - BLACK
- DC Control - BLUE
- Analog Signal – BLACK/WHITE or BLACK/RED

L. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes
shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

M. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and fluorescent service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

N. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power". Letters in the word "WARNING" shall be 0.75 inch high, white.

O. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

3.02 PAINTING

A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 9 for additional requirements.

B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.

C. Panels fabricated from stainless steel shall not be painted.

3.03 INSTALLATION

A. Refer to the Section entitled “Control and Information System” for additional requirements.

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the cabinets and panels, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Control and Information System Hardware, General
C. Enclosures, General
D. Functional Control Descriptions

PART 2 -- PRODUCTS

2.01 CABINETS AND PANELS

A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.

B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.

C. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum Type 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in chlorine storage/feed areas shall be of non-metallic, FRP construction, rated NEMA 4X.

D. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

E. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel, fast operating clamp assemblies that do not require bolts or screws to secure.
F. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits.

G. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

H. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC or DCU) shall be provided with a folding laptop programmer shelf on the inside of the door.

I. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Rittal. The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the panel instruments and accessories, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Control and Information System Hardware, General
C. Enclosures, General
D. Functional Control Descriptions

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in the Section entitled “Tools, Supplies and Spare Parts - General”. In addition, the following specific spare parts items shall be provided:

1. One of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract.

2. Five of each type of interposing relay provided under this Contract.

PART 2 -- PRODUCTS

2.01 ELECTRONIC INDICATORS

A. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24V excitation power supply shall be provided. Indicators shall be Red Lion Model IMP or APLCL, or equal.
2.02 SIGNAL CONVERTERS

A. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.

B. General Requirements – Converters shall be of the miniature type, utilizing all solid state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.

C. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.

D. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4-20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.

E. Frequency to Current Transducers – Frequency to current transducers shall convert pulse-rate and pulse-duration signals to 4-20 mA, 24 VDC analog signals. Converters shall include field-adjustable input frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Timeverter as manufactured by AGM, Moore Industries equivalent, Rochester Instrument Systems (RIS) equivalent, or equal.

F. Current to Frequency Transducers – Current to frequency transducers shall convert 4-20 mA, 24 VDC analog signals to pulse-rate and pulse-duration signals. Converters shall include field-adjustable output frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Quantimer as manufactured by AGM, Moore Industries equivalent, Rochester Instrument Systems (RIS) equivalent, or equal.

G. Integrators – Integrators shall be provided as interchangeable plug-in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be ± 0.1% of input span. Integrators shall convert linear analog signals to pulse rate and provide a solid-state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), or equal.

H. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4-20mA DC, and the set point
shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be ±0.1% per degree F. The repeatability shall be ±0.1% of span. The units shall be furnished with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.

I. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4-20mA DC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Contractor shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer’s standard enclosure for installation in an existing indoor electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), or equal.

J. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be miniature type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall be Type KU as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

K. Timing Relays – Timing Relays (TR) shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.

L. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA classified hazardous areas. Intrinsically safe relays and barriers shall be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

2.03 ACCESSORIES

A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.

B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type. Pilot lights shall be of the proper control voltage, LED type with light lens colors shall be as specified below.

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Running (Open)</td>
</tr>
<tr>
<td>Green</td>
<td>Stopped or Off (Closed)</td>
</tr>
<tr>
<td>Amber</td>
<td>Fault</td>
</tr>
</tbody>
</table>
White	Other

C. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.

D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.

E. Alarm horns shall be general-purpose type, flush panel mount, 115 VAC power supply or 24 VDC power supply, suitable for indoor or weatherproof service, as required. Volume shall be adjustable.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17560 - TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install and place in satisfactory operation the transient voltage surge suppression (TVSS) devices as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Control and Information System Hardware, General
C. Enclosures, General

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All surge protectors of each type provided under this Contract shall be furnished by a single manufacturer.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in the Section entitled “Tools, Supplies and Spare Parts – General”. In addition, the following specific spare parts items shall be provided:

1. Six of each type of transient voltage surge suppression (TVSS) devices provided under this Contract.

PART 2 -- PRODUCTS

2.01 ELECTRICAL TRANSIENT PROTECTION, GENERAL

A. All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.

B. Manufacturer’s Requirements: All transient voltage surge suppressor devices shall be multi-stage serial devices manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Phoenix Contact, EDCO, Transtector, or equal.

C. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.

D. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.
E. Suppressor Locations: As a minimum, provide surge suppressors at the following locations:

1. At all connections between AC power, DC power and associated electrical and electronic equipment, including panels, cabinets, rack assemblies, and field mounted powered instruments.

2. At both ends of all two-wire analog signal circuits and all four wire analog power/signal circuits.

3. At the panel end of all 24 VDC or 120 VAC discrete input (dry contact) and discrete output circuits.

4. At each device termination point of copper-based communication cables (e.g., serial, parallel, Ethernet, Device Net, etc.).

5. On all telephone communications lines.

6. RF antenna cable radio terminus.

F. All indoor and outdoor panels, racks and enclosures shall contain multi-stage surge suppression devices which shall be integral with the terminal block assembly as a complete surge protection system. Systems shall be DIN rail mounted of modular design for field replacement without the need to remove terminated wiring. System shall be Phoenix Contact PLUGTRAB series, or equal.

G. Surge protectors shall be as follows:

1. 120-Volt field mounted analog transmitter. The protector shall combine AC power protection and 4-20 mA signal line protection. The suppressor shall be EDCO series SLAC or equal.

2. Field mounted 120-Volt power surge suppressor shall be EDCO series HSP121BT or equal.

3. Panel mounted 120-volt power surge suppression shall be Phoenix PLUGTRAB, or equal.

4. Two and four wire 4-20 mA analog signal line and power protection at the panel side shall be Phoenix PLUGTRAB, or equal.

5. Field mounted two and four wire field mounted 4-20 mA analog signal line and power protection shall be JOSLYN model 1669-06, EDCO, or equal.

