APPENDIX A: TECHNICAL SPECIFICATIONS

FOR

CONSTRUCTION OF

VINE STREET WTP CHEMICAL SYSTEM IMPROVEMENTS

FOR

CITY OF ALBANY

DECEMBER 14, 2020

MURRAYSMITH
888 SW 5th Avenue, Suite 1170
Portland, OR 97204
503.225.9010

CITY OF ALBANY, OREGON

TECHNICAL SPECIFICATIONS

FOR

WTP 19-02 VINE STREET WTP CHEMICAL SYSTEM IMPROVEMENTS

PROFESSIONAL OF RECORD CERTIFICATION(s):

Andrew Szatkowski – Murraysmith  2020.12.10 14:05:09-08'00' RENEWS 6-30-22	I declare the Special Technical Specification(s) listed below are applicable to the design for the subject project for City of Beaverton (COB). Special Technical Specifications were prepared by me or under my supervision. Section(s): 011000, 012250, 013300, 017516, 024100, 068200, 079200, 101400, 23313, 331150, 400500, 400507, 400531, 400559.23, 400560, 407346, 433320, 434143
Date Signed: 12-10-20	

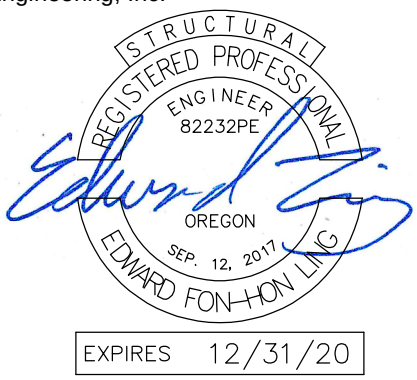
CITY OF ALBANY, OREGON

TECHNICAL SPECIFICATIONS

FOR

WTP 19-02 VINE STREET WTP CHEMICAL SYSTEM IMPROVEMENTS

PROFESSIONAL OF RECORD CERTIFICATION:

<table>
<tr>
<td>Edward Ling – Peterson Structural Engineering, Inc.
 

EXPIRES 12/31/20</td>
<td rowspan="2">I declare the Special Technical Specification(s) listed below are applicable to the design for the subject project for City of Beaverton (COB). Special Technical Specifications were prepared by me or under my supervision.

Section(s): 031100, 036000, 055000</td>
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<td>Date Signed: 12/7/2020</td>
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CITY OF ALBANY, OREGON

TECHNICAL SPECIFICATIONS

FOR

WTP 19-02 VINE STREET WTP CHEMICAL SYSTEM IMPROVEMENTS

PROFESSIONAL OF RECORD CERTIFICATION:

<table>
<tr>
<td>Michael Wallis – Industrial Systems, Inc.

 

EXPIRES: 6/30/22</td>
<td rowspan="2">I declare the Special Technical Specification(s) listed below are applicable to the design for the subject project for City of Beaverton (COB). Special Technical Specifications were prepared by me or under my supervision.

Section(s): 260500, 260505, 260519, 260526, 260529,260533, 260800, 260916, 262716, 262726, 406113, 406700, 407000, 407223, 407276, 408000</td>
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<td>Date Signed: 12/10/20</td>
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WTP 19-02 VINE STREET WTP CHEMICAL SYSTEM IMPROVEMENTS
FOR
CITY OF ALBANY, OREGON

TABLE OF CONTENTS

SECTION 01 10 00 - SUMMARY OF WORK

PART 1 GENERAL

This Summary of Work further defines the Work for the project, including project coordination requirements and work to be performed by the Owner.

1.1 SCOPE OF WORK

The work to be performed under these specifications and drawings consists of furnishing all services, materials, equipment, and labor necessary for improvements to the Vine Street Water Treatment Plant chemical feed systems.

The work includes, but is not limited to, the following: 1) relocate from the Soda Ash Building to the Chemical Building an existing hypochlorite feed panel, with pumps and associated piping and other equipment that is mounted on that panel; 2) relocate an existing hypochlorite chemical feed pump control panel from the Soda Ash Building to the Chemical Building; 3) install two OWNER-furnished hypochlorite storage tanks; 4) furnish and install piping and associated equipment between the tanks and the suction supply piping for the relocated chemical feed panel and furnish and install other piping associated with the tanks as shown in the Drawings; 5) furnish and install piping and associated equipment between the discharge piping of the relocated chemical feed panel and existing chemical feed pipes within the plant; 6) relocate a dry sodium fluorosilicate feed system from the Chemical Building to the Soda Ash Building; 7) repurpose an existing dry chemical feed system located in the Soda Ash Building for use as a sodium fluorosilicate feed system; 8) furnish and install a new scale beneath the hopper of the sodium fluorosilicate feed system; 9) move a dry polymer feed system from the first floor of the Chemical Building to the second floor of that building; 10) demolish and dispose of a coagulant storage tank currently located on the second floor of the Chemical Building; 11) relocate coagulant pumps from the second floor of the Chemical Building to the first floor; 12) furnish and install piping and appurtenances to connect the discharge of the coagulant pumps in their new location to existing injection points; 13) install one OWNER-furnished coagulant storage tank, and furnish and install piping and associated equipment between the tank and the suction of the relocated coagulant pumps as well as other piping associated with the tanks as shown in the Drawings; 14) install an owner-furnished slide gate on the raw water supply channel to the raw water clear well.

The work involves potential exposure to hazardous chemicals, including sodium fluorosilicate and concentrated sodium hypochlorite, and requires adherence to all Federal, State and local requirements for protection of workers and the environment.

The above general outline of principal features of the work does not in any way limit the responsibility of the CONTRACTOR(s) to perform all work and furnish all equipment, labor and materials required by the specifications and drawings. The drawings and specifications

shall be considered and used together. Anything appearing as a requirement of either shall be accepted as applicable to both even though not so stated therein or shown.

No attempt has been made in these specifications or drawings to segregate work covered by any trade or subcontract under one specification. Such segregation and establishment of subcontract limits will be solely a matter of specific agreement between the CONTRACTOR and its subcontractors and shall not be based upon any inclusion, segregation, or arrangement in or of these specifications.

1.2 CONSTRUCTION SEQUENCING

A. Construction sequencing is critical to successful completion of the project within the period of time that the plant undergoes seasonal shut down.

B. Contractor shall develop a construction sequencing plan in accordance with the requirements of Section 01 33 00, Submittal Procedures, Article 2.1, Construction Sequencing Plan.

C. The Contractor shall develop, maintain, and be solely responsible for sequencing all aspects of the project, complete, in accordance with all project work and operational parameters.

D. The construction sequencing plan shall consider all aspects of the work, schedule, weather, water system operation, and public and private access, including the need to:

1. Ensure the Owner's water system is not impacted outside identified allowable periods;

2. Ensure compliance with all permit conditions and restrictions;

3. Ensure safety of the public, personnel, and the project;

4. Conduct all operations in a manner that minimizes impact to the public, the Owner, and the adjacent projects or development.

1.3 COORDINATION OF DRAWINGS AND SPECIFICATIONS

The drawings and specifications are intended to describe and provide for a complete work. Any requirement in one is as binding as if stated in all. The CONTRACTOR shall provide any work or materials clearly implied in the Contract Documents even if the Contract Documents do not mention it specifically. If there is a conflict within the Contract Documents, it will be resolved by the following order of precedence specified elsewhere in the Contract Documents.

Dimensions shown on the drawings or that can be computed shall take precedence over scaled dimensions. Notes on drawings are part of the drawings and govern in the order described above. Notes on drawings shall take precedence over drawing details.

The intent of the drawings and specifications is to prescribe the details for the construction and completion of the work which the CONTRACTOR undertakes to perform according to the terms of the Contract. Where the drawings or specifications describe portions of the work in general terms, but details are incomplete or silent, it is understood that only the best general practice is to prevail and that only materials and workmanship of the best quality are to be used. Unless otherwise specified, the CONTRACTOR shall furnish all labor, materials, tools, equipment, and incidentals, and do all the work involved in executing the Contract in a manner satisfactory to the ENGINEER.

The contract drawings are designated by general title, sheet number and sheet title. When reference is made to the drawings, the "Sheet Number" of the drawing will be used. Each drawing bears the ENGINEER's File No. 20-2757 and the general title:

WTP 19-02 Vine Street WTP Chemical System Improvements

1.4 CODE REQUIREMENTS

All work shall be done in strict compliance with the requirements of:

A. Oregon Structural Specialty Code
B. Uniform Mechanical Code
C. Uniform Plumbing Code
D. National Electric Code
E. National Electric Safety Code
F. Oregon State Department of Labor and Industries
G. Linn County Code

In case of disagreement between codes or these specifications, the more restrictive shall prevail.

1.5 COORDINATION WITH OTHER CONTRACTORS AND WITH OWNER

The OWNER shall have another Contractor performing work elsewhere in the plant at the same time as this work. Certain work within this contract may require coordination with the work of the other contractor and OWNER. The CONTRACTOR under these specifications shall cooperate fully with all other contractors and OWNER and carefully fit its own work to such other work as may be directed by the ENGINEER. The CONTRACTOR shall not commit or permit any act to be committed which will interfere with the performance of work by any other contractor or the OWNER.

1.6 ACCESS TO WORK

Access to the work shall be provided as may be required by the OWNER or its representatives, and all authorized representatives of the state and federal governments and any other agencies having jurisdiction over any phase of the work, for inspection of the progress of the work, the methods of construction or any other required purposes.

1.7 SITE INVESTIGATION AND PHYSICAL DATA

The CONTRACTOR acknowledges that it is satisfied as to the nature and location of the work and the general and local conditions, including but not limited to those bearing upon transportation, disposal, handling and storage of materials, availability of water, roads, groundwater, access to the sites, coordination with other contractors, and conflicts with pipelines, structures and other contractors. Information and data furnished or referred to herein is furnished for information only. Any failure by the CONTRACTOR to become acquainted with the available information and existing conditions will not be a basis for relief from successfully performing the work and will not constitute justification for additional compensation.

The CONTRACTOR shall verify the locations and elevations of existing pipelines, structures, grades and utilities, prior to construction. The OWNER assumes no responsibility for any conclusions or interpretations made by the CONTRACTOR based on the information made available.

1.8 TEMPORARY UTILITIES FOR CONSTRUCTION PURPOSES

Water for construction purposes will be furnished by the OWNER at no cost. The CONTRACTOR shall furnish all valves, hoses, connections and other devices as necessary to obtain enough water for construction and for filling and testing of water lines as required. Fire hydrant use is allowed only by permission of the utility owner. Backflow protection is required on all connections to potable water systems.

1.9 FIELD SERVICE BY MANUFACTURER'S REPRESENTATIVE

The CONTRACTOR shall furnish the services of a manufacturer's or material supplier’s representative for all major equipment and materials furnished by the CONTRACTOR or OWNER under this contract, to check, place in operation and test the installation, and train operating personnel. The manufacturer's representative shall be qualified and authorized to perform repairs and maintenance on the equipment. The above gives a general scope of the services desired from the manufacturer's representative. It will be the responsibility of the CONTRACTOR and the equipment manufacturer to determine detailed requirements. Costs for services of the manufacturer's representative shall be included in the proposal of the CONTRACTOR. The operator training mentioned above shall include enough time during the CONTRACTOR’s operation and testing period to fully explain to the operating personnel the features of the equipment and maintenance thereof.

1.10 CONSTRUCTION WITHIN PUBLIC RIGHTS-OF-WAY

When the work contemplated is wholly or partly within the right-of-way of a public agency such as a city, county or state, the OWNER will obtain from these agencies any right-of-way and street opening permits and all other necessary permit(s) required for the work. The CONTRACTOR shall abide by all regulations and conditions stipulated in the permit(s). Such conditions and requirements are hereby made a part of these specifications, as fully and completely as though the same were fully set forth herein. The CONTRACTOR shall examine the permit(s) granted to the OWNER by any city, county, state and federal agencies. Failure to do so will not relieve the CONTRACTOR from compliance with the requirements stated therein.

The CONTRACTOR shall obtain all construction permits and pay all fees or charges and furnish any bonds and insurance coverages as necessary to insure that all requirements of the city, county, state or federal agencies will be observed and the roadway and ditches are restored to their original condition or one equally satisfactory. A copy of all permits shall be kept on the work site for use of the ENGINEER.

1.11 PRIVATE ROADS AND DRIVEWAYS

Bridges at entrances to business properties where vehicular traffic is necessary shall be provided and maintained. Bridges shall be adequate in width and strength for the service required. No private road or driveway may be closed without approval of the ENGINEER unless written authority has been given by the owner whose property has been affected. Driveways shall be left open and ready for use at the end of the work shift. All expenses involved in providing for construction, maintenance, and use of private roads or driveways, shall be borne by the CONTRACTOR and the amount thereof absorbed in the unit prices of the CONTRACTOR's bid.

1.12 SPECIAL INSPECTOR'S AUTHORITY AND DUTIES

The Owner shall employ a Special Inspector to perform all necessary Special Inspections unless otherwise specified.

The Contractor shall notify the Owner and Special Inspector in advance of all special inspections located at the project site in accordance with the notes on the structural Drawings. See Sheet S-1.

The Contractor shall, at the conclusion of individual Special Inspection visits, meet with both the Owner or Owner's Representative and the Special Inspector prior to the Special Inspector leaving the site.

1.13 DECHLORINATION AND DISPOSAL OF CHLORINATED WATER

Any discharge of chlorinated water shall either be through an approved connection to a public sanitary sewer system or shall include de-chlorination to limits acceptable by the Oregon State Department of Environmental Quality (DEQ) for discharge into the existing storm drainage system. No chlorinated water shall be discharged into the storm drainage system prior to approved de-chlorination treatment.

1.14 LIMITS OF THE WORK AND STORAGE OF SPOILS

The limits of the site which may be used for construction, storage, materials handling, parking of vehicles and other operations related to the project include the project site as shown on the drawings and adjacent public rights-of-way subject to permission of the public owner of that right-of-way. The limits of work also include rights of access obtained by the CONTRACTOR, subject to all public laws and regulations and rights of access by utility companies and other holders of easement rights.

1.15 EXISTING WATER SYSTEM SHUTDOWN

If the project involves the need to shut down an existing water system, the CONTRACTOR shall coordinate the work to insure a minimum of shutdown time. The CONTRACTOR shall submit a written shutdown schedule to the ENGINEER for approval. The CONTRACTOR shall provide 72-hour notice preceding each shutdown. See Section 33 12 13, Water Service Connections, for additional requirements.

1.16 FIELD CHANGES, ALIGNMENT, AND GRADE

Changes of alignment and grade shall be made during the course of work in order to avoid interference with unforeseen obstructions. The CONTRACTOR shall locate existing utilities to be crossed, by potholing ahead of the pipe installation, of sufficient distance to avoid conflicts through pipe joint deflection if possible. All costs for minor field changes of alignment and grade shall be borne by the CONTRACTOR. The ENGINEER will endeavor to make prompt decisions on such matters. CONTRACTOR shall anticipate a minimum of 72 hours for any decision requiring significant piping change.

1.17 TESTING AND OPERATION OF FACILITIES

It is the intent of the OWNER to have a complete and operable facility. All the work under this contract will be fully tested and inspected in accordance with the specifications. Upon completion of the work, the CONTRACTOR shall operate the completed facilities as required to test the equipment under the direction of the ENGINEER. During this period of operation by the CONTRACTOR, the new facilities will be tested thoroughly to determine their acceptance.

1.18 PROTECTION OF EXISTING STRUCTURES AND WORK

The CONTRACTOR must take all precautions and measures necessary to protect all existing structures and work. Any damage to existing structures and work shall be repaired by removing the damaged structure or work, replacing the work and restoring to original condition satisfactory to the ENGINEER.

1.19 SALVAGE AND DEBRIS

Unless otherwise indicated on the drawings or in the specifications, all castings, pipe, equipment, demolition debris, spoil or any other discarded material or equipment shall become the property of the CONTRACTOR and shall be disposed of in a manner compliant with applicable Federal, State, and local laws and regulations governing disposal of such waste products. No burning of debris or any other discarded material will be permitted.

1.20 SAFETY STANDARDS AND ACCIDENT PREVENTION

The CONTRACTOR shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours. The required and/or implied duty of the ENGINEER to conduct construction review of the CONTRACTOR's performance does not, and is not intended to, include review of the adequacy of the CONTRACTOR's safety measures in, on, or near the construction site.

The CONTRACTOR shall comply with the safety standards provisions of applicable laws and building and construction codes. The CONTRACTOR shall exercise every precaution at all times for the prevention of accidents and protection of persons, including employees, and property. During the execution of the work the CONTRACTOR shall provide and maintain all guards, railing, lights, warnings, and other protective devices which are required by law or which are reasonably necessary for the protection of persons and property from injury or damage.

1.21 PUBLIC SAFETY AND CONVENIENCE

General Rule: The CONTRACTOR shall ensure the safety of the public during its performance of the Work and shall minimize any public inconvenience in addition to any other requirement imposed by law. These duties include, but are not limited to, the matters listed below.