6. Two wire discrete input/output signal line protection at the panel side shall be Phoenix PLUGTRAB, or equal.

7. Non-fiber optic data networks (serial, parallel, Ethernet, Profibus, Device Net telephone, etc.) shall include signal line protection at each device termination point. Phoenix PLUGTRAB, or equal.
2.02 AC POWER PROTECTION CHARACTERISTICS

A. Surge suppressor assemblies for connections to AC power supply circuits shall be assemblies that:

1. Are constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Suppressor assemblies shall automatically recover from surge events.

2. Comply with all requirements of UL 1449, second edition and meet or exceed the following performance criteria based on a test surge wave shape with an 8-microsecond rise time and a 20-microsecond exponential decay time:

   a. Minimum Operating Voltage: 130V ac
   b. Maximum Breakdown Voltage: 150V ac
   c. Maximum Operating Current: 15 amps
   d. Peak First Stage Surge Current: 20,000 amps
   e. Maximum First Stage Clamping Voltage: 350 volts
   f. Maximum Second Stage Clamping Voltage: 210 volts
   g. Ambient Temperature Range: -20 degrees C to +85 degrees C

2.03 ANALOG SIGNAL CIRCUIT PROTECTION CHARACTERISTICS

A. Surge suppressors for analog signal circuits shall:

1. Limit line-to-ground and line-to-line voltage to 33 volts on 24V dc circuits.

2. Meet or exceed the following performance criteria based on a test surge wave with 8-microsecond rise time and 20-microsecond exponential decay time:

   a. Recovery: Automatic
   b. Peak Source Current: 10,000 amps
   c. Pulse Lift Before Failure: 100 occurrences
   d. Minimum Voltage Clamp Rating: 33 volts
   e. Series Impedance: 24 ohms total
   f. Temperature Range: -20 degrees C to +85 degrees C
   g. Operating Voltage: Less than 30V dc
   h. Operating Current: 4 to 20 mA dc
   i. Resistance Line-to-Ground: Greater than 1 megohm
2.04 DISCRETE SIGNAL CIRCUIT PROTECTION CHARACTERISTICS

A. Surge suppressors for analog signal circuits shall:

1. Limit line-to-ground and line-to-line voltage to 60 volts on 24V dc circuits.

2. Meet or exceed the following performance criteria based on a test surge wave with 8-microsecond rise time and 20-microsecond exponential decay time:

   a. Recovery: Automatic
   b. Peak Source Current: 10,000 amps
   c. Pulse Lift Before Failure: 100 occurrences
   d. Minimum Voltage Clamp Rating: 60 volts
   e. Series Impedance: 15 ohms total
   f. Temperature Range: -40 degrees C to +85 degrees C
   g. Resistance Line-to-Ground: Greater than 1 megohm

2.05 COMMUNICATION CIRCUIT PROTECTION CHARACTERISTICS

A. Surge suppressors for copper-based data communication circuits shall:

1. Be designed for the specific data communication media and protocol to be protected (e.g., telephone, serial, parallel, Ethernet, DeviceNet, coax, twinaxial, twisted pair, RF, etc.).

2. Provide protection of equipment to within the equipment’s surge withstand levels for applicable standard test wave forms of the following standards:

   a. IEC 60-1 / DIN VDE 0432 part 2
   b. CCITT K17 / DIN VDE 0845 part 2
   c. IEEE C62.31

3. Provide automatic recovery.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Install in accordance with manufacture recommended practices and applicable codes.

- END OF SECTION -
SECTION 17600 - UNPOWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test and place in operation unpowered process instrumentation (flow elements, level switches, analysis elements, detectors, etc.) as shown on the Contract Drawings and as specified.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of unpowered process instrumentation on process lines shall be provided under this Contract.

C. Tappings and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor’s responsibility to ensure that the location, supports, orientation and dimensions of the connections and tappings for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 QUALITY ASSURANCE

A. The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature and define parameters of configuration and construction:

1. ISA - Instrument Society of America.

2. OSHA - Occupational Safety and Health Administration.

3. EPA - Environmental Protection Agency.


5. Refer to Division 16 for additional electrical standards and requirements.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, instruments shall be ruggedized construction of materials to suit specified environmental conditions. Instruments shall be rugged and mounted on walls, pipe stanchions on in-line as specified.
PART 3 -- EXECUTION

3.01 INSTALLATION

A. General: Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Contract Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square ½-inch thick aluminum steel base plate unless shown adjacent to a wall or otherwise noted. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than ½-inch by use of phenolic spacers. Expansion shields in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, Type 304 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Contract Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be Type 304 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the Specifications.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The Contractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or its designated representative(s), reserve the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of its responsibility for meeting all specified requirements.

2. The Contractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel,
equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

3. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, in duplicate, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation and control system.

B. Calibration Requirements

1. The Contractor shall supply factory calibration data for Engineer's information and/or review for the following:
   a. Instruments that are generally factory calibrated.
   b. Instruments that are specified to be factory calibrated.
   c. Instruments that have calibration curve based upon empirical data.

2. The Contractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

3. Each instrument shall be calibrated at 10, 50 and 90 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Bureau of Standards.

4. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposal calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

5. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

6. Upon completion of calibration, devices shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltage, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

- END OF SECTION -
SECTION 17698 - INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Unpowered Instruments, General
C. Powered Instruments, General

PART 2 -- PRODUCTS

2.01 INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

A. General: Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This subarticle shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

B. Process Tubing: Process tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37 degrees stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.

C. Power, Control and Signal Cables: Power, control and signal wiring shall be provided under Division 16 of the Specifications.

D. Chemical Diaphragm Seals: Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all Type 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, diaphragm material shall be non-reactive with the process fluid in all cases. Refer to the Instrument Schedules for specific materials requirements. Seal shall have fill connection, ¼-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements and shall be provided with 316 SS factory filled capillaries. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

E. Isolating Ring Seals: For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).
1. Full Line Size Isolating Ring Seals - Wherever the associated pressure instrument is used for control purposes, the sensor body shall be full line size wafer design. Except where noted on the Drawings and/or Instrument Schedule, full line size ring seals will have tapped ring seals as specified in Item 2, below. Full line size isolating ring seals shall have Type 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in-line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Isolating ring seals shall be RED Valve Series 40, Ronningen-Petter Iso-Ring, Moyno RKL Series W, Onyx Isolator Ring, or equal.

2. Tapped Isolating Ring Seals - For all other solids bearing fluids, pressure shall be sensed via a minimum ½-inch diameter spool-type isolating ring seal mounted on a ½-inch pipe nipple at 90 degrees from the process piping. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally. Tapped isolating ring seals for solids service shall be Red Valve Series 42/742, Ronningen-Petter Iso-Spool, Onyx Isolator Ring, or equal.

F. Filling Medium: The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10°F to +150°F. Filling medium shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.

G. Isolation Valves: Isolation valves shall be ½-inch diameter ball valves with Type 316 stainless steel body, Type 316 stainless steel ball, except that materials of construction shall be suitable for the associated process fluid where applicable (i.e., chemical service).

H. Sirens: Sirens shall be UL Listed, heavy duty, AC motor driven, weatherproof type capable of producing a minimum of 111 dBA at 10 feet. Power supply shall be 120 VAC, 60 hertz. Siren shall be McMaster-Carr Model 6392T11, Federal Signal Corporation equivalent, Edwards Signaling Company equivalent, or equal.

I. Strobe Lights: Strobe lights shall be high profile with Type 304 stainless steel base. Light is rated NEMA 4. Light shall have an outer dome to provide extra lens protection. Lens color shall be as indicated on the Drawings. Surface mount hardware shall be included. Power supply shall be 120 VAC, 60 hertz. Strobe light shall be McMaster-Carr Model 5848T71, Federal Signal Corporation equivalent, Edwards Signaling Company equivalent, or equal.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
SECTION 17700 - POWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test and place in operation powered process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process control system as shown on the Drawings and as specified. Powered instruments are those instruments which require power (120 VAC or 24 VDC loop power) to operate.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract.

C. Tappings and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and tappings for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

B. Unpowered Instruments, General

C. Powered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.03 GENERAL INFORMATION AND DESCRIPTION

A. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all powered instruments and appurtenances whether specifically mentioned in the Specification or not.

B. The powered instruments shall be furnished and installed with all necessary accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. These installations shall incorporate the highest standards for the type of service shown on the Drawings including loop testing of the entire installation and instruction of operating personnel in the care, operation, calibration and maintenance of all powered instrumentation.
C. All the powered instrumentation shall be of first class workmanship and shall be entirely designed and suitable for the intended services. All materials used in fabricating the equipment shall be new and undamaged.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

D. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 (B) herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Floating outputs shall be provided for all transmitters.

E. Unless otherwise specified, field instrument and power supply enclosures shall be Type 316 stainless steel, fiberglass or PVC coated copper free cast aluminum NEMA 4X construction.

F. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

G. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -15 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

H. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

I. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for
compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

J. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

K. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The Contractor shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on 2-inch diameter aluminum pipe stands welded to a 10-inch square ½-inch thick aluminum base plate unless shown adjacent to a wall or otherwise noted. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than ½-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60-inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, Type 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be Type 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring: Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits
enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The Contractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or its designated representative, reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of its responsibility for meeting all specified requirements.

2. The Contractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

3. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, in duplicate, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

B. Field Instrument Calibration Requirements

1. The Contractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Institute for Standards and Technology (NIST).

3. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the
calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltage, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the Contractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

B. Powered Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one portable primary head simulator for calibration and testing of magnetic flowmeter signal converters. The calibrator shall be furnished complete with rechargeable battery pack, test leads, spare battery pack, charger, carrying case and accessories. Calibrator shall be furnished by the flowmeter manufacturer, and shall be fully matched to the instrumentation furnished.

PART 2 -- PRODUCTS

2.01 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a stainless steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes.

D. Grounding rings shall be provided for all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum Type 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65 degrees C. The flow tube and
electrical connection shall meet NEMA 6P or IPS68 rating for continuous submergence under 3 meters of water. The transmitter housing shall meet NEMA 4X requirements as a minimum.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of $10^9$-$10^{11}$ ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external dry contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote HART configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.50% of rate over the flow velocity range of 0.3 to 10.0 m/s. Repeatability shall be 0.1% of rate; minimum rangeability shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50 degrees C. Power supply shall be 115 VAC, 60 Hz.

M. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. The cable shall be terminated and potted by the manufacturer at the flow tube to prevent moisture intrusion. Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

N. Magnetic flow meter systems including flow tubes, cables, transmitters and appurtenances described herein shall be by a single manufacturer and shall be one of the following: Siemens, Rosemount, ABB/Fischer & Porter, Endress + Hauser, Foxboro, Krohne or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS
A. Install flow tubes, cables, and transmitters in strict accordance with the manufacturer’s recommendations. Do not disconnect manufacturer-terminated cables from the flow tube.

B. Ground flow tubes and grounding rings in strict accordance with the manufacturer’s recommendations.

- END OF SECTION -
SECTION 17740 - ULTRASONIC LIQUID LEVEL MEASUREMENT SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the ultrasonic liquid level measurement systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Powered Instruments, General

PART 2 -- PRODUCTS

2.01 ULTRASONIC LEVEL TRANSMITTERS

A. Ultrasonic level transmitters shall include, in a single housing, an ultrasonic level sensor, 4-20 mA transmitter, one relay output, and a display. The ultrasonic level transmitter shall be required to monitor the level of process liquids or slurries within a range of 0.8 – 16.4 feet. Location and measuring range of the sensors and transmitters shall be as shown on the Drawings and/or as specified.

B. For outdoor installation, the use of approved watertight conduit hub/glands shall be required. Nozzle mounting applications shall include mounting flange adapter supplied by the manufacturer, which is compatible with the process media and the nozzle flange connection. Channel or wall mounting applications shall include mounting bracket supplied by the manufacturer and constructed of Type 316 stainless steel material. Sensor mounting thread shall be 2-inch NPT.

C. The level sensor shall be unaffected by moisture droplets on the transducer face and operate on the ultrasonic echo ranging principle. The sensor shall also be resistant to corrosive materials. Sensor accuracy shall be a minimum of 0.25 percent of level measurement range, and include integral temperature compensation with an accuracy of 0.25% of range. Resolution shall be 0.125 inches or less.