Access: The CONTRACTOR shall not unreasonably restrict access to public facilities, commercial property, fire hydrants, residential property, and other areas where the public can be expected to be present, such as sidewalks and streets without first obtaining approval of the OWNER. Driveways shall be closed only with the approval of the OWNER or after obtaining specific permission from the property owner or owners. In addition, the

CONTRACTOR shall not obstruct or interfere with travel over any public street or sidewalk without approval of the OWNER.

Public Transit: The CONTRACTOR shall not interfere with the normal operation of any public transit vehicles unless otherwise authorized.

Work Site: The CONTRACTOR shall keep the Project site safe in compliance with applicable law. Safety includes, but is not limited to: 1) providing an approved type of secured and adequate barricades or fences that are easily visible from a reasonable distance around open excavations; 2) closing up or covering with steel plates all open excavations at the end of each Working Day in all street areas and in all other areas when it is reasonably required for public safety; 3) marking all open work and obstructions by lights at night; 4) installing and maintaining all necessary signs, lights, flares, barricades, railings, runways, stairs, bridges, and facilities; 5) observing any and all safety instructions received from the OWNER; and 6) following all laws and regulations concerning worker and public safety. In the event that the law requires greater safety obligations than that imposed by the OWNER, the CONTRACTOR shall comply with the law.

Emergency: Emergency vehicles, including but not limited to police, fire, and disaster units shall be provided access to the work site at all times.

Cleanliness: The CONTRACTOR shall, on a continuing basis, keep the surfaces of all public and private roadways, sidewalks, and other pathways free of dirt, mud, cold plane grindings, and other matters that the CONTRACTOR may place upon the road. The cost of performing such work shall be included in the CONTRACTOR's Bid and no additional payment will be made for performing this task.

Parking: The CONTRACTOR shall make any necessary contacts with all applicable governmental bodies to arrange for the removal of parked automobiles, vehicles and other obstructions if they would interfere with the performance of the CONTRACTOR'S work.

Accidents: The CONTRACTOR'S Project Manager or superintendent shall be in charge of accident prevention. CONTRACTOR shall take all actions necessary to prevent damage, injury and loss to persons and property as a result of accidents.

Project Health and Safety Plan: CONTRACTOR shall develop, publish, and implement an overall Project Health and Safety Program for the Project. This Program shall conform to all applicable codes. Contractor shall submit the written Safety Program to the OWNER within 30 days after the receipt of the written Notice to Proceed. The Plan shall be assembled to address project specific health and safety issues to both the public and on-site personnel. The plan shall include the following items when they apply:

- Employee Orientation
- Safety Inspections
- Instruction and Training
- Hazardous Materials
- Hazardous Communications Program
- Job Hazard Analysis

- Accident Reporting
- Signs and Barricades
- Fire Prevention and Protection
- Welding, Cutting, and Burning
- Painting and Surface Treatment
- Electricity
- Machinery and Mechanized Equipment
- Excavations
- Sanitation
- Chlorine Safety
- First Aid/Medical Facilities
- Personal Protective Equipment
- Confined Space Entry Plan
- Shoring Plan
- Fall Protection Plan
- Emergency Action Plan
- Housekeeping
- Safety Training Requirements and Certification
- Pedestrian Access Around Work Site During Construction and After Hours

If the project requires other health and safety issues to be addressed, they too shall be included in the Project Health and Safety Plan. The Program shall subsequently be distributed to and implemented by the CONTRACTOR's personnel as well as its Subcontractors and Suppliers. CONTRACTOR shall fully implement and comply with the Safety Program and shall submit to the OWNER a letter signed by CONTRACTOR'S owner/president affirming such implementation and compliance within 15 days after on-site work has started. CONTRACTOR shall notify the OWNER when safety meeting will be held so that Owner's personnel may attend. A copy of the approved Health and Safety Plan must be maintained on-site at all times during the life of the Project.

The OWNER has no responsibility for Work site safety. Work site safety is the responsibility of the CONTRACTOR. The CONTRACTOR is required to have a competent person on site at all times during construction activities.

The CONTRACTOR shall provide signs on work zone fencing that provide information regarding access to businesses and stating that such businesses are open and in operation. The CONTRACTOR shall furnish and install the signs and provide sign attachments for the various business names.

1.22 WARRANTY PERIOD

The CONTRACTOR shall warrant all furnished materials and equipment for a period of one year from date of final acceptance of the Work by the OWNER. This warranty shall mean prompt attention to the correction and/or complete replacement of the faulty material or equipment. The expiration of the one-year warranty period shall not affect any other claims or remedy available to the OWNER. There may be other warranty provisions in these contract documents in addition to those noted above.

1.23 UTILITY PROPERTIES AND SERVICE

In areas where the CONTRACTOR's operations are adjacent to or near a utility and such operations may cause damage which might result in significant expense, loss and inconvenience, the operations shall be suspended until all arrangements necessary for the protection thereof have been made by the CONTRACTOR.

The CONTRACTOR shall notify all utility offices which may be affected by the construction operation at least 48 hours in advance. Before exposing any utility, the utility having jurisdiction shall grant permission and may oversee the operation. Should service of any utility be interrupted due to the CONTRACTOR's operation, the proper authority shall be notified immediately. It is of the utmost importance that the CONTRACTOR cooperates with the said authority in restoring the service as promptly as possible. Any costs shall be borne by the CONTRACTOR.

1.24 SANITARY FACILITIES

The CONTRACTOR shall provide and maintain sanitary facilities for its employees and its subcontractors' employees that will comply with the regulations of the local and State Departments of Health and as directed by the ENGINEER.

1.25 STREET CLEANUP

The CONTRACTOR shall clean daily all dirt, gravel, construction debris, and other foreign material resulting from its operations from all streets and roads.

1.26 VEHICLE PARKING

The vehicles of the CONTRACTOR's and subcontractors' employees shall be parked in accordance with local parking ordinances and shall be parked in such a manner as to maintain access by OWNER's staff to the existing water treatment plant facilities at all times throughout construction. OWNER shall identify at the preconstruction conference appropriate locations for the parking of vehicles by the CONTRACTOR's and subcontractors' employees. Protection of Quality of Water

The work to be performed may involve connections to an existing potable water system. If such work is included in the project, the CONTRACTOR shall take such precautions as are necessary or as may be required to prevent the contamination of the water. Such contamination may include but shall not be limited to deleterious chemicals such as fuel, cleaning agents, paint, demolition and construction debris, sandblasting residue, etc. In the event contamination does occur, the CONTRACTOR shall, at its own expense, perform such work as may be necessary to repair any damage or to clean the affected areas of the water mains to a condition satisfactory to the ENGINEER.

The work to be performed involves the excavation, cutting, removal and modifications to an existing well casing(s). All work required under this contract shall be performed in

accordance with Oregon Administrative Rules of the Oregon Water Resources Department, Chapter 690, including but not limited to OAR 690-200, Water Supply Well Construction and Maintenance and OAR 690-210, Well Construction Standards.

1.27 RECORD DRAWINGS

CONTRACTOR shall maintain at the site one set of specifications, full size drawings, shop drawings, equipment drawings, and supplemental drawings which shall be corrected as the work progresses to show all changes made. Drawings shall be available for inspection by the ENGINEER. Upon completion of the contract and prior to final payment, specifications and drawings shall be turned over to the ENGINEER.

1.28 "OR EQUAL" CLAUSE

In order to establish a basis of quality, certain processes, types of machinery and equipment or kinds of material may be specified on the drawings or herein by designating a manufacturer's name and referring to its brand or product designation. It is not the intent of these specifications to exclude other processes, equipment or materials of a type and quality equal to those designated. When a manufacturer's name, brand, or item designation is given, it shall be understood that the words "or equal" follow such name or designation, whether in fact they do so or not. If the CONTRACTOR desires to furnish items of equipment by manufacturers other than those specified, he shall secure the approval of the ENGINEER prior to placing a purchase order.

No extras will be allowed the CONTRACTOR for any changes required to adopt the substitute equipment. Therefore, the CONTRACTOR's proposal for an alternate shall include all costs for any modifications to the drawings, such as structural and foundation changes, additional piping or changes in piping, electrical changes or any other modifications which may be necessary or required for approval and adoption of the proposed alternate equipment. Approval of alternate equipment by the ENGINEER before or after bidding does not guarantee or imply that the alternate equipment will fit the design without modifications.

1.29 SURVEYS

Based upon the information provided by the Contract Documents, the CONTRACTOR shall develop and make all detail surveys necessary for layout and construction, including exact component location, working points, lines, and elevations. Prior to construction, the field layout shall be approved by the OWNER's representative. The CONTRACTOR shall have the responsibility to carefully preserve bench marks, reference points, and stakes, and in the case of destruction thereof by the CONTRACTOR or resulting from its negligence, the CONTRACTOR shall be charged with the expense and damage resulting therefore and shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points, and stakes.

1.30 WORK HOUR LIMITATIONS

All work shall be conducted between the hours of 7:00 a.m. and 6:00 p.m. on non-holiday weekdays only, unless specified otherwise elsewhere in these Contract Documents. No weekend work will be allowed. Requests for variations in work hours shall be made in writing for consideration by the OWNER. No work shall be conducted outside of the above-described days and hours without prior approval of the OWNER.

1.31 DUST PREVENTION

All unpaved streets, roads, detours, haul roads, or other areas where dust may be generated shall receive an approved dust-preventive treatment or be routinely watered to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced.

Dust emissions from reservoir construction activities including sandblasting and painting shall be controlled to be within applicable environmental regulations. The CONTRACTOR shall be responsible for cleaning and repair of properties near the reservoir site which may become damaged by sandblasting or painting emissions.

1.32 NOISE LIMITATIONS

The project areas are located adjacent to a residential zoned area. All applicable City, County ordinances, and State and Federal regulations shall be complied with.

1.33 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

A. Materials and equipment stored overnight shall be placed neatly on the job site. Unusable materials (i.e. rejected or damaged liner material, old concrete chunks, metal scraps, etc.) shall be expeditiously removed from the job site.

   Provide appropriate barricades, signs, and traffic control devices in like-new condition where necessary to protect the public from any hazards associated with the storage of materials and equipment used for this project.

B. No equipment and/or materials shall be stored outside the immediate work area on public right-of-ways, in the following locations, or in the following manner:

   1. In any maintained landscaped or lawn area.
   2. In a manner that would totally eliminate an individual residents' street parking.
   3. In front of any business.

   The “immediate work area” is the area where work is taking place or will be taking place within one calendar day. The CONTRACTOR shall immediately move stored material or equipment which causes a nuisance or creates complaints.

1.34 COMPETENT PERSON DESIGNATION

CONTRACTOR shall designate a qualified and experienced “competent person” at the site whose duties and responsibilities shall include enforcement of applicable OSHA regulations regarding excavations, the prevention of accidents, and the maintenance and supervision of construction site safety precautions and programs.

1.35 EMERGENCY MAINTENANCE SUPERVISOR

The CONTRACTOR shall submit to the ENGINEER the names, addresses, and telephone numbers of at least two employees responsible for performing emergency maintenance and repairs when the CONTRACTOR is not working. These employees shall be designated, in writing by the CONTRACTOR, to act as its representatives and shall have full authority to act on its behalf. At least one of the designated employees shall be available for a telephone call any time an emergency arises.

1.36 PREVAILING WAGE RATES FOR PUBLIC WORKS CONTRACTS IN OREGON

The CONTRACTOR shall abide by ORS 279C.800 through 279C.870 which relate to the prevailing wage rates for the building and construction trades in the State of Oregon. These prevailing wage rates are shown in the Bureau of Labor and Industries document which is included elsewhere in these contract documents.

1.37 OREGON PRODUCTS

CONTRACTOR's attention is directed to the provisions of Oregon Law, ORS 279A.120 regarding the preference for products that have been manufactured or produced in Oregon. CONTRACTOR shall use Oregon-produced or manufactured materials with respect to common building materials such as cement, sand, crushed rock, gravel, plaster, etc., and Oregon-manufactured products in all cases where price, fitness, availability and quality are otherwise equal.

1.38 USE OF EXPLOSIVES

The use of explosives shall not be allowed on this project.

1.39 CONTAMINATED MATERIAL

A. General

It is possible that the CONTRACTOR may encounter contaminated material (soil and/or water) during excavation activities. This specification identifies requirements for handling and disposing contaminated media.

B. Definitions

1. “Contaminated material” is defined as soil, water, free product, Underground Storage Tanks (UST), buried abandoned utility lines containing residual or free product, solid waste, treated wood waste, chemical containers, or other solid, liquid, or gas substances with contamination levels above background levels.

2. “Hazardous substances” shall mean those substances or materials defined in the Oregon Revised Statutes (ORS) 465.200, as amended.

3. “Release” shall have the meaning as defined in ORS 465.200, as amended.

4. “Environmental laws” shall mean any applicable statute, law, ordinance, order, consent decree, judgment, permit, license, code, covenant, deed, common law, treaty, convention or other requirement pertaining to protection of the environment, health or safety, natural resources, conservation, wildlife, waste management or disposal, hazardous substances or pollution, including but not limited to regulation of releases to air, land, water, and groundwater.

C. Execution

1. Discovery of Contaminated Material

   In the event that the CONTRACTOR, during the course of construction or during any other activities authorized under this contract, should encounter suspected contaminated material or any other materials suspected of posing a threat to human health and the environment, the CONTRACTOR shall notify the ENGINEER immediately and manage according to requirements identified below.

2. Discovery of Contaminated Soil

   CONTRACTOR shall note evidence of contamination (odor, visual staining of soil, free liquid product seeping from soil, sheen on groundwater, etc.) and note location of evidence on a sketch of the excavation and provide to the ENGINEER.

   CONTRACTOR shall report the discovery to the ENGINEER immediately. CONTRACTOR shall stop all excavation activities and secure the site to prevent entry by the public. The excavation shall not be backfilled. Protect all open excavations with berms, plates and fencing. CONTRACTOR may continue with work in other non-contaminated areas.

   CONTRACTOR shall assist ENGINEER in collecting sample(s) of suspected contaminated media for testing and characterization. CONTRACTOR shall allow 21 days, at no cost to OWNER, for testing, results and instructions as to how to proceed with contaminated materials.

The CONTRACTOR shall obtain a copy of an approved soil disposal/acceptance permit (Disposal/Treatment Facility requires transporter to have a copy of the permit.)

CONTRACTOR will transport and dispose of contaminated material at an approved disposal/treatment facility.

CONTRACTOR shall provide the ENGINEER with a copy of the contaminated soil disposal receipt.

3. Handling of Contaminated Soil

After approval from the ENGINEER, excavate the soil in a manner that prevents commingling of contaminated and non-contaminated soil. ENGINEER will make determination (based on soil saturation) if contaminated soil can be directly transported to a treatment or disposal facility, or if soil needs to be stockpiled to reduce water content. ENGINEER will determine when stockpiled soil can be transported off-site.

CONTRACTOR will be responsible for stockpiling contaminated soil in containers or on impervious surface to prevent the spread of contamination. Any water runoff from the contaminated soil stockpile area(s) must be contained by CONTRACTOR and handled as contaminated water.

Minimize movement of excavation equipment over or through contaminated soil to prevent movement of contaminated soil into areas where no contaminated soil exists.

Stockpiles will be created on an approved site and shall be surrounded by a fence to limit access. The stockpiles must be covered and bermed during periods of rainfall to prevent run-on and run-off. The stockpiles shall be covered with a minimum 10-mil high density polyethylene (HDPE) plastic during periods of strong winds, nightfall, over the weekends, or during extended work stoppages. If dust is observed coming from the stockpiles, the stockpiles shall be either covered or the dust controlled with water.

Maintain excavation equipment in good working order. Prevent spillage of oil, fuel, or hazardous substances from equipment. In particular, promptly repair oil leaks from equipment and clean up any contaminated soil.

4. Transport of Contaminated Materials

CONTRACTOR shall comply with all applicable Federal, State, or local laws, codes, and ordinances that govern or regulate contaminated substance transportation. Contaminated soils placed in stockpiles shall be loaded into trucks in a manner that prevents the spilling or tracking of contaminated soil into areas of the site with

uncontaminated soil. Loose material falling onto the exterior of the truck during loading shall be removed before the truck leaves the loading area. Any material collected in the loading area shall either be placed back into the truck or back into the stockpile. If loading areas are unpaved, the surface soil shall be sampled at the conclusion of the loading activities to confirm that contaminated soil is not present. If loading areas are paved, any loose soil shall be cleaned from the pavement at the conclusion of the loading activities.

Specific truck haul routes shall be established before beginning off-site contaminated media transport. On-site truck routes shall be established to minimize or prevent movement of trucks over contaminated soils. Off-site truck routes shall be established to reduce the risk of releases of contaminated soils and impact on local traffic. The CONTRACTOR shall be responsible for ensuring that loaded truck weights are within acceptable limits. All trucks shall be covered before they leave the loading area.

The CONTRACTOR shall ensure that all drivers of vehicles transporting contaminated substances have in their possession during transport all applicable Oregon State and local vehicle insurance requirements, valid driver's license, and vehicle registration and license. The CONTRACTOR shall be responsible for informing all drivers of transport vehicle about:

a. The nature of the material transported.

b. Required routes to and from the off-site thermal treatment or disposal facility.

c. Applicable County street regulations and requirements, and State of Oregon Department of Transportation codes, regulations and requirements.

d. The County's requirement for proper handling and transportation of the substances.