D. The transmitter shall be equipped with a 4-20 mA output linear with liquid level. Power supply shall be 12-28V DC, loop powered. The transmitter shall be programmable by using the built-in display and pushbuttons. Display shall be the segmented LED type with 3 digits plus indication of engineering units and alarm conditions.

E. Ultrasonic level transmitters shall be “The Probe” by Siemens/Milltronics, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Where two or more ultrasonic level instruments are mounted in close proximity to each other, the transmitters shall coordinate operation to prevent interference from adjacent units.
Coordination shall be accomplished via an interconnecting communication cable furnished by the manufacturer.

B. Where level transducers may become submerged, provide a manufacturer-supplied submergence hood.

- END OF SECTION -
SECTION 17760 - PRESSURE INDICATING TRANSMITTERS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure indicating transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System Scope and General Requirements

B. Powered Instruments, General

PART 2 - PRODUCTS

2.01 GAUGE PRESSURE INDICATING TRANSMITTERS

A. Gauge pressure transmitters shall be of the capacitance type with a process-isolated diaphragm with silicone oil fill, microprocessor-based "smart" electronics, and a field adjustable rangeability of 100:1 input range. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.065 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits. Output shall be linear isolated 4-20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be -40 to 85 degrees Celsius at 0-100% relative humidity. Each transmitter shall have a stainless steel tag with calibration data attached to body.

B. The piezoresistive silicon pressure sensor shall be mechanically, electrically, and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds. Total long term stability (frequency of calibration) shall be not less than 0.125% for five years.

C. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service.
D. Gauge pressure indicating transmitters shall be Model 3051T as manufactured by Rosemount, or equal.

2.02 DIFFERENTIAL PRESSURE INDICATING TRANSMITTERS

A. Differential pressure indicating transmitters shall be the same as the gauge pressure transmitters except for body specifications. Differential pressure units shall be furnished with close coupled stainless steel three valve manifold assembly. Manifold assembly shall be HEX Products Model HM, or equal.

B. The electronics sections of differential pressure transmitters shall contain user-selectable square root extractors to provide a linear 4-20 mA DC output proportional to flow, when activated. Square root extractor circuitry shall be activated only for incompressible fluid flow applications (i.e., water). Flow rates for compressible fluids (i.e., air) shall be calculated externally using line temperature and static pressure corrections as specified elsewhere in Division 17. In addition, each flow transmitter shall be furnished with laminated flow versus differential pressure curves wall mounted adjacent to the transmitter.

C. Differential pressure indicating transmitters shall be Model 3051C as manufactured by Rosemount, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Part 3 of the Section entitled “Powered Instruments, General”.

- END OF SECTION -
SECTION 17800 - ANALYTICAL INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The instrumentation subcontractor shall furnish, install, test and place in operation the analytical instruments as scheduled in the following sections together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with the process control system as shown on the Drawings and as specified. The Contractor may elect to install sensors on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated indicators, sensors, sampling pumps, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The instrumentation subcontractor shall supervise installation of equipment provided under this Section where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the analytical instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instruments furnished under this Section are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

B. Enclosures, General

C. Unpowered Instruments General

D. Instrumentation and Control System Accessories

E. Powered Instruments General

F. Analytical instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Shall be provided as specified in the Section entitled “Tools, Supplies and Spare Parts – General”.

B. Additional items as recommended by the analytical instrument manufacturers or as described for the specified analytical instrument sections shall be provided.
PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer’s latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:

1. Where the manufacturer’s enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O’Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer’s standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O’Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer’s NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 B herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be Type 316 stainless steel, fiberglass (or equivalent) or PVC coated copper-free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.
I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamperes into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

2.02 ANALYSIS INSTRUMENTS

A. Liquid samples shall not pass through housings containing analyzer electronics. Process fluid temperature will be within a range of 40 to 90 degrees F.

B. Where ambient temperatures will affect accuracy by more than 1 percent of span, a suitable isothermal enclosure with thermostatically controlled space heater shall be provided.

C. Sample assemblies shall be suitable for submersion or flow-through service as noted and shall be chemically inert to constituents of raw wastewater solids or other chemical environment, as scheduled. Where the sample is drawn prior to filtration, the sample assemblies shall be capable of handling solids and grease.

D. Each analyzer requiring reagents and/or other replaceable parts shall be furnished with sufficient chemicals and replaceable parts for startup and acceptance tests and the specified warranty period.

E. Contractor's submittals on these analyzers shall include information on monthly reagent consumption and a list of replaceable parts required for periodic maintenance and the recommended operating periods between replacements. Installation of analyzers and sample preparation shall be in accordance with the analyzer manufacturer's instructions.

F. Analysis instrumentation performance, accuracy and reproducibility shall be as prescribed in APHA/AWWA/WEF "Standard Methods for the Examination of Water and Wastewater", latest edition. For those measurements specified herein, for which performance characteristics are not listed in the above, the supplier shall state instrument performance characteristics. The "referee" method shall be as prescribed in EPA Methods for Chemical Analysis of Water and Wastes (1971).

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

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1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on 2-inch diameter pipe stands welded to a 10-inch square by ½-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or Type 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than ½-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be Type 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. The instrumentation subcontractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or its designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of its responsibility for meeting all specified requirements.

B. The instrumentation subcontractor shall provide the services of factory trained technicians,
tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

C. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, in duplicate, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

D. Field instrument calibration shall conform to the following requirements:

1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments and specified chemicals of known values to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The instrumentation subcontractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the instrumentation subcontractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.
SECTION 17821 - TURBIDITY MONITORING SYSTEMS (LOW RANGE)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the low range turbidity monitoring systems, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System
B. Analytical Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. One year supply of wet calibration materials and a complete wet calibration kit.
B. One dry verification module.
C. One year supply of automatic cleaning wipers.

PART 2 -- PRODUCTS

2.01 TURBIDITY MONITORS (LOW RANGE)

A. Turbidity sensors and controllers shall be microprocessor-based, meeting the International Standard for measurement of Turbidity (ISO 7027) and shall provide continuous monitoring.