The CONTRACTOR shall not allow contaminated substances to be spilled or tracked off-site at any time during the project. Trucks used for the transportation of contaminated substances off-site shall be watertight, substance compatible, licensed, insured, and permitted pursuant to federal, state, and local statutes, rules, regulations and ordinances.

If contaminated media is discarded prior to removal of contaminated material, the price per cubic yard of soil materials and price per 100 gallons of contaminated water will be negotiated with OWNER.

1.40 FACILITY OPERATIONS REQUIREMENTS

The work included in these plans and specifications is to be performed at a Water Treatment Plant. The plant will be offline during construction. However, the CONTRACTOR shall

cooperate fully with the OWNER and the ENGINEER to ensure that the OWNER's personnel maintain full access to the plant so they can continue to conduct maintenance and repairs and any other activities that operations staff must conduct while the plant is offline to ensure that the plant is ready to resume operations immediately upin completion of the work.

The specific major requirements for maintaining plant operations are listed below. These requirements are not necessarily complete in every detail:

A. Five day's-notice shall be given to the OWNER by the CONTRACTOR when any interruption of or modification to the operation of the existing plant and/or piping is desired.

B. Follow the sequence of construction requirements as described elsewhere in this section.

1.41 SPECIAL INSPECTIONS

Special inspections and testing as required by Chapter 17 of the IBC shall be conducted by Special Inspectors and Testing Agencies retained and approved by the OWNER as required and as indicated in the Contract Documents.

A. Special Inspectors and Testing Agencies Responsibilities

1. Verify that manufacturers maintain detailed fabrication and quality control procedures and review the completeness and adequacy of those procedures to perform the Work.

2. Promptly notify OWNER, ENGINEER and CONTRACTOR of irregularities and deficiencies observed in the Work during performance of their services.

3. Submit certified written report of each test, inspection and similar quality control service to OWNER, ENGINEER, CONTRACTOR and jurisdictional authorities. Interpret test results and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

4. Submit final report of special inspections at Substantial Completion, including a list of unresolved deficiencies.

5. Re-test and re-inspect corrected work.

B. CONTRACTOR'S Responsibilities

1. Provide quality requirements to all subcontractors and enforce all requirements.

2. Notify OWNER, ENGINEER, Special Inspectors and Testing Agencies at least 48 hours in advance of time when Work that requires testing or special inspecting will be performed, unless otherwise indicated in the Contract Documents.

3. Pay for any CONTRACTOR requested testing and inspecting not required by the Contract Documents.

4. Pay for any re-testing or re-inspections by Special Inspectors and Testing Agencies for replacement work resulting from work that failed to comply with the Contract Documents. OWNER will deduct such costs from the Contract Price.

5. Submit copies of licenses, certifications, correspondence, records and similar documents used to establish compliance with standards and regulations that pertain to performance of the Work to the OWNER, ENGINEER and Special Inspectors.

6. Where Special Inspection requires preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

    a. Provide test specimens representative of proposed products and construction in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

    b. Provide information on configurations of test assemblies, testing procedures and laboratory test records to adequately demonstrate capability of products to comply with performance requirements.

7. Cooperate with Agencies performing required tests, special inspections and similar quality control services. Notify Agencies in advance of operations to permit assignment of personnel. Provide the following:

    a. Access to the Work.

    b. Incidental labor, equipment and materials necessary to facilitate tests and special inspections.

    c. Adequate quantities of representative samples of materials that require testing and inspecting. Assist Agencies in obtaining samples.

    d. Provide facilities for storage and field curing of test samples.

    e. Deliver samples to Testing Agencies.

8. Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and special inspecting.

9. Schedule times for tests, special inspections, obtaining samples and similar activities. Distribute schedule to OWNER, ENGINEER, Special Inspectors, Testing Agencies and each party involved in portions of the work where tests and special inspections are required.

END OF SECTION

SECTION 01 22 50 - LUMP SUM MEASUREMENT AND PAYMENT

PART 1 GENERAL

Payment for this project will be on a lump sum basis. The lump sum price shall constitute full compensation for all work required by the contract documents.

END OF SECTION

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section contains administrative and procedural requirements for submittals for review, information, and for Project closeout.

B. Section includes:

1. Submittal requirements.
2. Submittal procedures.
3. Engineer review.
4. Resubmittal procedures.
5. Product data.
6. Shop Drawings.
7. Samples.
8. Design data.
9. Test reports.
10. Certificates.
11. Manufacturer's instructions.
12. Manufacturer's field reports.
13. Erection Drawings.
14. Construction progress schedules.
15. Breakdown of contract price.
16. Operation and maintenance (O&M) instructions.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action.

B. Informational Submittals: Written and graphic information and physical Samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SHOP DRAWING AND SAMPLE SUBMITTAL REQUIREMENTS

A. Before submitting a Shop Drawing or Sample, Contractor shall have:

1. Reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents

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

3. Determined and verified the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

4. Determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

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

C. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication with the Shop Drawings or Sample submittal.

1.4 SUBMITTAL PROCEDURES

A. Contractor shall submit Shop Drawings and Samples to Engineer for review.

B. Transmit each submittal with Engineer-accepted transmittal form certifying compliance with requirements of Contract Documents.

C. Sequentially number transmittal forms. Mark transmittal forms for resubmittals with original number and sequential alphabetic suffix.

D. Show each Submittal with the following numbering and tracking system:

1. Submittals shall be numbered according to specification section. For example, the first product submittal for Section 05 50 00 would be "05 50 00-1". Resubmittals of that submittal would be "05 50 00-1.1", followed by "05 50 00-1.2", and so on. The second product submittal for that Section would be "05 50 00-2".

2. Submittals containing product information from multiple sections of the specifications will not be reviewed. Contractor and/or their supplier shall divide submittals in a manner that meets the numbering and tracking system requirements stated herein.

3. Alternative method of numbering may be used if acceptable to Engineer.

E. Identify: Project, Contractor, subcontractor and supplier, pertinent drawing and detail number, and specification Section number appropriate to submittal.

F. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.

G. Coordinate submission of related items.

1. All shop drawings for interrelated items shall be scheduled for submission at the same time.

2. The Engineer may hold shop drawings in cases where partial submission cannot be reviewed until the complete submission has been received or where shop drawings cannot be reviewed until correlated items affected by them have been received. When such shop drawings are held, the Engineer will advise the Contractor in writing that the shop drawing submitted will not be reviewed until shop drawings for all related items have been received.

H. When hard copies of submittals are provided by the Contractor, six copies of all materials shall be provided to the Engineer. Two copies of reviewed submittals will be kept by the Engineer, two copies of reviewed submittals will be transmitted to the Owner, and two copies of reviewed submittals will be returned to the Contractor. If the Contractor requests that more than two copies of the reviewed submittal be returned, then the Contractor shall submit the appropriate quantity of submittals.

I. When electronic transmittals of submittals are provided by the Contractor under established protocols described elsewhere in the Contract Documents or as jointly developed by the Owner, Engineer and Contractor, provide electronic submittals in portable document format (PDF) in addition to the source document format (Word, Excel, AutoCAD, etc.). Reviewed submittals will be returned to the Contractor as PDF electronic files.

J. For each submittal for review, allow not less than 14 days for Engineer review, excluding delivery time to and from Contractor.

K. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.

L. Allow space on submittals for Contractor and Engineer review stamps or comments.

M. When revised for resubmission, the Contractor shall identify changes made since previous submission. A narrative of changes shall be provided, and shop drawings or calculations shall indicate that a revision was made.

N. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with review comments.

O. Submittals not requested will not be recognized nor processed.

P. Incomplete Submittals: Engineer will not review. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Engineer.

1.5 ENGINEER REVIEW

A. Informational submittals and other similar data are for Engineer's information, do not require Engineer's responsive action, and will not be reviewed or returned with comment.

B. The Engineer’s review of submittals and shop drawings is not a check of any dimension or quantity and will not relieve the Contractor from responsibility for errors of any sort in the submittals and shop drawings.

C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

D. The Engineer will review the submitted data and shop drawings and return to the Contractor with notations thereon indicating "No Exception Taken", "Make Corrections Noted", "Rejected", "Revise and Resubmit", or "Submit Specified Item".

E. If more than two submissions of an item are required to meet the Project specifications, Contractor shall be responsible for Engineer’s charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

F. Engineer’s review will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

G. Engineer’s review will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.

H. Engineer’s review of a separate item as such will not indicate approval of the assembly in which the item functions.

I. Engineer’s review of a Shop Drawing or Sample shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 1.4.C and Engineer

has given written acceptance of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such accepted variation from the requirements of the Contract Documents in a Field Order.

J. Engineer's review of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 1.4 A. and B.

K. Engineer's review of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.

L. Neither Engineer's receipt, review, return of a Shop Drawing, Sample, or other submittal shall result in such item becoming a Contract Document.

M. Contractor shall perform the Work in compliance with the requirements and commitments set forth in returned Shop Drawings and Samples, subject to the provisions of Paragraph 1.6.I.

1.6 RESUBMITTAL PROCEDURES

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

B. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required review of an item with no more than two submittals. Engineer will record Engineer's time for reviewing a third or subsequent submittal of a Shop Drawings, sample, or other item requiring review, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.

C. If Contractor requests a change of a previously reviewed submittal item, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

PART 2 PRODUCTS

2.1 CONSTRUCTION SEQUENCING PLAN

A. Within 10 days after the Effective Date of the Contract, prepare and submit to the Engineer a practicable schedule showing the order in which the Contractor proposes to carry out the Work, the dates on which the important features of the work will start,

and the contemplated dates for completing same. In addition to a time-scaled bar chart schedule depicting the project critical path, the Contractor shall submit a detailed CPM logic diagram. The CPM diagram and time-scaled bar chart shall include the following:

- Construction activities
- Submittal and review of material samples and shop drawings
- Procurement and delivery of critical materials
- Fabrication, installation, and testing of special material and equipment
- Duration of work, including completion times of all stages and their sub-phases

The activities shall be separately identifiable by coding or use of sub-networks or both. The duration of each activity shall be verifiable by manpower and equipment allocation, in common units of measure, or by delivery dates and shall be justifiable by the Contractor upon the request of the Engineer.

B. Attention is drawn to typical local climatic weather patterns and Work shall be coordinated accordingly.

C. Complete project schedule shall be revised and resubmitted to the Engineer at a minimum occurrence of every 4 weeks for review.

D. Three-Week Lookahead Schedules: Provide each week at the weekly construction meeting. The previous week's completed work shall be shown on the schedule for a total of 4 weeks shown.

2.2 BREAKDOWN OF CONTRACT PRICE

A. Within 10 days after the Effective Date of the Contract, submit a complete breakdown of all lump sum bid items showing the value assigned to each part of the work, including an allowance for profit and overhead adding up to the total lump sum contract price.

B. Breakdown of lump sum bids shall be coordinated with the items in the schedule and shall be in sufficient detail to serve as the basis for progress payments during construction.

C. Engineer will review the contract price breakdown and may request items to be further broken down or for more items be added in order to facilitate tracking of work progress for payment.

D. Preparatory work, bonds, and insurance required in setting up the job will be allowed as a separate entry on the cost breakdown but shall not exceed 5 percent of the total base bid.

E. Upon acceptance of the breakdown of the contract price by the Engineer, it shall be used as the basis for all requests for payment.

2.3 PRODUCT DATA

A. Product Data: Action Submittal: Submit to Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents. Submitted data shall be sufficient in detail for determination of compliance with the Contract Documents.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

1. Note submittal will be returned to Contractor without review of submittal if products, models, options, and other data are not clearly marked or identified.

C. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

2.4 SHOP DRAWINGS

A. Shop Drawings: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer licensed in the state of Project responsible for designing components shown on Shop Drawings.

1. Include signed and sealed calculations to support design.

2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.

3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. All dimensioned shop drawings shall be scalable and provided as full-sized (22-inch x 34-inch) sheets. PDF electronic files shall print as scalable full-sized sheets.

2.5 SAMPLES

A. Samples: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Samples for Selection as Specified in Product Sections:

1. Submit to Engineer for aesthetic, color, and finish selection.

2. Submit Samples of finishes, textures, and patterns for Owner selection.

C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.

D. Include identification on each Sample, with full Project information.

E. Submit number of Samples specified in individual Specification Sections; Engineer will retain one Sample.

F. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

G. Samples will not be used for testing purposes unless specifically stated in Specification Section.

2.6 DESIGN DATA

A. Informational Submittal: Submit data for Engineer's knowledge as Contract administrator or for Owner.

B. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

2.7 TEST REPORTS

A. Informational Submittal: Submit reports for Engineer's knowledge and records as Contract administrator or for Owner.

B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

2.8 CERTIFICATES

A. Informational Submittal: Submit certification by manufacturer, installation/application Subcontractor, or Contractor to Engineer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product but must be acceptable to Engineer.

2.9 MANUFACTURER'S INSTRUCTIONS

A. Informational Submittal: Submit manufacturer's installation instructions for Engineer's knowledge as Contract administrator or for Owner.

B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Engineer in quantities specified for Product Data.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

2.10 MANUFACTURER'S FIELD REPORTS

A. Informational Submittal: Submit reports for Engineer's knowledge and records as Contract administrator or for Owner.

B. Submit report within 48 hours of observation to Engineer for information.

C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

2.11 ERECTION DRAWINGS

A. Informational Submittal: Submit Drawings for Engineer's knowledge and records as Contract administrator or for Owner.

B. Submit Drawings for information assessing conformance with information given and design concept expressed in Contract Documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

2.12 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. Submit preliminary O&M materials for review by Engineer. The equipment manufacturer may furnish instruction manuals prepared specifically for the equipment furnished or standard manuals may be used if statements like "if your equipment has this accessory..." or listings of equipment not furnished are eliminated. O&M materials will be returned to the Contractor for resubmittal if the O&M materials do not clearly indicate what specific equipment was furnished and all items not provided being clearly crossed out. Poorly reproduced copies are not acceptable. Operation and maintenance instructions shall contain the following as a minimum:

1. Reviewed shop drawings and submittal data;

2. Model, type, size, and serial numbers of equipment furnished;

3. Equipment and driver nameplate data;

4. List of parts showing replacement numbers;

5. Recommended list of spare parts;

6. Complete operating instructions including start-up, shutdown, adjustments, cleaning, etc.;

7. Maintenance and repair requirements including frequency and detailed instructions; and

8. Name, address and phone numbers of local representative and authorized repair service.

B. Following review of the preliminary O&M materials by the Engineer and before acceptance of the Work, submit four hardcopies of complete, final operation and maintenance instructions for all equipment supplied. Submit items in 8-1/2 x 11-inch heavy-duty three-ring binders when appropriate, or in 8-1/2 x 11-inch file folders. In addition to the hardcopies, provide an electronic version of the complete, final operation and maintenance instructions in PDF format. Submitted PDFs shall be fully searchable for ease of future review. All binders and folders shall have clear plastic pockets on the front of the cover and the spine to allow for insertion of identifying information.

2.13 OTHER REQUIRED SUBMITTALS

A. Other required submittals include the items listed below. This list is provided for Contractor's convenience only and may not be complete in all respects. Contractor shall provide all submittals specified or required, whether or not listed here.

1. Contractor Emergency Contact List.
2. Erosion and Sediment Control Plan.

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 75 16 - TESTING, TRAINING, AND SYSTEM START-UP

PART 1 GENERAL

1.1 SCOPE

This section specifies equipment and system testing and start-up, services of manufacturer's representatives, training of OWNER's personnel, and final testing requirements for the complete facility.

1.2 CONTRACT REQUIREMENTS

A. Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete all testing, training, and start-up within the Contract Time(s).

C. Furnish all necessary labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

D. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation, testing, and operator training.

1.3 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 2 weeks prior to planned initial equipment or system start-up.

B. Provide detailed Start-up Progress Schedule with the following activities identified:

1. Manufacturer’s services
2. Installation certifications
3. Operator training
4. Submission of operation and maintenance manual
5. Functional testing
6. Performance testing
7. Operational testing

C. Provide testing plan with test logs for each item of equipment and/or system. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems if required, which are necessary to complete start-up of new equipment and systems.

E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.4 GENERAL START-UP AND TESTING PROCEDURES

A. Mechanical Systems:

1. Remove rust preventatives and oils applied to protect equipment during construction.

2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.

3. Flush fuel system and provide fuel for testing and start-up.

4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.

5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.

6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.

7. Perform cold alignment and hot alignment to manufacturer's tolerances.

8. Adjust V-belt tension and variable pitch sheaves.

9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to ensure no leakage but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.

10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.

11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical Systems

1. Perform insulation resistance tests on wiring except 120-volt lighting, wiring, and control wiring inside electrical panels.

2. Perform continuity tests on grounding systems.

3. Test and set switchgear and circuit breaker relays for proper operation.

4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.

5. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation Systems

1. Bench or field calibrate instruments and make required adjustments and control point settings.

2. Leak test pneumatic controls and instrument air piping.

3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

1.5 FUNCTIONAL TESTING

A. Functionally test mechanical and electrical equipment for proper operation after general start-up and testing tasks have been completed.

B. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

C. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

D. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.6 CERTIFICATE OF PROPER INSTALLATION

A. At completion of functional testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:

1. Has been properly installed, aligned, adjusted, and lubricated.

2. Is free of any stresses imposed by connecting piping or anchor bolts.

3. Is suitable for satisfactory full-time operation under full load conditions.

4. Operates within the allowable limits for vibration.

5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.

6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly functioning.

B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:

1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.

2. Control logic for equipment start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.

C. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.7 TRAINING OF OWNER'S PERSONNEL

A. Provide operations and maintenance training for items of mechanical, electrical, and instrumentation equipment. Utilize manufacturer's representatives to conduct training sessions.

B. Coordinate training schedule with City staff. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than two sessions per week.

C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems 2 weeks prior to training session for that piece of equipment or system.

D. Satisfactorily complete functional testing before beginning operator training.

E. The OWNER may videotape the training for later use with the OWNER's personnel.

1.8 OPERATIONAL TESTING

A. Conduct operational test of the entire facility after completion of operator training. Demonstrate satisfactory operation of equipment and systems in actual operation.

B. Conduct operational test for continuous 7-day period.

C. Owner will provide operations personnel, power, fuel, and other consumables for duration of test.

D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

1.9 RECORD KEEPING

A. Maintain and submit to ENGINEER the following records generated during start-up and testing phase of project:

1. Daily logs of equipment testing identifying all tests conducted and outcome.

2. Logs of time spent by manufacturer's representatives performing services on the job site.

3. Equipment lubrication records.

4. Electrical phase, voltage, and amperage measurements.

5. Insulation resistance measurements.

6. Pump torsional and lateral vibration analysis report.

7. Data sheets of control loop testing including testing and calibration of instrumentation devices and set points.

END OF SECTION

SECTION 02 41 00 - DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of existing facilities.
2. Abandoning and removing utilities.

B. Related Sections:

1. Section 33 11 50 - Existing Pipe Abandonment

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit to Engineer a copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

1.3 QUALITY ASSURANCE

A. Existing Conditions: Determine the extent of work required and limitations before proceeding with Work.

B. Conform to applicable local, state, and federal codes for environmental requirements in relation to disposal of debris.

1. Burning at the Site for the disposal of refuse, debris, and waste materials resulting from demolition and site clearing operations shall not be permitted.

C. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.

D. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of workmen, other persons, and property in the vicinity of the Work and requirements of the General Provisions.

E. If the existing material to be demolished and removed contains any hazardous materials which will require special handling upon removal, such as asbestos or lead, it is the responsibility of the Contractor to remove and dispose of the material in accordance with all applicable federal, state and local regulations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Existing Materials: All materials, equipment, miscellaneous items, and debris involved, occurring, or resulting from demolition, clearing, and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or Specifications.

PART 3 EXECUTION

3.1 EXAMINATION

A. The Owner assumes no responsibility for the actual condition of the facilities to be demolished. The Contractor shall visit the site, inspect all facilities and be familiar with all existing conditions and utilities.

B. Demolition drawings identify major equipment and structures to be demolished only. Auxiliary utilities such as water, air, chemicals, drainage, lubrication oil, hydraulic power fluid, electrical wiring, controls, and instrumentation are not necessarily shown shall be considered incidental to all demolition work.

C. Identify waste and salvage areas for placing removed materials.

3.2 PREPARATION

A. Carefully coordinate the work of this Section with all other work and construction.

B. Call Local Utility Line Information service not less than three working days before performing any work that requires excavation.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Disconnect or arrange for disconnection of utilities (if any) affected by required work.

3. Keep all active utilities intact and in continuous operations.

3.3 PROTECTION

A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.

B. Survey control: Protect benchmarks, survey control points, and existing structures from damage or displacement.

C. Preservation and Trimming of Trees, Shrubs and Other Vegetation: As specified in Section 31 10 00-3.4.C, Site Clearing.

D. Landscaped Areas: Protect existing landscaped areas as specified in Section 31 10 00-3.4.D, Site Clearing.

E. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, sidewalks, paving, guy wires, utility poles, and curbs.

F. Repair and Replacement:

1. Damaged items, including but not restricted to those noted above, shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of Work of this contract.

2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

3.4 DEMOLITION

A. Carefully consider all bearing loads and capacities for placement of equipment and material on site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, consult with Engineer prior to the placement of such equipment or material.

B. Demolition of Existing Structures:

1. Excavate around existing structures as required to perform demolition operations and to plug associated existing pipelines where shown in the Drawing.

2. Provide shoring, bracing, and supports, as required, to ensure adjacent structures are not damaged and structural elements of existing structure are not overloaded during demolition activities.

a. Increase structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under any part of this Contract.

b. Remove all temporary protection when the Work is complete or when so authorized by the Engineer.

3. Any floors that are to remain in place shall be completely cracked through to allow for drainage. Cracking shall be accomplished by dropping a demolition ball or by other methods approved by the Engineer.

4. Remove and dispose of all exposed and/or protruding reinforcing, metalwork, piping, plumbing, and conduits resulting from demolition activities, and all woodwork, roofing, and electrical and mechanical equipment removed from demolished structures.

    a. Reinforcing bars shall be cut flush with final wall elevations as shown in the Drawings.

    b. No detached metalwork, excluding concrete reinforcing bars, shall be buried with the concrete and masonry rubble.

C. All existing improvements designated in the Drawings or specified to be removed, including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing, and similar structures occurring above, at, or below existing ground surface shall be included in the demolition work.

D. Unless otherwise specified, any resulting voids shall be backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.

3.5 EXISTING WATER UTILITY PIPING ABANDONMENT

A. As specified in Section 33 11 50, Existing Pipe Abandonment.

3.6 ELECTRICAL AND CONTROL SYSTEM DEMOLITION

A. All electrical and control system demolition work shall at all times be conducted in a safe and proper manner to avoid injury from electrical shock to all personnel.

1. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable.

2. At no time shall live electrical wiring or connections or those which can become energized be accessible to any persons without suitable protection or warning signs.

3.7 REMOVAL

A. Remove debris, metal, concrete, rubble and abandoned piping resulting from abandonment and/or demolition activities from site.

B. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

C. Removal: All material resulting from demolition shall be removed from the project site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.

3.8 CLEANUP:

A. During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, debris, and dust. Leave all areas affected by the work in a clean, condition, as may be subject to OWNER approval.

B. Adjacent areas within structures shall be cleaned of dust, dirt, and debris resulting from demolition. Protect or partition off adjacent areas during demolition to minimize the amount of dust, dirt, and debris that may enter adjacent areas.

C. Adjacent areas shall be returned to their existing condition prior to the start of work.

3.9 SCHEDULES

A. The following materials are to be demolished and removed for the project site:

1. Steel Coagulant tank and associated concrete supports.
2. Exposed Metal pipe
3. Exposed PVC pipe.

END OF SECTION

SECTION 03 11 00 - CONCRETE WORK

PART 1 GENERAL

1.1 SUMMARY

A. The extent of concrete work is shown on the Drawings.

B. Work includes providing formwork and shoring for cast-in-place concrete and installation of related items including reinforcing steel bar (rebar), anchor bolts, setting plates, bearing plates, anchorages, inserts, reveals, frames, nosings, sleeves and other items to be embedded in concrete.

C. Definitions

1. Batch: Used in this specification to define an overall class of concrete as delivered from a concrete batching plant or on-site batching operation. Batching operations can continue for hours or days and as long as the class of concrete is similar, the batch would be considered the same. Multiple mixer truck loads could be used to deliver a “batch” of concrete over the course of multiple hours or days.

2. Batched/Batching: The loading of concrete, as combined and mixed at a batching/ready-mix plant, into a concrete mixer truck for delivery to the job site.

3. Truckload: A standard concrete mixer truck size is assumed to have a concrete capacity of 8 cubic yards. A truckload is used to help define the frequency of testing which of occurs per concrete mixer truck.

4. Ready-Mix Concrete: Concrete that is manufactured in a batch plant, according to a set engineered mix design. This specification assumes ready-mix concrete will be delivered by mixer truck to the job site.

1.2 QUALITY ASSURANCE

A. Codes and Standards

Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified here:

ACI 301 “Specifications for Structural Concrete for Buildings”

ACI 311 “Recommended Practice for Concrete Inspection”

ACI 318 “Building Code Requirements for Reinforced Concrete”

ACI 347 “Recommended Practice for Concrete Formwork”

ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete"

Concrete Reinforcing Steel Institute, "Manual of Standard Practice"

Comply with building code requirements which are more stringent than the above and all OSHA requirements.

B. American Society for Testing and Materials (ASTM)

1. C31, Making and Curing Concrete Test Specimens in the Field.
2. C33, Specification for Concrete Aggregate.
3. C39, Compressive Strength of Cylindrical Concrete Specimens.
4. C40, Organic Impurities in Fine Aggregate for Concrete.
5. C85, Cement Content of Hardened Portland Cement Concrete.
6. C88, Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.
7. C94, Standard Specifications for Ready-Mixed Concrete.
8. C131, Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
9. C136, Method for Sieve Analysis to Fine and Coarse Aggregate.
10. C143, Slump of Portland Cement Concrete.
11. C150, Standard Specification for Portland Cement.
12. C156, Water Retention by Concrete Curing Materials.
13. C173, Air Content of Freshly Mixed Concrete by the Volumetric Method.
14. C231, Air Content of Freshly Mixed Concrete by the Pressure Method.
15. C233, Standard Method of Testing Air-Entraining Admixtures for Concrete.
16. C260, Standard Specifications for Air-Entraining Admixtures for Concrete.
17. C289, Standard Test Method for Potential Reactivity of Aggregates (Chemical Method).

18. C441, Standard Test Method for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction.

19. C457, Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete.

20. C494, Standard Specifications for Chemical Admixtures for Concrete.

21. C670, Preparing Precision Statements for Test Methods for Construction Materials.

22. C803, Penetration Resistance of Hardened Concrete.

C. Workmanship

The CONTRACTOR is responsible for correction of concrete work that does not conform to the specified requirements, including strength, tolerances, and finishes. Correct deficient concrete as directed by the OWNER or ENGINEER. The CONTRACTOR shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

D. Concrete Testing Service

The OWNER or a representative of the OWNER will engage a special inspector/testing laboratory to perform material evaluation tests and to design concrete mixes. See detailed requirements in Part 3.14 “Quality Control Testing during Construction”. Per the OWNER or ENGINEER’s requirements the CONTRACTOR shall notify the designated representative to schedule the special inspections and materials testing required by the project documents.

E. Testing Requirements

Materials and installed work may require testing and retesting, as directed by the OWNER or ENGINEER, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times.

The costs for preparation of mix designs (if required by the OWNER to be performed by an independent testing laboratory) and testing of concrete and materials shall be borne by the OWNER, except when materials do not meet specified requirements, in which case such costs shall be borne by the CONTRACTOR.

F. Tests for Concrete Materials

1. Test aggregates by the methods of sampling and testing of ASTM C33.

2. For Portland cement, sample the cement and determine the properties by the methods of test of ASTM C150.

3. Submit written reports to the OWNER and ENGINEER, for each material sampled and tested prior to the start of work. Provide the project identification name and number, date of report, name of CONTRACTOR, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.

4. Certificates of material properties and compliance with specified requirements may be submitted in lieu of testing. The materials producer and the CONTRACTOR must sign certificates of compliance.

G. Allowable Tolerances:

1. Construct formwork to provide completed cast-in-place concrete surfaces complying with the tolerances specified in ACI 347, and as follows:

   a. Variation from plumb in lines and surfaces of columns, piers, walls and rises; 1/4-inch per 10 feet, but not more than 1-inch. For exposed corner columns, control joint grooves, and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum; 1/2-inch maximum in 40 feet or more.

   b. Variation from level or grade in slab soffits, ceilings, beam soffits, and rises 1/4-inch in 10 feet, 3/8-inch in any bay or 20 feet maximum, and 3/4-inch in 40 feet or more. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum and 1/2-inch in 40 feet or more.

   c. Variation from position of the linear lines and related columns, walls, and partitions, 1/2-inch in any bay or 20 feet maximum, and 1-inch in 40 feet or more.

   d. Variation in sizes and locations of sleeves, floor openings, and wall openings, 1/4-inch.

   e. Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls, minus 1/4-inch and plus 1/2-inch.

   f. Variations in footing plan dimensions, minus 1/2-inch and plus two (2) inches; misplacement or eccentricity, two (2) percent of the footing width in direction of misplacement but not more than two (2) inches; thickness reduction, minus five (5) percent.

g. Variation in steps - In a flight of stairs, 1/8-inch for rise and 1/4-inch for treads; in consecutive steps, 1/16-inch for rise and 1/8-inch for treads.

h. Circular structures shall be constructed in a true circular form, with maximum variation of 1/4-inch from the dimensions shown on the plans.

2. Before concrete placement check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

3. During concrete placement check formwork and related supports to ensure that forms are not displaced and that completed work will be within specified tolerances.

H. Quality Control Testing During Construction

See Section 3 - Execution.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. For information only, submit a electronic copy of manufacturer's data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water stops, joint systems, chemical floor hardeners, dry-shake finish materials, and others. Bind and submit in one submittal.

C. Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with the ACE 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangements of concrete reinforcement. Include special reinforcement required at openings through concrete structures and indicate spacer or burner bars.

D. Submit shop drawings for fabrication and erection of specific finished concrete surfaces as shown or specified. Show the general construction of forms including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items which affect the exposed concrete visually. Submit form drawings for building columns, walls, fascias, and intersections, and concrete pan and joist system. Submit for typical sections only. ENGINEER's review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is the CONTRACTOR's responsibility.

E. Submit electronic copy of laboratory test reports for concrete materials and mix design tests as specified.

F. Material Certificates may be provided in lieu of materials laboratory test reports. The material manufacturer and the CONTRACTOR, certifying that each material item complies with, or exceeds, the specified requirements shall sign material certificates.

1.4 CONCRETE MIX DESIGNS

A. All concrete materials shall be proportioned so as to produce a workable mixture in which the water content will not exceed the maximum specified.

B. If the concrete mix designs specified herein have not been used previously by the ready-mix supplier or if directed by the ENGINEER, mix proportions and concrete strength curves for regular cylinder tests, based on the relationship of 7, 14 and 28 day strengths versus slump values of two (2), four (4), and six (6) inches, all conforming to these Specifications, shall be established by an approved ready-mix supplier or an independent testing laboratory. A laboratory, independent of the ready-mix supplier, shall be required to prepare and test all concrete cylinders.

The costs for preparation of mix designs (if required by the OWNER to be performed by an independent testing laboratory) and testing of concrete and materials shall be borne by the OWNER, except when materials do not meet specified requirements, in which case such costs shall be borne by the CONTRACTOR.

C. The exact proportions by weight of all materials entering into the concrete delivered to the jobsite shall conform to the approved mix design unless specifically so directed by the ENGINEER or Laboratory for improved specified strength or desired density, uniformity and workability.

D. The proportions of such mix design shall be based on a full cubic yard of hardened concrete.

E. Ready-mix companies or jobsite batch plants shall furnish delivery tickets, signed by a Certified Weighmaster, on which each shall state the weight of aggregates, sand, cement, admixtures and water and the number of cubic yards of concrete furnished, which will be compared against the approved mix design.

F. There shall be no variation in the weights and proportions of materials from the approved mix design.

G. There shall be no variation in the quality and source of materials once they have been approved for the specific mix design.

1.5 READY-MIXED CONCRETE

Ready-mixed concrete shall conform to the requirements of ACI 301 and ASTM C 94. In case of conflict, ACI 301 shall govern.

1.6 JOB CONDITIONS

Maintain continuous traffic control and access for vehicular and pedestrian traffic as required for other construction activities as well as to adjoining facilities for regular operation. Utilize flagmen, barricades, warning signs and warning lights as required, to maintain a safe entrance and passage on all roads or drives abutting the project.

PART 2 PRODUCTS

2.1 WALL FORMS

A. Full Height Pours: The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.

B. Wall Form Ties

1. Form ties which remain in the wall of a subgrade water-retaining structure shall have waterstops and a 1.5 inch minimum breakback or cone depth.

2. Snap ties, if used, shall not be broken until the concrete has reached the design concrete strength. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used. The use of tie wires as form ties will not be permitted. Fully threaded stub bolts may be used in lieu of smooth ties with waterstops.

3. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess. Provide A-58 SURE PLUG as manufactured by DAYTON SUPERIOR or approved equal.

4. Ties shall positively secure the wall to the required dimension and hold the wall to that dimension prior to and during concrete placement.

C. Wall Form Stiffeners

1. Horizontal walers shall consist of structural steel channels, angles or tubing of adequate size to retain the concrete without deflecting.

2. As required the walers shall be rolled or welded to the proper radii or offset brackets shall be used for shaping the wall to the dimensions shown on the

Drawings and shall be used both for inside and outside wall forms in direct contact with the wall panels and at vertical spacings of no more than 96 inches on center.