B. Features

1. The sensor shall continuously measure turbidity in water using detectors at 90 and 180 degrees.
2. The measurement technology shall use infrared pulse scattered light process according DIN EN ISO 7027.
3. The measuring range shall be from 0.0001 to 1000 NTU.
4. The precision shall be ±0.5% or ±0.008 NTU of the measured value.
5. The response time shall be approximately 1 to 60 seconds.
6. The flow rate of sample shall be 0.2 to 1 L/minute.
7. Controller output shall be 4-20 mA.
8. Controller power requirement shall be 115 VAC 60 Hz.
9. Sensor and controller enclosures shall be rated IP 65.
10. The sensor shall be equipped with a self-cleaning sample chamber that uses a silicon wiper that is held in place magnetically.

11. The sensor shall include a calibration/verification module with a factory-certified calibration value for periodic verification of calibration.

12. Turbidity monitoring systems shall be Hach ULTRATURB plus sc sensor and SC 200 controller, or equal.

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control System Input/Output Schedule

B. Functional Control Descriptions

PART 2 -- INSTRUMENT SCHEDULE

<table>
<thead>
<tr>
<th>Magnetic Flow Meters - Section 17701</th>
<th>Tag Number</th>
<th>Service Description</th>
<th>State/Span</th>
<th>Remarks</th>
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<tr>
<td>FE/FIT-30000</td>
<td>Surface Scour Supply Flow</td>
<td>0-100 gpm</td>
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<td>FE/FIT-31000</td>
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<td>0-4 mgd</td>
<td>8” flow tube</td>
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<tr>
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<td>FE/FIT-33000</td>
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<th>Ultrasonic Level Transmitters - Section 17740</th>
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<td>Elevation</td>
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<tr>
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<td>LE/LT 35000</td>
<td>Clearwell Level</td>
<td>0 - 9 ft</td>
<td>Field verify existing range.</td>
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<td>Filter Influent Level</td>
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<tr>
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<td>Filter No. 1 Headloss</td>
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<td>Provide 5-valve manifold.</td>
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<tr>
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<td>Finished Water Turbidity</td>
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- END OF SECTION -
PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place into satisfactory operation all control system inputs and outputs as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Schedules and Control Descriptions
B. Functional Control Descriptions

PART 2 -- CONTROL SYSTEM INPUT / OUTPUT SCHEDULE

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<thead>
<tr>
<th>I.D. NUMBER</th>
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<td>BATTERY LOW(^1)</td>
<td>DIDL</td>
<td>I-06</td>
</tr>
</tbody>
</table>

1. Battery Low alarm shall be provided if available from valve actuator.

PART 3 -- EXECUTION

3.01 INPUT/OUTPUT TYPES

A. Signals transmitted or received via PLC input/output cards are as follows:

- DO – Discrete Output
- DI – Discrete Input
- AO – Analog Output
- AI – Analog Input

B. Signals transmitted or received via PLC communication ports are as follows:

- DODL – Discrete Output Data Link
- DIDL – Discrete Input Data Link
- AODL – Analog Output Data Link
- AIDL – Analog Input Data Link
C. All PLC data shall be made available to the OIT via its data link using identical tag names and numbers to facilitate consistency between the PLC and OIT databases.

D. Refer to the Section entitled “Functional Control Descriptions” for further description of input/output and OIT control interface requirements.

- END OF SECTION -
SECTION 17950 - FUNCTIONAL CONTROL DESCRIPTIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all control strategies, real time and historical databases, operator interface terminal (OIT) configuration, human-machine interface (HMI) configuration, and related programming as herein specified and as shown on the Drawings.

B. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.

C. All equipment and services required to be installed in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Contractor through the instrumentation subcontractor or individual equipment suppliers, as appropriate.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Control and Information System

B. Section 17920 - Control System Input / Output Schedule

PART 2 -- FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL

2.01 DEFINITIONS

A. RUNNING status signals shall be from auxiliary contacts (or data link registers) provided with the motor control equipment (i.e., starter, VFD, SCR, etc.), which shall close (or change value) when the equipment is running.

B. AUTO status signals shall be defined as HAND-OFF-AUTO switch in the AUTO position where LOCAL hardwired automatic control is provided. Alternatively, the AUTO status may be a virtual input where the process control system control strategy is in the AUTO (versus MANUAL) mode where equipment is remotely controlled by the process control system.

C. FAULT status signals shall be defined as motor overload and/or any other shut down mode such as over torque, over temperature, low oil pressure, high vibration, etc.

D. REMOTE (versus LOCAL) status signal shall be defined as a dry contact (or data link registers) which indicates that equipment control power is energized and the HAND-OFF-REMOTE switch is in the REMOTE position to permit remote control by the process control system.
2.02 CONVENTIONS

A. OIT and HMI graphic display symbols and indicator lights on all MCC’s, control panels, starter enclosures, etc. shall conform to the following color convention:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running/On/Open</td>
<td>Red</td>
</tr>
<tr>
<td>Stopped/Off/Closed (in local)</td>
<td>Grey</td>
</tr>
<tr>
<td>Stopped/Off/Closed (in remote)</td>
<td>Green</td>
</tr>
<tr>
<td>Fault/Alarm</td>
<td>Amber</td>
</tr>
<tr>
<td>Generic Status</td>
<td>Blue or White</td>
</tr>
</tbody>
</table>

B. OIT and HMI indications of non-adjustable values shall include text and/or background colors distinct from indications of adjustable values.

C. OIT and HMI alarms shall blink when unacknowledged and shall not blink after acknowledgement.

2.03 PROCESS CONTROL

A. Where set points, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable on the HMI and are to be adjusted based on actual operating conditions; the instrumentation subcontractor shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.

B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:

1. For alarms and control actions derived from analog input signals, use adjustable time delays and dead bands.

2. For alarms and control actions derived from discrete input signals, use adjustable time delays.

3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for dead bands shall be 5 percent of span (range 0-100%).

4. Equipment, which is started or stopped manually by the operator, shall start or stop immediately, with no time delay.

C. All feedback control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the Integral and Derivative functions to zero. All setpoints, sequence times, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the Control Panel Interface or Operator Workstation as shown on the Drawings or indicated in the Specifications.

D. All PLC-controlled equipment shall be provided with adjustable (0-60 seconds) start and stop delays in the PLC control logic. Unless otherwise specified, these delays shall be
initially set at one second. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in MCC's and equipment control panels. Unless otherwise specified, all PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power.

E. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero. All run-time calculations shall be performed at the PLC level and maintained in the PLC data table.

F. Equipment failure shall be generated through the PLC for any drive, motor, actuator etc. for which a run command has been issued, but for which the PLC does not receive a run status or expected position status signal within a predefined time (based on equipment suppliers' recommendations, adjustable on the HMI). The failed-to-start, failed-to-open, failed-to-close, failed-to-move, or any other control discrepancy conditions shall be alarmed on the HMI.

G. Individual instrument failure signals shall be generated by the PLC for each instrument that is generating an out-of-range signal (e.g. significantly less than 4 mA or greater than 20 mA) or that is indicating a malfunction from self-diagnostic features (e.g. poor signal quality, bad data, out-of-calibration). The failure signals shall be individually alarmed in the HMI.

H. A PLC control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in REMOTE and/or if equipment in REMOTE is not all in the AUTO mode. If equipment within an equipment chain is required to be running for program operation and it is running in LOCAL or MANUAL, then the program shall run and control the other equipment that is in AUTO.

2.04 PROCESS CONTROL MODULES

A. The control strategies are written descriptions of the programming required to implement regulatory and sequential control of unit processes or equipment as shown on the Drawings or as specified herein. Control strategies shall fully reside in the memory of the designated PLC unit and shall use modules (reusable code) where shown on the Drawings, where specified, or where any PLC code would otherwise be repeated to a large extent. Modules shall be used to the extent practical for ease of editing PLC code. The instrumentation subcontractor shall use modules available within the applications programming interface (API's) provided by the PLC manufacturer as well as custom modules created specifically for the unit processes and equipment specified.

B. Certain modules that apply to all inputs and outputs, virtual variables, and PID controllers are not shown on the P and ID drawings. Provision shall be made to include the following modules as applicable, even though one or more of the modules may be disabled for each application:

- MINT - Motor Interface
- PFRST - Power Failure Restart

C. The P&ID's do not show all of the modules required for sequence control. In most cases, the symbol "I" and the associated control strategy number depict discrete logic functions. The required sequence logic features are specified in the control strategy description.
2.05 MODULE DESCRIPTIONS

A. A functional description of each process control module is given in this Section. Module descriptions, equations are provided below to define the functional requirements of each module. The regulatory and sequence control modules required are shown on the P and ID's and specified in the control strategy schedules.

B. Each module shall be structured to permit the realization of all control strategy linkage requirements. In addition, each module shall be designed so that bumpless, balance free transfers are obtained during operating mode changeover and initialization. Where applicable, user-changeable parameters shall be automatically defaulted to a pre-set value if a specific value is not given during system generation.

C. Modules shall be based upon the process control unit software requirements specified and configured in functional logic blocks or subroutines as necessary to accomplish the functions described herein. The CONTRACTOR may substitute functionally equivalent modules subject to the ENGINEER's favorable review.

D. MINT-Motor Interface - MINT in combination with manual and automatic control strategies, shall provide basic control functions common to each type of controlled equipment. The functions shall include: remote-manual control, software switching between manual and automatic control (when automatic control is available), control/status discrepancy alarms, equipment fault alarms, bumpless transfer from Auto to Manual mode, bumpless transfer from Local to Remote (Manual) mode. The MINT module shall be applied to each type of controlled equipment as follows:

1. Equipment controlled by Start/Stop Commands:
   Inputs: Remote, Running
   Outputs: Start, Stop

2. Equipment controlled by Start/Stop and multiple speeds or directions:
   Inputs: Remote, Running (high speed or forward), Running (low speed or reverse), Running x n (n= number of speeds or directions)
   Outputs: Start (high speed or forward), Start (low speed or reverse), Start x n (n = number of speeds or directions), Stop

3. Equipment controlled by start/stop and variable speed:
   Inputs: Remote, Speed, Running
   Outputs: Speed Command, Start, Stop

4. Motorized Actuators controlled by Open/Close Commands
   Inputs: Remote, Opened, Closed, Opening, Closing
   Outputs: Open, Close

5. Motorized Actuators controlled by Position Commands
   Inputs: Remote, Position
Outputs:  Position Command

Software and physical signaling shall be maintained or momentary contacts as required by the software or electrical elementary diagrams of the controlled equipment.

Remote control in Manual or Automatic modes shall require that the equipment control selector switch (or software switch) be in the Remote position. When not in Remote, MINT shall continue to monitor the status of the equipment such that bumpless transfer to Remote-Manual mode shall occur upon return of the equipment to Remote control. When switching into Remote control, equipment shall be placed in Manual mode and the commanded state shall match the current state of the equipment.

The MINT shall latch a single Common Fault bit when any one or more of the following conditions occurs:

1. Control Discrepancy Fault

   When the remote control command changes, the appropriate output shall be switched and a delay timer initiated. During the countdown to zero, the commanded state shall be compared with the status. When the two agree, the output shall be latched and the timer shall be reset and stopped.

   If the timer expires before the requested state is achieved, the equipment shall register a discrepancy alarm and the output command shall be removed by the associated control strategy. When the operator resets the alarm the equipment shall remain in its current state until commanded to change by the operator or an automatic control strategy.

2. Equipment Fault

   Equipment fault signals are those signals originating from the equipment or their associated control panel(s) that indicates the equipment must immediately stop. It shall not include warnings or service requirement indications. When an equipment fault signal is received, MINT shall start a timer. When the timer expires the equipment shall register a fault alarm and the output command shall be removed by the associated control strategy. When the operator resets the alarm the equipment shall remain in its current state until commanded to change by manual control or an automatic control strategy.

3. Loss of Communications

   The MINT block shall monitor communication status between the PLC and the equipment. The communications status shall be generated by each PLC that communicates over a digital communications link to other PLC’s, remote I/O racks, or equipment. The PLC shall employ a watchdog timer or other method that provide positive indication of communications. Methods that rely on the fluctuation of process data are not acceptable. The loss of communications alarm shall be generated after a time delay.