3. There shall be at least one such waler within 24 inches of the top and bottom of the wall.

4. The largest dimension of the steel waler shall be in the radial direction.

5. Vertical structural steel or wood members shall be used at a minimum horizontal spacing of 74 inches and shall have sufficient rigidity and strength to insure the proper vertical alignments with the aid of braces under all predictable stress conditions.

6. In lieu of the above, a different system and spacings may be used if it is satisfactorily demonstrated to the ENGINEER that it will be equally effective.

2.2 FORMS FOR EXPOSED FINISH CONCRETE

Unless otherwise shown or specified, construct all formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood-faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Finish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection. Use overlaid plywood complying with U.S. Product Standard PS-1 “B-B High Density Overlaid Concrete Form”, Class I. Use flexible spring steel forms or laminated boards free of distortion and defects to form radius bends as required.

2.3 FORMS FOR UNEXPOSED FINISH CONCRETE

A. Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least two (2) edges and one (1) side for tight fit.

2.4 FORM MATERIALS

A. Form Coatings

Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound. Petroleum based coatings shall not be used for structures in creeks and waterways. Biodegradable coatings shall be used which will not contaminate the creeks/waterways or an alternate method for stripping the form shall be proposed.

B. Chamfers, Reveals, Drips

Provide preformed PVC or shaped wood or metal of size and profile as shown on drawings.

C. Cylindrical Columns and Supports

Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation. Provide units having “seamless” interior to minimize spiral gaps or seams.

D. Pan Forms

Provide forms for concrete pan-type construction complete with covers and end enclosures to form a true, clean, smooth concrete surface. Design units for easy removal without damaging placed concrete. Block adjoining pan units if required to avoid lateral deflection of formwork during concrete placement and compaction. Provide standard or tapered end forms, as shown.

If required, factory-fabricate pan form units to required sizes and shapes of the following:

1. Steel - 16 gauge minimum, free of dents, irregularities, sag and rust, or

2. Glass-Fiber Reinforced Plastic - Molded under pressure with matched dies, 0.11 inches minimum wall thickness.

E. Inserts & Embeds

Provide metal inserts for anchorage of materials or equipment to concrete construction, not supplied by other trades and as required for the work. Provide “Parabolt” by the Molly Company, “Phillips Red-Head”, “Burke” or approved equal products. The CONTRACTOR is responsible for insuring that all required anchorage not specified in the project documents is installed per current building code and applicable ICC report requirements.

2.5 REINFORCING MATERIALS

A.	Reinforcing Bar (rebar):	ASTM A615 or ASTM 706 and as follows below
	Stirrups and Ties	Grade 60 (Grade 40 may be used for #3 and smaller)
	All other Uses	Grade 60

B. Steel Wire: ASTM A82, plain, cold-drawn, steel.

C. Welded Wire Fabric (WWF): ASTM A185, welded steel wire fabric.

D. Supports for Reinforcement

Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations, unless otherwise specified. Wood, brick, concrete blocks and other devices will not be acceptable. For slabs-on-grade, use supports with sand plates or horizontal runners where wetted base materials will not support chair legs. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are hot-dip galvanized, after fabrication, or plastic protected or stainless steel protected.

A. Epoxy Doweling of Reinforcement

Reinforcement doweled into existing concrete shall use Dewalt Pure110+ Adhesive, AC100+ Gold or approved equal. Embedment and placement shall be as indicated on the drawings. Prepare holes per manufacturer instructions.

2.6 CONCRETE MATERIALS

A. Portland Cement

ASTM C150, Type II, unless otherwise acceptable to ENGINEER. Use only one (1) brand of cement throughout the project, unless otherwise acceptable to the ENGINEER. The use of ground granulated blast furnace slag is not allowed.

B. Aggregates

ASTM C33 and as herein specified. Provide aggregates from a single source for all exposed concrete.

Local aggregates not complying with ASTM C33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the ENGINEER.

1. Fine Aggregate - Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances. Dune sand, bank-run sand and manufactured sand are not acceptable.

2. Coarse Aggregate - Clean, uncoated, processed aggregate containing no clay, mud, loam or foreign matter, as follows:

   a. Crushed stone processed from natural rock or stone.

   b. Washed gravel, either natural or crushed. Use of pit or bank run gravel is not permitted.

   c. Maximum Aggregate Size - Not larger than one-fifth (1/5) of the narrowest dimensions between sides of forms, one-third (1/3) of the depth of slabs, nor three-fourths (3/4) of the minimum clear space between individual reinforcing bars or bundles of bars.

3. These limitations may be waived if, in the judgment of the ENGINEER, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

4. In general it is desired that normal commercial mixes using 3/4-inch maximum aggregate size be used.

5. Aggregate for exposed aggregate concrete shall consist of selected aggregate of washed clean river gravel in color range of medium to dark in browns and grays; material uniformly sized 5/8-inch to 3/4-inch.

C. Water: Clean, fresh, potable.

D. Air Entraining Admixture: ASTM C260.

E. Water-Reducing Admixture: ASTM C494, Type A or F

F. Set-Control Admixtures: ASTM C494, as follows:

1. Type B, Retarding.
2. Type C, Accelerating.
3. Type D, Water-reducing and Retarding.
4. Type E, Water-reducing and Accelerating.

Calcium chloride will not be permitted in concrete, unless otherwise authorized in writing by the ENGINEER.

2.7 RELATED MATERIALS

A. Form Ties (for forms other than wall forms)

Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

Unless otherwise shown, provide ties so portion remaining within concrete after removal is at least 1.5 inches inside concrete. Unless otherwise shown, provide form ties, which will not leave holes larger than 1-inch in diameter in concrete surface.

B. Concrete Curing Materials

Acrylic curing and sealing compound - Water emulsion acrylic curing and sealing compound formulated of acrylic polymers of water based carrier. W.R. Meadows, Inc. VOCOMP-20 or approved equal.

C. Epoxy Adhesive

Provide Sikadur Hi-Mod (Sikastik 370) or Sikadur Hi-Mod Gel (Sikastix 390) or approved equal for application to wire-brushed and prepared existing concrete to be mated to new concrete. Apply per manufacturer's recommendations.

D. Chemical-Hardener Finish: Provide Hornolith from Tamms Industries, or approved equal.

2.8 PROPORTIONING NORMAL CONCRETE

A. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each class of concrete required, complying with ACI 211.1. All measurements shall be by weight. All concrete admixtures will either be by the same supplier to insure compatibility. If different suppliers are used a memorandum from EACH admixture supplier will be provided stating the compatibility of their product with the other supplier's products.

B. The slump shall be between two inches and four inches when tested in accordance with ASTM Specifications C 143. Variations in the slump range may be allowed by the ENGINEER if admixtures, such as water reducers or superplasticizers, are utilized in the concrete mix. Regardless of the measured slump, the maximum allowable water-cement ratios as specified here-in, shall be strictly adhered to.

C. Compressive Strength, Water and Cement Content

Not withstanding what has been stated here-before, and unless shown otherwise on the Drawings, the concrete shall meet the following requirements. All concrete except as noted otherwise on the drawings shall have 4,500 psi 28-day compressive strength and a maximum water/cement ratio of 0.45.Up to a maximum of 15% of cementitious material may be fly ash in accordance with ASTM C618. The use ground granulated blast furnace slag is not allowed for any surfaces in contact with potable water.

D. Retarding Densifiers

1. All concrete (as defined in 2.9 below) used for wall construction shall also contain DARATARD-17, as manufactured by Grace Const. Products, Cambridge, MA or MBL-82, as manufactured by Master Builders, Cleveland, OH in the amounts recommended by the additive manufacturer whenever the air temperature during the pour exceeds 85° F.

2. To be considered as equal, any alternate product offered for consideration shall contain no calcium chloride, and shall be compatible with air-entrained cements and air-entraining admixtures conforming to the applicable ASTM, AASHTO, ANSI and Federal specifications.

3. CONTRACTOR shall certify that admixtures do not contain calcium chlorides or other corrosive materials.

E. Air-Entraining Agents

1. All concrete that that is specified to be air entrained or that may be exposed to freeze/thaw action either during construction or the service life of the structure must be air entrained.

2. Air-entraining agents shall meet ASTM C 260, ASTM C 233 and ASTM C 457.

3. The total volumetric air content of the concrete before placement shall be 0 percent +/- 1.5 percent as determined by ASTM C 173 or ASTM 231 for mixes using a 3/4"nominal aggregate size.

4. Subject to these Specifications, consideration will be given to the following products: PROTEX “AES,” GRACE “DAREX AEA,” MASTER BUILDERS “MB-AE10,” or SIKA CHEMICAL “AER.”

F. Water Reducing Admixtures

1. In addition to air-entrainment, approved water reducing additives, which do not affect the ultimate performance of any steel in any way, may be added to maintain the maximum water content below that specified herein. Water reducing additives shall conform to ASTM C 494, Type A or D.

2. The use of water reducing additives shall not permit a reduction in the minimum specified cement content or in the specified amount of air-entrainment.

3. Admixtures shall contain no calcium chloride, tri-ethanolamine or fly ash. All admixtures shall be from the same manufacturer.

4. Superplasticizers, if allowed by the ENGINEER, shall conform to ASTM C 494, Type F or G, batch plant added using second or third generation only.

5. Set control admixtures if allowed by the ENGINEER, shall conform to ASTM C 494, Type B (retarding) or Type C (accelerating).

2.9 CONCRETE MIXING

A. Ready-Mix Concrete

1. Comply with the requirements of ASTM C94, and as herein specified. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required. When the air temperature is between 85°F and 90°F, reduce the mixing and delivery time from 1-1/2 hours to 75 minutes, and when the air temperature is above 90°F, reduce the mixing and delivery time to 60 minutes.

2. Minimum Mix Time: Once all materials are in the drum, the minimum mixing time shall be for 10 minutes before concrete is placed.

PART 3 EXECUTION

3.1 FORMS

A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. Construct formworks so concrete members and structures are of correct size, shape, alignment, elevation and position.

B. Design formworks to be readily removable without impact shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms complying with ACI 347, to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

D. Fabricate forms for easy removal without hammering or prying against the concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

E. Erect falsework and support; brace and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures.

Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

Support form facing materials by structural members spaced sufficiently close to prevent deflection. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances.

F. Forms for Exposed Concrete

Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes. Do not use metal cover plates for patching holes or defects in forms. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material, which will produce bow. Assemble forms so they may be readily removed without damage to exposed concrete surfaces. Form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

Corner Treatment - Form exposed corners of beams and columns to produce square, smooth, solid, unbroken lines, except as otherwise indicated.

G. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings of forms at inconspicuous locations.

H. Chamfer exposed corners and edges, reveals and drips as shown using wood, metal, PVC or rubber strips fabricated to produce uniform smooth lines and tight edge joints. A ½ inch chamfer at exposed edges is typical unless noted otherwise.

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

J. Cleaning and Tightening - Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retighten forms after concrete placement if required to eliminate mortar leaks.

3.2 PLACING REINFORCEMENT

Detail and place according to ACI Manual SP-66. Unless otherwise noted, minimum cover shall be 1-1/2 inches for No. 5 and smaller bars, 2.0-inches for No. 6 and larger bars or for any bars exposed to exterior or wet environments, and 3.0-inches when poured against earth. Unless otherwise noted, bend all horizontals reinforcing a minimum of two (2) feet at corners and wall intersections.

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

B. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.

C. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. Do not place reinforcing bars more than two inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

D. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus two (2) inches, and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.3 JOINTS

A. Construction Joints - Locate and install construction joints not shown on the drawings, so as not to impair the strength and appearance of the structure, as acceptable to the ENGINEER. Install and locate other construction joints as specified.

B. Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints. Unless otherwise specified, reinforcement shall be lapped in accordance with ACI Standards.

C. Waterstops - Provide waterstops in construction joints as shown on the drawings. Install waterstops to form a continuous diaphragm in each joint. Make provisions to support and protect waterstops during the progress of the work. Fabricate field joints in waterstops in accordance with manufacturer’s printed instructions. Protect waterstop material from damage where it protrudes from any joint.

D. Isolation Joints in Slabs-on-Ground - Construct isolation joints in slabs-on-ground at all points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams and elsewhere as indicated.

E. Control Joints in Slabs-on-Ground - Construct control joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4-inch wide by one-fifth (1/5) to one-fourth (1/4) of the slab depth, unless otherwise shown.

1. Form control joints by the following methods

a. Inserting a premolded hardboard or fiberboard strip into the fresh concrete until the top surface of the strip is flush with the slab surface. After the concrete has cured, remove inserts and clean groove of loose debris.

b. Saw cutting a control joint in the required location. Plan for saw cutting so work does not damage reinforcing or violate edge distance minimums.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. General - Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of the items to be attached thereto.

B. Edge Forms and Screed Strips for Slabs - Set edge forms or bulkheads and intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screed strips by the use of strike-off templates or accepted compacting type screeds.

3.5 PREPARATION OF FORM SURFACES

Coat the contact surfaces of forms with a form-coating compound before reinforcement is placed. Thin formcoating compounds only with thinning agent of type, and in amount, and under conditions of the form-coating compound manufacturer’s directions. Use dissipating-type form oil at surfaces to receive cement plaster finish. Do not allow excess form-coating material to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer’s instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.6 CONCRETE PLACEMENT

A. Pre-Placement Inspection

1. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts involved

in ample time to permit the installation of their work; cooperate with other trades in setting such work as required. Notify ENGINEER in time for inspection prior to pouring.

2. Remove all garbage and debris from the base of formwork. Items such as aluminum cans, food containers, plywood, and their like are to be cleaned-up and disposed.

3. Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used.

4. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

5. Concrete Curbs and Paving - Do not place concrete until subbase is completed and approved by the ENGINEER as required to provide uniform dampened condition at the time concrete is placed. Moisten subbase as required to provide uniform dampened condition at the time concrete is placed.

B. Place concrete in compliance with the practices and recommendations of ACI 304 and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Perform concrete placing at such a rate that concrete, which is being integrated, with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure, which will cause segregation.

2. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.

3. Do not use concrete which becomes non-plastic and unworkable or does not meet the required quality control limits or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the project site and dispose of in an acceptable location. Do not use concrete whose allowable mixing time has been exceeded.

C. Concrete Conveying

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods, which will prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.

3. The CONTRACTOR shall provide traffic control on the narrow access roads to the work sites.

4. The CONTRACTOR shall not wash concrete trucks/chutes/equipment off at the project site unless plastic tarps and hay bales are employed to contain the concrete. The CONTRACTOR will be required to haul off-site all concrete contaminated soil.

D. Placing Concrete into Forms

1. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

2. Do not interrupt successive placement; do not permit cold joints to occur.

3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and project conditions. Vibration of forms and reinforcing will not be permitted.

5. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete at least six (6) inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.

6. Do not place concrete in supporting elements until the concrete previously placed in columns and walls is no longer plastic.

E. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment so the concrete is thoroughly worked around reinforcement and other embedded items and into corners.

3. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground, as specified for formed concrete structures. Consolidate concrete in the remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other acceptable methods. Limit the time of vibrating consolidation to prevent bringing an excess of fine aggregate to the surface.

4. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

5. Maintain reinforcing steel in the proper position continuously during concrete placement operations.

F. Bonding

1. Roughen surfaces of set concrete at all joints except where bonding is obtained by use of concrete bonding agent, and clean surfaces of laitance, coatings, loose particles and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and not to leave laitance, loose particles of aggregate or damaged concrete at the surface.

2. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:

   a. At joints between footings and walls or columns, and between walls or columns and beams or slabs they support, and elsewhere unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing fresh concrete.

   b. At joints in exposed work; at vertical joints in walls; at joints in girders, beams, supported slabs and other structural members; and at joints designed to contain liquids; dampen, but do not saturate the roughened and cleaned surface of set concrete and apply a liberal coating of neat cement grout.

   c. Use neat cement grout consisting of equal parts Portland cement and fine aggregate by weight and not more than six (6) gallons of water per sack of cement. Apply with a stiff broom or brush to a minimum thickness of 1/16-inch. Deposit fresh concrete before cement grout has attained its initial set.

d. In lieu of neat cement grout, bonding grout may be a commercial bonding agent. Apply to cleaned concrete surfaces in accordance with the printed instructions of the bonding material manufacturer.

3. Prepare for bonding of fresh concrete to fully cured hardened concrete or existing concrete by using an epoxy-resin-bonding agent as follows:

   a. Handle and store epoxy-resin adhesive binder in compliance with the manufacturer's printed instructions, including safety precautions.

   b. Mix the epoxy-resin adhesive binder in the proportions recommended by the manufacturer, carefully following directions for safety of personnel.

   c. Before depositing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with epoxy-resin grout not less than 1/16-inch thick. Place fresh concrete while the epoxy-resin material is still tacky, without removing the in-place grout coat, and as directed by the epoxy-resin manufacturer.

G. Cold Weather Placing

1. Protect all concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.

2. When the air temperature has fallen to or is expected to fall below 40°F, provide adequate means to maintain the temperature in the area where concrete is being placed at either 70°F for three (3) days or 50°F for five (5) days after placing. Provide temporary housing or coverings including tarpaulins or plastic film. Keep protections in place and intact at least 24 hours after artificial heat is discontinued. Keep concrete moist. Avoid rapid dry-out of concrete due to over-heating and avoid thermal shock due to sudden cooling or heating.

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

4. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.

5. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

H. Hot Weather Placing

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.

3. Cover reinforcing steel with water soaked burlap if it becomes too hot so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

4. Wet forms thoroughly before placing concrete.

5. Do not use retarding admixtures unless otherwise accepted in mix designs.

3.7 FINISH OF FORMED SURFACES

A. Rough Form Finish

For formed concrete surfaces not exposed to view in the finish work or covered by other construction, unless otherwise shown or specified. This is the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.

B. Smooth Form Finish

Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view. Or that are to be covered with a coating material applied directly to the concrete, or a covering material bonded to the concrete such as waterproofing, damp proofing, painting or other similar system.

Produce smooth form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed.

C. Curb Finishes

Curbs shall be screeded off accurately to true lines and planes or warped surfaces as indicated or directed. Finish smooth. Arises shall be true and straight or properly eased

where curved and neatly rounded with approved tool. Smooth trowel finish with corners rounded to 3/4-inch radius.

D. Grout Cleaned Finish (Sacked)

Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment, and to all exposed to view interior and exterior building surfaces, typical.

Combine one part Portland cement to 1-1/2 parts fine sand by volume, and mix with water to the consistency of thick paint. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.

Thoroughly wet concrete surfaces and apply grout immediately to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces

At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.8 MONOLITHIC SLAB FINISHES

A. Float Finish

1. Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing or sand bed terrazzo, and as otherwise shown on drawings or in schedules.

2. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance not exceeding 1/4-inch in 10 feet when tested with a 10-foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill at low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

B. Trowel Finish

1. Apply trowel finish to monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and slab surfaces that are to be covered with resilient flooring, paint, or other thin-film finish coating system.

2. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.

3. Consolidate the concrete surface by the final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in 10 feet when tested with a 10-foot straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

C. Exposed Aggregate Finish

1. Screed to true plane, bullfloat surfaces, provide uniform double troweled finish. After troweling, let set until hard enough to wash without disturbing coarse aggregates. Simultaneously brush and spray with water to expose large aggregate and produce texture to match approved sample. Water cure or keep wet for 25 hours.

2. Scrub surface after 24 hours with a one (1) part muriatic acid to10 part water solution. Rinse thoroughly.

D. Broom Finish (Non-Slip)

1. Apply non-slip, broom finish to exterior concrete platforms, steps and ramps and elsewhere as shown on the drawings or in schedules.

2. Immediately after trowel finish, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route or in the direction of water flow. Use fiber-bristle broom unless otherwise directed. Coordinate the required final finish with the ENGINEER before application.

E. Chemical-Hardener Finish

1. Apply chemical curing-hardening compound or chemical-hardener to all interior concrete floors which will not receive applied finish materials. Mask adjacent work and surfaces to avoid over spray. Apply liquid chemical-hardener after complete curing and drying of the concrete surface.

2. Dilute the liquid hardener with water and apply in accordance with the manufacturer's printed directions. Evenly apply each coat and allow for drying between coats in accordance with manufacturer's printed directions.

3. After the final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

F. Non-slip Aggregate Finish

Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, and elsewhere as shown on the drawings or in schedules.

After completion of float finishing and before starting trowel finish, uniformly spread 25 pounds of dampened non-slip aggregate per 100 square feet of surface. Tamp aggregate flush with surface using steel trowel, but do not force the non-slip aggregate particles below surface. After broadcasting and tamping, apply trowel finish as herein specified. After curing, lightly work the surface with a steel wire brush, or an abrasive stone, and water to expose the non-slip aggregate.

3.9 SCHEDULE OF CONCRETE SURFACE FINISHES

Surface Description	Type	Finish Requirement
A. Interior Vertical Surfaces	Formed	Smooth Form Finish

3.10 CONCRETE CURING AND PROTECTION

A. General

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.

2. Start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.

3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least seven (7) days and in accordance with ACI 301 procedures. Avoid rapid drying at the end of the final curing period.

B. Curing Methods

Perform curing of concrete by moist curing, by moisture-retaining cover curing, by membrane curing or by combinations thereof, as herein specified. Provide the curing methods indicated as follows:

1. For concrete floor slabs provide moisture curing, moisture cover curing or liquid membrane/chemical curing-hardening curing. If liquid membrane curing is used, it must be compatible with concrete hardening compounds to be applied later.

2. For other concrete work, provide moisture curing or moisture cover curing. Do not use liquid membrane or chemical curing-hardening curing on any concrete work to receive any applied finishes.

3. For curing, use only water that is free of impurities, which could etch or discolor exposed, natural concrete surfaces.

4. Provide moisture curing by any of the following methods:

    a. Keeping the surface of the concrete continuously wet by covering with water.

    b. Continuous water-fog spray.

    c. Covering the concrete surface with the specified absorptive cover thoroughly saturated with water and keeping the absorptive cover continuously wet. Place absorptive cover so as to provide coverage of the concrete surfaces and edges with a 4-inch lap over adjacent absorptive covers.

5. Provide moisture-cover curing as follows - Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete placed in the widest practicable width with sides and ends lapped at least three (3) inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.

6. Provide liquid membrane curing as follows:

    a. Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a coat continuous operation by power spray equipment in accordance with the manufacturer’s directions. Recoat areas, which are subjected to heavy rainfall within three (3) hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.

    b. Do not use membrane-curing compounds on surfaces, which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete. Such as other concrete, liquid floor hardener,

waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to the ENGINEER.

7. Curing formed Surfaces - Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

8. Curing Unformed Surfaces

    a. Initially cure unformed surfaces, such as slabs, floor topping and other flat surfaces by moist curing, whenever possible.

    b. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.

    c. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise acceptable to the ENGINEER.

9. Provide liquid curing-hardening compound as follows:

    a. Apply to horizontal surfaces when concrete is dry to touch by means of power spray, hand spray or hair broom in accordance with manufacturer's directions.

C. Temperature of Concrete during Curing

1. When the atmospheric temperature is 40°F and below, maintain the concrete temperature between 50°F and 70°F continuously throughout the curing period. When necessary, make arrangements before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protections complying with the requirements of ACI 306.

2. When the atmospheric temperature is 80°F, and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation wind breaks or shading, and for fog spraying, wet sprinkling or moisture-retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protections complying with the requirements of ACI 305.

3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete, which exceed 5°F in any one-hour and 50°F in any 24-hour period.

D. Protection from Mechanical Injury - During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.11 MISCELLANEOUS CONCRETE ITEMS

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

B. Curbs - Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations - Provide machine and equipment bases and foundations as shown on the drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing the machines and equipment.

3.12 REMOVAL OF SHORES AND FORMS

A. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support the work without excessive stress or deflection.

Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until the concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

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

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

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

E. Re-Use of Forms

Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Architect.

No forming material will be allowed to be built permanently into exposed visible surfaces.

3.13 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas

1. Repair and patch defective areas with cement mortar immediately after removal of forms but only when directed by the ENGINEER.

2. Cut out honeycomb, rock pockets, voids over 1/2-inch diameter and holes left by tie rods and bolts down to solid concrete but, in no case, to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the ENGINEER.

3. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

4. Fill holes extending through concrete by means of a plunger type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure complete filling.

B. Repair of Formed Surfaces

1. Repair exposed-to-view formed concrete surfaces that contain defects, which adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the ENGINEER. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolt; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.

2. Repair concealed formed concrete surfaces that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01-inch wide, cracks or any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corners.

C. Repair of Unformed Surfaces

1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.

2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.

3. Repair finished unformed surfaces that contain defects, which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets and other objectionable conditions.

4. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so those repairs can be made without damage to adjacent areas.

5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the ENGINEER.

6. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least

3/4-inch clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with a neat cement grout coating, or use concrete bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same material to provide concrete of the same type or class as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

7. Repair isolated random cracks and single holes not over 1 inch in diameter by the dry-pack method. Groove the top of cracks and cut out holes to sound concrete and clean off dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with a neat cement grout coating. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.

8. For repair of existing unformed surfaces, mechanically remove all lose concrete as required to expose sound aggregate. Clean concrete surfaces to achieve a contaminate free, open textured surface. Square cut or under cut perimeter to minimum depth as specified by the repair mortar manufacturer. Remove all lose concrete around the exposed steel and hand tool or blast clean all portions of rebar with visible rust to near white metal finish. If half of the diameter of the reinforcing steel is exposed, chip out behind the reinforcing to a 1/2-inch minimum depth. Splice new reinforcing steel to existing where corrosion has depleted the cross-section area by 25%. Apply a corrosion inhibitor/primer/bonding agent to all exposed rebar and other steel components and to concrete surfaces to be repaired per manufacturer's requirements, such as Sika Armatec 110 . Apply a polymer-modified, cement-based, repair mortar, trowel applied as specified by the manufacturer, such as Sika MonoTop 615.

9. Repair methods not specified above may be used subject to the acceptance of the ENGINEER.

3.14 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The OWNER or a representative of the OWNER will engage a special inspector/testing laboratory to perform all tests and to submit test reports to the OWNER, ENGINEER, and the CONTRACTOR.

B. Concrete shall be sampled and tested for quality control during the placement of concrete, as follows:

1. Sampling Fresh Concrete - ASTM C172, except modified for slump to comply with ASTM C94.

2. Slump Test - ASTM 143; one (1) test for each set of compressive strength test specimens. Samples shall be taken at point of discharge.

3. Air Content - ASTM C231, pressure method; one (1) for each set of compressive strength test specimens.

4. Compression Test Specimen - ASTM C31; One (1) Set which consist of a minimum of four (4) standard cylinders to allow for compressive strength testing, unless otherwise directed. If early loading of members or sections is desired by the CONTRACTOR, additional tests cylinders shall be collected for testing. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

5. Concrete Temperature - Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens is made.

6. Compressive Strength Tests - ASTM C39; One (1) Set for each 100 cubic yards or fraction thereof, of each concrete class placed in any one (1) day, OR for each 5,000 square feet of surface area placed, OR as per minimums outlined below.

   a. When the frequency of testing will provide less than five (5) Sets of cylinders by which to perform strength tests for a given class of concrete, conduct testing, as follows.

      1) For a class of concrete with a total batch size of greater than 500 cubic yards or 25,000 square feet of surface area, collect test Sets as outlined above.

      2) For a class of concrete with a total batch size of less than 500 cubic yards or 25,000 square feet of surface area, but greater than 300 cubic yards or 15,000 square feet of surface area, collect four (4) Sets for testing. Two (2) Sets near the beginning of pouring, one (1) Set mid-way through pouring and one (1) Set towards the end of pouring.

      3) For a class of concrete with a total batch size of less than 300 cubic yards or 15,000 square feet of surface area, but greater than 50 cubic yards or 2,500 square feet of surface area, collect four (3) sets of testing. One (1) Set near the beginning of pouring, one (1) Set mid-way through pouring and one (1) Set towards the end of pouring.

4) When the total quantity of a given class of concrete is less than 50 cubic yards, and NO anchors are embedded in the concrete, the ENGINEER may waive the strength tests if, in their judgment, adequate evidence of satisfactory strength is provided. Otherwise testing shall occur as outlined in 3.14.B.6.a

b. Testing Procedure: A Set of specimens with yield four (4) cylinders. Therefore, five (5) Sets will yield 20 cylinders, four (4) Sets will yield 16 cylinders, three (3) Sets will yield 12 cylinders, From each set test one (1) cylinder at seven (7) days, test two (2) cylinders at 28 days, and one (1) cylinder shall be retained in reserve for later testing if required. Additional cylinders can be obtained, at the CONTRACTOR's or OWNER's discretion, for testing at alternate times.

c. If required by the building official, perform strength tests of cylinders cured under field conditions. Field cured cylinders shall be taken and molded at the same time and from the same samples as the laboratory cured test cylinders. When the strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

C. Report test results in writing to the ENGINEER and the CONTRACTOR on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of CONTRACTOR, name of concrete supplier and concrete mixing truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength and type of break for both 7-day tests and 28-day tests.

D. Additional tests - The testing service will make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained in the structure, as directed by the ENGINEER. The testing service shall conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. CONTRACTOR shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

END OF SECTION

SECTION 03 60 00 - GROUTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all work necessary to form, mix, place, cure, repair, finish, and perform all other work as required to produce finished grout, in accordance with the requirements of the Contract Documents.

B. Work covered in this Section includes:

1. Patching, grouting, and sealing.
2. Grouting for support of plumbing and chemical piping
3. Grout for support of mechanical, electrical, and communications equipment
4. Removal of loose and spalling grout and concrete.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete Work.

B. Section 05 50 00 – Metal Fabrications

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Specifications, codes, and standards shall be as specified in Section 03 30 00, Cast-in-Place Concrete Work and as referred to herein.

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified.

B. Codes and Standards

1. American Society for Testing and Materials (ASTM)

a. C31, “Standard Practice for Making and Curing Concrete Test Specimens in the Field”

b. C33, “Standard Specification for Concrete Aggregate”

c. C39, “Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens”

d. C40, “Standard Test Method for Organic Impurities in Fine Aggregate for Concrete”

e. C1084, “Standard Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete”

f. C88, “Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate”

g. C94, “Standard Specification for Ready-Mixed Concrete”

h. C109, “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens)”

i. C131, “Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”

j. C136, “Standard Test Method for Sieve Analysis to Fine and Coarse Aggregate”

k. C143, “Standard Test Method for Slump of Hydraulic Cement Concrete”

l. C150, “Standard Specification for Portland Cement”

m. C156, “Standard Test Method for Water Loss Through Liquid Membrane Forming Curing Compounds for Concrete”

n. C173, “Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method”

o. C231, “Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method”

p. C233, “Standard Test Method for Air-Entraining Admixtures for Concrete”

q. C260, “Standard Specifications for Air-Entraining Admixtures for Concrete”

r. C289, “Standard Test Method for Potential Alkali Silica Reactivity of Aggregates (Chemical Method)”

s. C441, “Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction”

t. C457, “Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete”

u. C494, “Standard Specification for Chemical Admixtures for Concrete”

v. C531, “Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes”

w. C579, “Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes”

x. C827, “Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures”

y. C670, “Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials”

z. C803, “Standard Test Method for Penetration Resistance of Hardened Concrete”

2. American Concrete Institute (ACI)

a. “Specifications for Structural Concrete,” ACI 301 as supplemented and modified herein.

b. “Standard Practice for Selecting Proportions for Normal Heavyweight, and Mass Concrete,” ACI 211.1.

3. CRD-C 621, Corps of Engineers Specification for Non-Shrink Grout

1.4 SUBMITTALS

A. Manufacturer Technical Data and Strength Test Results: For sack-mix grouts used on minor-structure/systems provide datasheet information verifying the compressive strength, shrinkage, and expansion requirements specified herein for grout used.

B. Manufacturer's Literature: Containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of non-shrink and epoxy grout used in the work.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not place grout when temperature or humidity will affect the performance or appearance of the grout.

B. Do not place grout on dirty, wet, or frozen substrates

PART 2 PRODUCTS

2.1 PREPACKAGED GROUTS

A. Non-shrink grout: This type of grout is to be used wherever grout is required in the Contract Documents, unless another type is specifically referenced.

B. Non-shrink grout shall be a prepackaged, inorganic, non-gas- liberating, non-metallic, 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 of each class of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.

C. Class A non-shrink grouts shall have minimum 28 day compressive strength of 5000 psi; shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C827; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state when tested.

D. Class B non-shrink grouts shall have minimum 28 day compressive strength of 5000 psi and meeting the shrinkage and expansion requirements for Class A non-shrink grout.

E. General Non-Metallic and Non-Shrink Grout shall have minimum 28 day compressive strength of 4000 psi when tested and meet the shrinkage and expansion requirements for Class A non-shrink grout.

F. Application

1. Class A non-shrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under the exterior rim of the steel tank and all equipment base plates, and at all locations where grout is specified in the contract documents; except, for those applications for Class B non-shrink grout specified herein. Class A non-shrink grout may be used in place of Class B non-shrink grout for all applications.

2. Class B non-shrink grout shall be used or the repair of all holes and defects in concrete members which are not water-bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place.

3. General Non-Metallic and Non-Shrink Grout shall be used for non-repair interior or exterior grout applications.

2.2 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where “dry pack” is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as specified herein for the particular application.

B. The slump for topping grout and concrete fill shall be adjusted to match placement and finishing conditions but shall not exceed four (4) inches.

2.3 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers approved by the ENGINEER. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

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

B. Base concrete or masonry must have attained its design strength before grout is placed, unless authorized by the ENGINEER.

3.2 GROUTING PROCEDURES

Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution of prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

3.3 INSTALLATION

A. Grout Below Bearing Plates:

1. Support bearing plates above cleaned bearing surfaces with double-nutted anchor bolts or wedges.

2. Fill space below bearing plates supporting structural members and stationary equipment with non-metallic non shrink grout.