   The MINT shall also calculate the following equipment operation statistics and maintain PLC data table registers for scanning:
Accumulated Run-time (current day)
Accumulated Run-time (prior day)
Accumulated Run-time (current month)
Accumulated Run-time (prior month)
Accumulated Run-time (since last reset)
Number of Starts (current day)
Number of Starts (prior day)
Number of Starts (current month)
Number of Starts (prior month)
Number of Starts (since last reset)

E. **PFRST-Power Failure Restart** – All equipment controlled by the control system is to return to its pre-power failure state following the return of power. When power returns after a power failure (whether on emergency power or utility power), equipment that was running is to restart according to preset hardware time delay relays (for equipment with high electrical loads) or immediately (equipment with low electrical loads). Motorized actuators are to remain in their last position unless specified otherwise with functional control descriptions. It is imperative that the control system functions with all controlled equipment to smoothly and safely return the system to proper operations without operator intervention. In order to do so, the PFRST function will perform the following:

1. Monitor “Power Failure” for each piece of controlled equipment. Use individual power failure signals for each piece of equipment when available. If individual power failure signals are not available, use a general AC power failure signal.

2. When a power failure is detected, immediately alarm the condition on the HMI, freeze all control outputs in its pre-power failure state, and suppress any equipment alarms that are caused by the power failure. Immediately start a timer (Maximum Outage Timer). During this time the control output freeze and alarm suppression shall remain in effect.

3. When power returns, continue the control output freeze and alarm suppression for a preset time (Maximum Restart Timer). This will allow all hardwired time-delay relays to time out and transient equipment faults to self-clear.

4. After the Maximum Restart Timer expires, release the freeze on control outputs and alarm suppression. All discrete and analog control functions are to continue at the point of execution before the power failure. All discrete equipment that did not return to its original state will have its outputs turned off and a deviation alarm will be issued. This mode of execution will occur unless the Maximum Outage Timer has timed out.
5. If the Maximum Outage Timer times out, the equipment is to be returned to the manual control mode and a stop command issued. Motorized actuators are to be placed in manual mode and remain in their current position.

F. PID-Proportional plus Integral plus Derivative - the PID module is an incremental version of the feedback control algorithm used in analog controllers. The result of each module calculation is an incremental change to the manipulated variable which may be a valve position or motor speed as shown on the Drawings. The PID module shall either have its output connected to a final control element or cascaded to another module. The output of the control module (controlled variable) is the sum proportional, integral, and derivative calculations performed by the module. Other control modes, such as P, PI, PD and I shall be derived from the PID module by deleting terms as required. The PID controller shall be configured as forward or reverse acting depending on the nature of the process being controlled.

The PID module shall include a calculation for each of the three terms: P, I and D. However, a process control error calculation shall be used as the basis for all three. The error shall be the difference between the setpoint and the measured value. The “P” term shall multiply the error by a constant. The “I” term shall integrate the Error over time and multiply the result by a constant. The “D” term shall calculate the rate of change of the error and multiply by a constant. All constants, timing parameters, or other coefficients used within the PID algorithm shall be fully adjustable to facilitate tuning of the PID control loop.

The PID module shall include a deadband. An output shall be computed only when the error exceeds the deadband limit. If the error is within the deadband, the output shall be maintained at its last calculated value. The deadband limit settings may be asymmetrical with respect to zero error.

PART 3 -- FUNCTIONAL CONTROL DESCRIPTIONS

3.01 FILTER INFLUENT LEVEL CONTROLS

A. Drawing I-3

B. Control Description

The water treatment plant production rate is established by the raw water wells and pumping systems. To avoid overflowing upstream basins, the flow control through the filters is based on maintaining an appropriate range of water levels upstream of the filters. Therefore, this control strategy will control the level in the filter influent pipe as measured by LIT-30000 (hydrostatic level transmitter) by adjusting the total filter effluent flow rate among all filters that are in service and whose effluent flow control valves are in automatic flow control mode.

The filter influent level controller shall be an open loop controller with an input level range that corresponds to zero filter flow at minimum level and maximum filter flow at maximum level. The level range and the capacities for each filter shall be adjustable on the OIT. The initial filter capacity setpoints shall be 3.1 MGD each, individually adjustable.

Generate an alarm if the filter influent flume level remains above a high level setpoint for more than 30 seconds. Reset the alarm if the level falls 1 inch below the alarm setpoint.
C. Operator Interface

1. Influent level indication
2. Flow and level setpoints
3. Influent flume high level alarm
3.02 FILTRATION CONTROLS (TYPICAL FOR FILTERS 1, 2, 3, AND 4)

A. Drawing I-3 through I-6

B. Control Description

The filters shall have four modes of operation: In Service, Backwash, Filter to Drain, and Offline. The mode of operation shall be indicated whether under automatic, manual, or local control based on the following:

1. “In Service” shall be indicated when the filter influent valve (MOV-3x001) and effluent valve (MOV-3x006) are not closed and the filter is not in a backwash sequence.

2. “Backwash” shall be indicated when a backwash sequence has been initiated for a filter as described below in the Master Backwash Control description.

3. “Filter to Drain” shall be indicated when the drain valve (MOV-3x003) is not closed.

4. “Offline” shall be indicated when the effluent valve (MOV-3x006) and drain valve (MOV-3x003) are closed and the filter is not in a backwash sequence.

The modes of operation shall also be selectable by the operator from the OIT as follows:

1. When “In Service” is selected, the filter influent valve shall open and the effluent valve shall begin controlling flow through the filter. All other valves shall be closed.

2. When “Backwash” is selected, the filter shall enter the backwash queue as described below in the Master Backwash Control description. The filter shall remain in its current mode until the backwash is initiated by the operator.

3. When “Filter to Drain” is selected, the filter influent and drain valves shall be open, and all other valves shall be closed. When “Offline” is selected, all valves shall be closed.

The filter flow control valve actuator shall operate in local or remote via a local actuator mounted selector switch as follows:

**Local Mode:** When the Local/Remote selector switch on the associated valve actuator is toggled to "local", the operator shall be able to locally open and close the valve to any desired position. The flow rate shall be displayed locally on each magnetic flow meter transmitter.

**Remote Mode:** When the Local/Remote selector switch on the valve actuator is toggled to "remote", the control of the filter flow control valve is transferred to the PLC. The plant operator can select one of the three available control options as follows:

- **Manual Position Control:** The valve shall move to the any position entered by the operator on the OIT.