3. Fill space below bearing plates supporting vibrating equipment with metallic non shrink grout.

B. Grout in Steel Bollards:

1. Fill steel bollards with non-metallic non shrink grout.

2. Smooth trowel grout to 1-inch high convex curve at top of bollards.

C. Grout in Steel Door Frames: Install non-metallic non shrink grout between masonry rough opening and door frames in masonry walls, fully filling frames with grout.

3.4 COMPLETION

A. Adjusting Defective Work: Replace or patch grout and anchoring cement as directed by Architect.

B. Physical Barrier Protection:

1. Cover fresh grout and anchoring cement for 24 hours minimum.

2. Cover fresh grout and anchoring cement with plywood where exposed to construction traffic.

END OF SECTION

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. The extent of metal fabrications work is shown on the Drawings and includes items fabricated from iron, steel, stainless steel and aluminum shapes, plates, bars, sheets, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems in other sections of these specifications.

B. Section Includes:

1. Shop-fabricated metal items.
2. Anchor bolts.
3. Bollards
4. Miscellaneous fabrications, framing, and supports

1.2 REFERENCE STANDARDS

A. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

2. AWS D1.1 - Structural Welding Code - Steel.

3. AWS D1.6 - Structural Welding Code - Stainless Steel.

B. ASTM International:

1. ASTM A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.

2. ASTM A36 - Standard Specification for Carbon Structural Steel.

3. ASTM A47, grade as selected - Malleable Iron Castings.

4. ASTM A48, Class 30 - Gray Iron Castings.

5. ASTM A53- Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

6. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

7. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

8. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

9. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

10. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

11. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

12. ASTM A283, Grade C - Steel Plates to be Bent or Cold Formed.

13. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

14. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

15. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

16. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.

17. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

18. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

19. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.

20. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.

21. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.

22. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

23. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

24. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

25. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

26. ASTM A992 - Standard Specification for Structural Steel Shapes.

27. ASTM B26 - Standard Specification for Aluminum-Alloy Sand Castings.

28. ASTM B85 - Standard Specification for Aluminum-Alloy Die Castings.

29. ASTM B177 - Standard Guide for Engineering Chromium Electroplating.

30. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

31. ASTM F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

32. ASTM F436 - Standard Specification for Hardened Steel Washers.

33. ASTM F844 - Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

34. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Manufacturer's Data: For information only, submit copies of manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions for products to be used in miscellaneous metal work, including paint products.

C. Shop Drawings:

1. General: Submit copies of shop drawings for the fabrication and erection of all assemblies of miscellaneous metal work which are not completely shown by the manufacturer's data sheets.

    a. Include plans, elevations and details of sections and connections and fabricators proposed shop coat paint or galvanizing specifications.

    b. Show anchorage and accessory items.

c. Furnish setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete construction.

d. Indicate welded connections using standard AWS A2.4 welding symbols.

e. Indicate net weld lengths.

D. Samples:

1. Submit two sets of representative samples of materials, illustrating factory finishes as may be requested by the Owner or Engineer.

2. Engineer's review will be for color, texture, style and finish only.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Transporting, handling, storing, and protecting products shall be in accordance with manufacturer's requirements.

B. Inspection: Accept metal fabrications on-site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather or by ground contact.

1.5 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to preparation of Shop Drawings and fabrication. Indicate field measurements on Shop Drawings.

1. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication.

PART 2 PRODUCTS

2.1 GENERAL

A. For the fabrication of miscellaneous metal work items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, roughness and defects which impair strength, durability and appearance. Remove such blemishes by grinding or by welding and grinding prior to cleaning, treating and application of surface finishes including zinc coatings.

2.2 BOLLARDS

A. Description:

1. Steel pipe, concrete filled.
2. Crowned cap.
3. Size: 6-inch diameter, length as indicated on Drawings.
4. Shop Finish: Prime paint, one coat.

B. Concrete Fill:

1. Minimum Compressive Strength: 3,000 psi.
2. As specified in Section 03 30 00, Cast-in-Place Concrete Work

C. Anchors: Concealed type.

2.3 ANCHOR BOLTS

A. All anchors shall be epoxy, expansion or screw anchors as shown in the Drawings.

B. Materials:

1. As shown in the Drawings.

2. For wetted atmospheric conditions

   a. Type 316 stainless steel.

3. Threaded rod, nuts, bolts and washers:

   a. Material matching anchor insert type.

C. Types:

1. Threaded-type Concrete Inserts:

   a. Internally threaded to receive machine bolts.
   b. Malleable iron, ASTM A47.
   c. Cast steel, ASTM A27.
   d. Stainless steel, type 316, ASTM A320.

D. Manufacturers:

1. Hilti, Inc.
2. Simpson Strong-Tie Co., Inc.
3. DeWalt, Inc.
4. Proprietary products as named in the Drawings.

2.4 MISCELLANEOUS FABRICATIONS, FRAMING AND SUPPORTS

A. Provide miscellaneous steel framing and supports required to complete the Work.

B. Fabricate miscellaneous units to the sizes, shapes and profiles shown in the Drawings or, if not shown, of the required dimensions to receive adjacent grating, plates doors, or other work to be retained by the framing.

C. Except as otherwise shown, fabricate from structural steel shapes and plate and steel bars, all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection.

D. Cut, drill and tap units to receive hardware and similar items to be anchored to the work.

E. Equip units with integrally welded anchors for casting into concrete, bolting to structural steel or building into masonry. Furnish inserts if units must be installed after concrete is placed.

F. Galvanize all miscellaneous fabrications unless otherwise noted.

2.5 NON-SHRINK GROUT

A. Where required for anchoring, patching, or sealing, grouting and sealing compounds shall conform to the requirements of Section 03 60 00, Grouting.

2.6 MATERIALS

A. Materials listed below shall be provided unless otherwise noted in the Drawings or other sections of these specification.

B. Steel:

1. Structural Shapes: ASTM A36.

2. Channels and Angles: ASTM A36.

3. Steel Plate: ASTM A36.

    a. Steel Plate to be Bent or Cold Formed: ASTM A283, Grade C.

C. Stainless Steel:

1. Bars and Shapes: ASTM A276; Type 316.
2. Plate, Sheet, and Strip: ASTM A666; Type 316.
3. Bolts, Nuts, and Washers: ASTM A354; Type 316.
4. Welding Materials: AWS D1.6; type required for materials being welded.

D. Bolts, Nuts, and Washers for Equipment and Piping:

1. Select fasteners for the type, grade and class required for the installation of miscellaneous metal items.

2. Carbon Steel:

   a. General: Zinc-coated, ASTM A153.
   b. Structural Connections: ASTM A307, Grade 2 (60 ksi), hot-dip galvanized.
   c. Anchor Bolts: ASTM A307, Grade 2 (60 ksi), hot-dip galvanized.
   d. Pipe and Equipment Flange Bolts: ASTM A193, Grade B-7.
   e. High Strength Bolts: ASTM F3125, Heavy Hex Head.

3. Stainless Steel: Type 316 stainless steel, Class 2; ASTM A193 for bolts; ASTM A194 for nuts.

   a. Where stainless steel bolts are in contact with dissimilar metals, glass epoxy insulating sleeves and washers shall be used to electrically isolate the bolts.

2.7 FABRICATION

A. Workmanship:

1. Use materials of the size and thicknesses shown in the Drawings or, if not shown, of the required size and thickness to produce adequate strength and durability in the finished product for the intended use as approved by the Engineer.

2. Work to the dimensions shown in the Drawings or accepted on Shop Drawings, using proven details of fabrication and support.

3. Use the type of materials shown in the Drawings or specified for the various components of work.

4. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

5. Ease exposed edges to a radius of approximately 1/32-inch, unless otherwise shown in the Drawings.

6. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the Work.

B. Fit and shop-assemble items in largest practical sections for delivery to Site.

C. Fabricate items with joints tightly fitted and secured.

D. Continuously seal join members by means of continuous welds in accordance with the recommendations of AWS, unless otherwise noted or approved.

E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

H. Loose Bearing and Leveling Plates:

1. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area.

2. Drill plates to receive anchor bolts and for grouting as required.

3. Galvanize after fabrication.

I. Miscellaneous Steel Trim:

1. Provide shapes and sizes for profiles shown in the Drawings.

2. Except as otherwise indicated, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges.

3. Use concealed field splices wherever possible.

4. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other work.

J. Fabrication Tolerances:

1. Squareness: 1/8-inch maximum difference in diagonal measurements.
2. Maximum Offset between Faces: 1/16-inch.
3. Maximum Misalignment of Adjacent Members: 1/16-inch.
4. Maximum Bow: 1/8-inch in 48 inches.
5. Maximum Deviation from Plane: 1/16-inch in 48 inches.

2.8 FINISHES

A. Steel:

1. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

2. Do not prime surfaces in direct contact with concrete or where field welding is required.

3. Prime-paint items with one coat, except where galvanizing is specified.

4. Galvanizing for Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strips: ASTM A123; hot-dip galvanize after fabrication.

5. Galvanizing for Fasteners, Connectors, and Anchors:

   a. Hot-Dip Galvanizing: ASTM A153.
   b. Mechanical Galvanizing: ASTM B695; Class 50 minimum.

6. Bolts: Hot-dip galvanized.

7. Nuts: Hot-dip galvanized.

8. Washers: Hot-dip galvanized.

9. Touchup Primer for Galvanized Surfaces: ASTM A780 (A780M), A1. Repair Using Zinc-Based Alloys (Heat and Stick Method).

B. Stainless Steel:

1. Satin-Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.

2. Mirror-Polished Finish: Number 8, mirror polish with preliminary directional polish lines removed.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal and aluminum where Site welding is required.

B. Furnish setting drawings, diagrams, templates, instructions and directions for the installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections. Coordinate delivery of such items to the project Site.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, and free from distortion or defects.

B. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and attachments are installed.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

D. Fit exposed connections accurately together to form tight hairline joints.

E. Grind joints smooth and touch-up shop paint coat.

F. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

G. Field-weld components indicated on Drawings and Shop Drawings.

H. Perform field welding according to AWS D1.1 with regards to procedures of manual shielded metal-arc welding, the appearance and quality of welds made and the methods used in correcting welding work.

I. Obtain approval of Engineer prior to Site cutting or making adjustments not scheduled.

3.4 TOLERANCES

A. Maximum Variation from Plumb: 1/4-inch per story or for every 12 feet in height, whichever is greater, non-cumulative.

B. Maximum Variation from Level: 1/16-inch in 3 feet and 1/4-inch in 10 feet.

C. Maximum Offset from Alignment: 1/4-inch.

D. Maximum Out-of-Position: 1/4-inch.

3.5 FIELD QUALITY CONTROL

A. Welding: Inspect welds according to AWS D1.1.

B. Replace damaged or improperly functioning hardware.

C. After erection, touch up welds, abrasions, and damaged finishes with prime paint to match shop finishes.

1. For galvanizing repair, repair any damaged areas by heat and stick method as may be required.

D. Touch up factory-applied finishes according to manufacturer-recommended procedures.

3.6 ADJUSTING

A. Adjust operating hardware and lubricate as necessary for smooth operation.

END OF SECTION

SECTION 06 82 00 - FIBERGLASS REINFORCED PLASTIC GRATING

PART 1 GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR shall provide fabricated fiberglass reinforced plastic (FRP) grating, complete and in place, in accordance with the Contract Documents.

1.2 SUBMITTALS

A. Shop Drawings: Shop Drawings for every FRP item. Include plans, elevations, and profiles that clearly show material sizes, types, styles, part or catalog numbers. Drawings shall include complete details for the fabrication and erection of components, including location, dimensions, lengths, joining method, type and size of fasteners, clip angles, member sizes, and connection details.

B. Layout drawings for grating shall show the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.

C. Product Literature: Manufacturer's published literature including structural design data, structural properties, and load and deflection tables for each style and depth of grating, corrosion resistance tables, certificates of compliance, test reports (as applicable), anchoring system allowable load tables and ICBO reports.

D. Calculations: Structural calculations shall be submitted for brackets, support flanges, and fasteners or anchors. Calculations shall be signed and sealed by a professional engineer registered in the State of Oregon.

E. Samples: Samples of each type of product shall be submitted to the OWNER.

F. Color chart: A color chart representing the complete range of color options available shall be submitted to OWNER for color selection by OWNER.

G. Certification: The CONTRACTOR shall certify on the Shop Drawings that fabricated items are of sufficient strength to serve their intended function without undue distortion or deflection.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Items provided under this Section shall be furnished only by manufacturers having experience in the manufacture of similar products, with a record of 5 similar successful installations in the last 5 years.

B. Quality: Fiberglass items shall be constructed of new, first-class, commercial-quality, fiberglass fabric-reinforced polyester or vinyl ester resin laminate material of the strength, thickness, and dimensions indicated, using the matched die-molded method.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. FRP items shall be composed of fiberglass reinforcement and resin in quantities, qualities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions indicated.

B. Fiberglass reinforcement shall be continuous roving, continuous strand mat, and surfacing veil or a combination thereof in sufficient quantities for the application and physical properties required.

C. Unless indicated otherwise, resin shall be fire retardant isophthalic polyester or vinyl ester with chemical formulation as necessary to provide the corrosion resistance, strength, and other physical properties as required. FRP items used in chemical storage or containment areas shall be vinyl ester resin, with chemical formulations as necessary to provide the corrosion resistance, strength, and other physical properties required in those areas.

D. Finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids, and without dry spots, cracks, crazes, or unreinforced areas. Glass fibers shall be well covered with resin to protect against exposure from wear or weathering.

E. Resin shall include an ultraviolet (UV) inhibitor additive. FRP products located in exterior locations exposed to the weather or in UV facilities shall also have an additional 1-mil UV-resistant coating applied.

F. FRP products shall have a tested flame spread rating of 25 or less per ASTM E 84 - Surface Burning Characteristics of Building Materials. Gratings and stair treads shall also meet the self-extinguishing requirements of ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

G. Supports and Fasteners: The CONTRACTOR shall provide bolts, anchor bolts, nuts, washers, and supports as required for the WORK of this Section in accordance with the requirements of the manufacturers of the items. Concrete anchor systems shall be in accordance with Section 05500 - Metal Fabrications.

H. Cut or machined edges, holes, scratches, gouges, and abrasions shall be sealed with a resin compatible with the resin matrix used in the original item.

2.2 FIBERGLASS GRATING

A. General

1. Grating shall have 2” actual thickness unless otherwise approved by the OWNER.

2. Seat Angles: Where grating is supported on concrete members, continuous embedded seat angles shall be provided on all sides. Grating seat angles shall be made of FRP and be as detailed on the Drawings; except that specially manufactured pultruded FRP seat angles intended to be cast in concrete may be submitted for acceptance by the OWNER.

3. Raised Floor Grating: Wherever raised floor grating is indicated, provide a complete system of FRP grating, FRP support legs, and seat angles, fastening devices, and other accessories necessary for a complete installation. Grating and supports shall be designed to fit together tightly with no movement when subjected to the design loading. The support legs and grating shall be produced by the same manufacturer and be intended to work together as a unit. The spacing of the legs shall be determined so as not to interfere with piping and equipment and to meet the requirements indicated herein.

4. Load/Deflection Requirements: Grating shall be capable of spanning the distances indicated with a minimum safety factor of 3 for stresses and without exceeding a deflection equal to the lesser of 1/4-inch or the span divided by 360. The loading used for determining stresses and deflections shall be the uniform live load of the adjacent floor area or 200 pounds per square foot, whichever is greater, or a concentrated load of 1000 pounds at the center of the span, unless otherwise indicated.

5. Color: The color of the grating and seat angles shall match. The color shall be as selected by the OWNER. The color selected shall result in no additional cost to the OWNER.

6. The top surface of grating shall be provided with a non-slip surface by embedding or bonding grit to the FRP.

7. Penetrations: Cutouts shall be provided were needed for penetrations through the grating. The grating shall be reinforced where necessary to meet the load/deflection requirements despite the cutouts.

8. Dimensional Requirements: When grating is designed to span primarily in one direction, the grating shall be fabricated to span in the shorter span direction, unless indicated otherwise. Individual pieces of grating shall not exceed 80 pounds in weight, unless indicated otherwise.

9. Mechanical grating clips shall be manufactured of Type 316 stainless steel. Grating hold-down clips shall be provided, spaced at a maximum of 4-feet apart or as recommended by the manufacturer, whichever is less. A minimum of 4 clips per piece of grating is required.

2.3 MOLDED FRP GRATING

A. Molded FRP grating shall be of a one piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane. Grating shall have a square or rectangular mesh pattern.

B. Gratings shall be reinforced with continuous rovings of equal number of layers in each direction to provide bidirectional load bearing.

C. Molded FRP grating shall be Fibergrate by Fibergrate Composite Structures, Inc., Corgrate Molded Fiberglass Grating by IKG Industries, Duragrate by Strongwell; or equal.

2.4 PULTRUDED FRP GRATING

A. Pultruded FRP grating shall be fabricated from bearing bars and cross rods manufactured by the pultrusion process. The glass fiber reinforcement for the bearing bars shall have a core of continuous glass strand rovings wrapped with a continuous strand glass mat. The outermost layer covering shall be a surface veil to provide a resin-rich surface. Bearing bars shall be interlocked and chemically bonded into place to provide a panel that resists twist forces and prevents internal movement of the bearing bars.