- **Manual Flow Control:** The valve shall modulate based on a PID control loop to achieve a flow rate setpoint entered by the operator on the OIT.
Automatic Flow Control: The valve shall modulate based on a PID control loop to achieve a flow rate setpoint derived from the filter influent level controller.

Generate an alarm if any filter flow rate exceeds 3.2 MGD. Reset the alarm if the flow rate falls below 3.1 MGD.

C. Operator Interface
   1. Flow Indication
   2. Valve Controller (Manual / Auto)
   3. Valve Position (Manual)
   4. Filter Flow Controller (Manual / Auto)
   5. Filter Flow (Manual)
   6. Filter high flow rate alarms and alarm setpoints

3.03 FILTER MASTER BACKWASH CONTROL

A. Drawing I-3 through I-6

B. Control Description

Filter backwash scheduling shall be controlled by the Filter Master Backwash Control Strategy and issue appropriate commands to the subordinate filter controls. The Filter Master Backwash Control shall place the filters into a backwash queue based upon any or all of the following conditions:

1. If the filter's head loss exceeds 6 feet for more than 60 seconds.
2. If the filter's turbidity exceeds 1.0 NTU for more than 300 seconds and the filter has not been backwashed within the last eight hours.
3. If the filter's accumulated run-time since it completed its last backwash cycle exceeds 100 hours.
4. Operator requests a backwash as described above in Filtration Controls.

If more than one filter is placed in the queue, the queue shall be organized based upon the time of placement in the queue and shall display the current status of the following parameters in a table format on the OIT:

1. Turbidity
2. Head Loss
3. Filter Run-time
4. Time Placed in Queue
The operator shall have the option of removing a filter from the backwash queue if the filter's accumulated run-time since its last backwash is less than 100 hours and the filter headloss and turbidity are below the limits described above.

Each filter in the backwash queue must be individually acknowledged by the operator prior to initiating the backwash. The acknowledgement status of each filter in the queue shall be indicated on the OIT. Once a filter in the queue is acknowledged by the operator, the filter shall initiate backwashing if no other filter is backwashing, and all required valve actuators are ready. A valve actuator shall be considered ready if its selector switch is in Remote, is not faulted, and is in Automatic mode (if automatic backwash is selected). Once initiated, the operator shall have the option of canceling the backwash and placing the filter back into the queue.

C. Local Control: None

D. Operator Interface

1. Head Loss (Each Filter)
2. Turbidity (Each Filter)
3. Run-time (Each Filter)
4. Time/Date placed in queue (Each Filter)
5. Operator Acknowledgement / Queue Placement
6. Headloss, turbidity, and runtime setpoints and time delays.

3.04 FILTER BACKWASH SEQUENCE

A. Drawing I-3 through I-6

B. Control Description

Each filter shall have two modes of backwash operation; individually selectable by the operator from the OIT.

The backwash operating modes are as follows:

1. Mode 1 – Manual Backwash: In this mode, the operator shall manually control all filter valves to complete the backwash sequence. The operator shall manually reset the filter run timer at the end of the manual backwash. The OIT shall display backwash in manual mode.

2. Mode 2 – Automatic Backwash: In this mode, the following automatic control sequence shall commence (all timers and setpoints shall be adjustable on the OIT):
   a. The OIT shall display backwash in automatic mode.
   b. The filter influent valve (MOV-3x001) shall begin to close.
c. Upon closure of the filter influent valve and after the water level drops approximately 12 inches above the media (LT-3x000) the filter flow control valve (MOV-3x006) shall be closed.

d. The filter waste backwash valve (MOV-3x004) shall open to direct backwash to the waste flume.

e. The filter surface scour valve (MOV-3x005) shall open.

f. Upon confirmation of the opening of the filter surface scour valve, the surface scour supply valve (MOV-30000) shall modulate based on a PID control loop to maintain a surface scour flow rate of 61 gpm for 60 seconds.

g. The surface scour supply valve (MOV-30000) shall then close and the filter backwash supply valve (MOV-3x002) shall open.

h. Upon confirmation of the opening of the filter backwash supply valve, the backwash supply isolation valve (MOV-30001) shall close forcing all transfer pump flow to the filter backwash supply.

i. The full backwash flow rate shall be maintained for 6 minutes.

j. After the 6 minutes of backwashing, the surface scour supply valve (MOV-30000) shall modulate based on a PID control loop to maintain 61 gpm for a simultaneous backwash and surface scour for 90 seconds. The backwash supply isolation valve (MOV-30001) shall then open.

k. When the backwash supply isolation valve (MOV-30001) is fully open, the filter backwash supply valve (MOV-3x002) shall close.

l. The surface scour shall continue for 60 seconds.

m. The surface scour supply valve (MOV-30000) and the filter surface scour valve (MOV-3x005) shall then close.

n. Upon confirmation of closure of the filter surface scour valve and after an adjustable time delay (60 seconds), the filter waste backwash valve (MOV-3x004) shall close.

o. The OIT shall display “Filter Backwash Complete”.

p. The following sequence shall be performed to automatically return the filter to service:

1) After a 30 minute delay (adjustable) the filter influent valve (MOV-3x001) shall open.

2) Upon confirmation of opening of the filter influent valve, the filter drain valve (MOV-3x003) shall open. Water shall be filtered to the drain for an operator adjustable period initially set at 3 minutes.

Provide an optional mode to extend the filter to drain up to 30 minutes based on the filter effluent turbidity (AY-3x000). If enabled, this mode
of operation will continue to filter to drain until the turbidity remains below 1.0 NTU 15 seconds. If the turbidity does not fall below 1.0 NTU within the 30 minutes, place the filter “Offline” and generate an alarm.

3) After the “filter to drain” period, the filter drain valve (MOV-3x003) shall close. 10 seconds after the filter drain valve begins to close, the filter flow control valve (MOV-3x002) shall be enabled to allow a smooth transition between filtering to drain and filtering to the clearwell without stopping the flow through the filter.

4) The filter will now be in service and the OIT shall display “Filter in Service”.

C. Local Control: None

D. Operator Interface: Refer to Control Description

- END OF SECTION –