B. Pultruded FRP grating shall be Safe-T-Span by Fibergrate Composite Structures, Inc.; Corgrate by IKG Industries; Duradek by Strongwell; or equal.

PART 3 EXECUTION

3.1 PRODUCT DELIVERY AND STORAGE

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins, catalysts, and hardeners shall be crated or boxed separately.

B. Storage of Products: Materials shall be carefully handled to protect them from abrasion, cracking, chipping, twisting, deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins, catalysts, and hardeners in dry indoor storage facilities between 70 and 85 degrees F (21 to 29 degrees C). There shall be labels on the outside of the boxes indicating that the products shall be stored as described above.

3.2 GENERAL

A. FRP products shall meet the dimensional requirements and tolerances indicated. The CONTRACTOR shall verify measurements and determine correct size and locations of required holes or cutouts from field dimensions before fabrication.

B. FRP products shall be fabricated free from warps, twists, or other defects that affect appearance and serviceability.

C. The CONTRACTOR shall install FRP structures in accordance with the manufacturer's assembly drawings. Field cut and drill FRP 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.

D. Bonding of FRP items shall be through the use of an epoxy adhesive recommended by the manufacturer of the particular item. The surfaces to be bonded shall be solvent cleaned and abraded sufficiently to remove the surface gloss and to remove any mold release agent or other contaminants which may interfere with proper bonding. The adhesive manufacturer's instructions and recommendations shall be followed. The items bonded shall not be stressed until at least 48 hours have passed.

3.3 GRATING

A. Layout: Each grating section shall be readily removable except where indicated. As much as possible, manufacturer shall provide openings and holes where indicated on the Contract Drawings. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.

1. Install the grating with a minimum 1.5-inch bearing surface at the support ends.

2. Tolerances between sections shall provide for not more than 1/4-inch clearance between adjacent sections or between grating and frames. Adjacent sections shall line up to form an uninterrupted straight line where possible.

3. The grating shall be as free, as commercially possible from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles, and pits. The surface shall have a smooth finish (except for non-slip surfaces).

4. Seat angles shall be mitered and bonded at corners to produce smooth, even, level seating surface.

5. Grating shall be installed so that the top surface is level and even with adjacent walking surfaces. There shall be no protrusions above the top surface.

6. Grating shall be fastened to supports as required by mfr.

END OF SECTION

SECTION 07 92 00 - SEALANTS AND CAULKING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish and install sealing or caulking joints between dissimilar materials for watertight seal.

B. Section includes:

1. Sealants
2. Filler gaskets
3. Primers and bond breakers

1.2 DEFINITIONS

A. Sealants: Where the words “sealants” or “caulking” are used in this text, they shall be considered to be synonymous and shall mean sealant or caulking compounds as specified under Part 2 of this specification.

1.3 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.
B. Product data and materials list of items proposed to be provided under this Section.
C. Sufficient technical data to demonstrate compliance with the specified requirements.

PART 2 PRODUCTS

2.1 JOINT SEALANTS, GENERAL

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

2.2 SILICONE JOINT SEALANTS

A. Type 1 - Silicone base, nonsag, nonimmersible, single-component, moisture moisture curing: ASTM C920, Type S, Grade NS, Class 25. Capable of withstanding movement up to 50 percent of joint width.

1. Dow Corning Corp.; No. 790
2. General Electric; Silpruf
3. BASF; Sonneborn, Omniseal-50.

2.3 URETHANE JOINT SEALANTS

A. Type 2 – Multipart Polyurethane, Nonsag, Nonimmersible, Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.

1. BASF; Sonneborn NP-2
2. Pecora Corp.; Dynatrol II
3. Tremco; Dymeric 240
4. Sika Chemical Corp.; Sikaflex 2c NS

B. Type 3 - One-Part Polyurethane, Nonimmersible, Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.

1. Pecora Corp.; Dynatrol 1 XL
2. Tremco; Dymonic
3. BASF; Sonneborn, NP-I

C. Type 4 - Tape Sealant, Compressible polyurethane foam impregnated with polybutylene or polymer-modified asphalt, Color: Black, Size: 3/4-inch-wide by length required by expanded thickness recommended by manufacturer for particular application.

1. Emseal Joint Systems, Ltd.; AST—High Acrylic
2. Dayton Superior; Polytite Standard
3. PARR Technologies; PARR Sealant EP-7212-T

2.4 IMMERSIBLE JOINT SEALANTS

A. Immersible Joint Sealants. Suitable for immersion in liquids; ASTM C1247, Class 1; tested in deionized water unless otherwise indicated

B. Type 5 – Multipart Polyurethane, Self-leveling, Immersible, multicomponent, chemical curing; ASTM C920 Type M, Grade P, Class 25, capable of being continuously immersed in water.

1. BASF; Sonneborn, SL-2
2. Pecora Corp.; Urexspan NR 200
3. Tremco; THC-900/901
4. Sika Chemical Corp.; Sikaflex 2c SL

C. Type 6 - Multipart Polyurethane, Nonsag, Immersible, Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25, Capable of being continuously immersed in water.

1. Pecora; DynaTrol II
2. Tremco; Dymeric 240

3. BASF; Sonneborn NP-2
4. Sika Chemical Corp.; Sikaflex 2c NS

D. Type 7 – One-part Polyurethane, immersible, Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25, Capable of being continuously immersed in water.

1. Nonsag: Sika Chemical Corp.; Sikaflex-1a
2. Nonsag: Tremco; Vulkem 116
3. Self-leveling: BASF; Sonneborn, SL-1
4. Self-leveling: Tremco; Vulkem 45
5. Self-leveling: Sika Chemical Corp.; Sikaflex 1c SL

2.5 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Type 8 – Sanitary sealant, silicone base, similar to type 1, above, formulated to resist mold growth and repeated exposure to high humidity while retaining adhesion, flexibility, and color.

1. Dow Corning Corp.; 786
2. General Electric; Sanitary Sealant SCS1700

2.6 PREFORMED COMPRESSIBLE JOINT SEALS

A. Exterior Conditions, widths up to 5 inches, color selected by Owner's Representative.

1. BASF; Wabo Weatherseal II
2. Emseal Joint Systems Limited; Colorseal

B. Interior Conditions, widths up to 3 inches, color black.

1. BASF, Inverseal

2.7 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. BASF Corporation; Construction Systems
2. Pecora Corporation
3. Sherwin-Williams Company (The)

4. Tremco Incorporated

2.8 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Alcot Plastics Ltd.
2. BASF Corporation; Construction Systems
3. Construction Foam Products; a division of Nomaco, Inc.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

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

2.9 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.1 PREPARATION

A. Surfaces to receive caulking materials shall be thoroughly cleaned in compliance with joint-sealant manufacturer's written instructions and free of any non-compatible primers or protective coatings, including lacquers, form coatings, clear sealers, etc.

B. Brush out all foreign matter and loose particles from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

C. Clean metal surfaces with solvents and wipe dry while the surface is still wet with solvent.

D. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

a. Concrete.
b. Masonry.
c. Unglazed surfaces of ceramic tile.
d. Exterior insulation and finish systems.

3.2 INSTALLATION

A. Primers and Bond Breakers

1. Apply to surfaces as required by joint-sealant manufacturer's written installation instructions for products and applications indicated.

2. In general, prime all concrete and Portland cement-based plaster or grout surfaces.

3. Prime wood surfaces where specifically required.

4. Use proper type primers and bond breakers, apply per sealant manufacturer’s printed instructions.

B. Sealants

1. Provide watertight caulked joints at all building exterior locations where possible water penetration through joint may occur.

2. If caulking systems for such joints are not shown, provide as specifically approved.

C. Gaskets or Fillers

1. Compress all gaskets to tight fit. Where required as backing for caulking system, roll or stretch in gasket sections to depth from sealant face or as shown (in general, to 3/8-inch).

2. Install gun grade material with gun nozzle of similar size as joint width as shown. Tool all beads, after application to assume full firm contact. Strike off excess material.

3. Maintain edge surfaces adjacent to joints clean and free of caulking stain and excess material. Trim joints as required per manufacturer's printed instructions.

4. Do not apply caulking materials to a "bleeding" type of surface, such as asphaltic or other oil-emitting types. Where such material occurs at caulking joint (roofing, etc.), isolate from caulking with gasket filler.

5. Avoid mixing any water in caulking mixture before and during application. Do not thin material.

D. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

4. Provide flush joint profile according to Figure 8B in ASTM C1193.

5. Provide recessed joint configuration of recess depth according to Figure 8C in ASTM C1193.

a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.3 CORRECTIONS AND CLEANUP

A. Remove all damaged, defective or improperly installed sealant and/or caulking and replace.

B. Clean and remove all sealant and caulking from adjacent surfaces.

C. Upon completion of the work, remove all disused implements, rubbish, and debris, and leave premises neat and clean.

3.4 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Color: As selected by OWNER.

Joint Locations	Sealant Type(s)
Expansion/Contraction and Control Joints at:	
Concrete Floor Slabs (except for water-holding Structures)	5, 7
Slabs Subject to Vehicle and Pedestrian Traffic	5, 7
Masonry and Manufactured Stone Walls	1, 2, 3, 6, 7
Material Joints at:	
Metal Door, Window, and Louver Frames (Exterior)	1, 3, 7
Wall Penetrations (Exterior)	1, 3, 7
Wall Penetrations (Interior)	1, 3, 7
Floor Penetrations	3, 7
Ceiling Penetrations	1, 2, 3, 6, 7
Roof Penetrations	7
Sheet Metal Flashings	7
Sheet Metal Roofing and Siding	4, 7
Other Joints:	
Threshold Sealant Bed	7
Around Plumbing Fixtures	8

END OF SECTION

SECTION 10 14 00 - SIGNAGE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes: Plastic and metal signs.

1.2 REFERENCES

A. National Fire Protection Association (NFPA):

1. 704 - Standard System for the Identification of the Hazards of Materials for Emergency Response.

B. Occupational Safety and Health Administration (OSHA).

1.3 SUBMITTALS

A. Product data:

B. Shop drawings: Include lists of sign types, sizes, text, and colors; mounting details; locations; and cast metal plaque rubbings and templates.

C. Samples: Include actual materials.

D. Manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed products for minimum 5 years with satisfactory performance record of minimum 5 years.

B. Regulatory requirements: Provide signage in accordance with Americans with Disabilities Act as published in the Federal Register, Volume 56, No. 144, Friday, July 26, 1991.

PART 2 PRODUCTS

2.1 PLASTIC SIGNAGE SYSTEM

A. Manufacturers:

1. Furnish and install signs from one of the following:

a. Best Manufacturing Sign Systems, System 900013.

b. Andco Industries Corp., equivalent product.
c. Vomar Products, Inc., equivalent product.
d. Approved equal

B. Attachment:

1. Vinyl tape, self-adhering.

C. Lettering:

1. Helvetica medium, 3/4 inches high.

D. Material for interior use:

1. Plastic 1/8-inch thick raised letters.

E. Material for exterior use:

1. Fiberglass 1/4 inch thick with high gloss finish, raised letters, blasted from single piece of fiberglass for integral letter and background.

2. No adhesive as mechanical fastening of letters shall be allowed.

F. Colors:

1. As selected by OWNER from manufacturer's standard colors.

G. See Schedule for size, location, text and quantity.

2.2 METAL SAFETY SIGNS

A. Manufacturer: Meeting OSHA Requirements; 40-mil thick aluminum with baked enamel finish. One of the following or equal:

1. Seton Name Plate Co., Special Wording.
2. Emedco.

B. Danger sign colors:

1. Background: White.
2. Heading: White lettering on red oval with white border in black rectangular panel.
3. Message: Black lettering on white.
4. Size: As scheduled.

C. Caution sign colors:

1. Background: Yellow.

2. Heading: Yellow lettering on black rectangular panel.
3. Message: Black lettering on yellow.
4. Size: As scheduled.

D. Safety instruction signs:

1. Background: White.
2. Heading: White lettering on green rectangular panel.
3. Message: Black lettering.
4. Size: As scheduled.

E. Warning sign colors:

1. Background: Orange.
2. Heading: Black lettering on orange diamond in black rectangular panel.
3. Message: Flack lettering on orange.
4. Size: As scheduled.

F. Notice information signs:

1. Background: White.
2. Heading: White lettering on blue rectangular panel.
3. Message: Black lettering.
4. Size: As scheduled.

G. Fasteners: Round head stainless steel bolts or screws.

H. See Schedule for specific sign size, location, text, and quantity.

2.3 HAZARD MATERIAL SIGNALS

A. Manufacturer: One of the following or equal:

1. Seton Name Plate Co.
2. Emedco.

B. Hazard material signals: In accordance with NFPA 704; vinyl panels, letters, and symbols with pressure sensitive adhesive, sizes as required for viewing distances, letters and symbols in accordance with the Schedule.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect adjacent surfaces which may be damaged by installation of signs.
B. Prepare substrates in accordance with sign manufacturer's instructions.

C. Remove scale, dirt, grease, and other contaminates from substrates.

3.2 INSTALLATION

A. Install signs in accordance with sign manufacturer's instructions.
B. Fasten signs securely in level, plumb, and true to plane positions.
C. Install signs where indicated on the Drawings or as indicated in the following schedules.

3.3 PLASTIC SIGN SCHEDULE

A. Chemical Fill Stations:

1. Aluminum Chlorohydrate

a. Location: On wall outside above chemical fill connection.
b. Height: 60 inches above floor to center of sign.
c. Size: 18 inches wide by 8 inches high.
d. Colors: As selected by OWNER.
e. Text: ALUMINUM CHLOROHYDRATE FILL STATION
MECHANICAL FILL ONLY: NO PNEUMATIC FILL

2. Sodium Hypochlorite, Tank 1

a. Location: On wall outside above chemical fill connection.
b. Height: 60 inches above finished grade to center of sign.
c. Size: 18 inches wide by 8 inches high.
d. Colors: As selected by OWNER.
e. Text: SODIUM HYPOCHLORITE TANK 1 FILL STATION
MECHANICAL FILL ONLY: NO PNEUMATIC FILL

3. Sodium Hypochlorite, Tank 2

a. Location: On wall outside above chemical fill connection.
b. Height: 60 inches above finished grade to center of sign.
c. Size: 18 inches wide by 8 inches high.
d. Colors: As selected by OWNER.
e. Text: SODIUM HYPOCHLORITE TANK 2 FILL STATION
MECHANICAL FILL ONLY: NO PNEUMATIC FILL

B. Exterior Sump Pump Discharge Connection:

a. Location: On wall outside above chemical fill connection.
b. Height: 60 inches above floor to center of sign.
c. Size: 18 inches wide by 8 inches high.
d. Colors: As selected by OWNER

e. Text: SUMP PUMP DISCHARGE CONNECTION
PROPERLY DISPOSE OF CHEMICAL WASTE

3.4 METAL SAFETY SIGN SCHEDULE

A. Aluminum Chlorohydrate Tank

1. Location: On sodium bisulfite tank.
2. Height: 20 inches wide by 10 inches high.
3. Text: 50% ALUMINUM CHLOROHYDRATE

B. Sodium Hypochlorite Tank 1

1. Location: On sodium hypochlorite tank.
2. Height: 20 inches wide by 10 inches high.
3. Heading: CAUTION
4. Text: 12.5% SODIUM HYPOCHLORITE
OXIDIZER, REACTIVE, CORROSIVE

C. Sodium Hypochlorite Tank 2

1. Location: On sodium hypochlorite tank.
2. Height: 20 inches wide by 10 inches high.
3. Heading: CAUTION
4. Text: 12.5% SODIUM HYPOCHLORITE
OXIDIZER, REACTIVE, CORROSIVE

3.5 HAZARDOUS MATERIAL SIGN SCHEDULE

A. Hazard Sign for Sodium Hypochlorite 12.5%

1. Location: On inactive leaf of double door, south entrance to the chemical storage building and on the chemical tank.
2. Size: Per NFPA 704.
3. Health: 3
4. Flammability: 0
5. Reactivity: 1
6. Special: COR

END OF SECTION

SECTION 23 31 13

METAL DUCTS AND ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.

2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.

3. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.

4. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure).

5. ASTM International (ASTM):

   a. A36/A36M, Standard Specification for Carbon Structural Steel.

   b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

   c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

   d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.

   e. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

   f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

   g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.

   h. A653/A653M, Standard Specifications for Steel Sheet, Zinc- Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment.

j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.

k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold- Rolled, Carbon, Structural, High-Strength Low-Alloy, High-

Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

l. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low- Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

m. B209, Standard Specification for Aluminum and Aluminum- Alloy Sheet and Plate.

n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.

p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.

r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

6. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.

7. National Fire Protection Association (NFPA):

a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

b. 90B Standard for the Installation of Warm Air Heating and Air- Conditioning Systems.

c. 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

e. 259, Standard Test Method for Potential Heat of Building Materials.

f. 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

a. Duct Construction Standards.
b. Guidelines for Seismic Restraints of Mechanical Systems.
c. Fibrous Glass Duct Construction Standards.
d. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
e. HVAC Air Duct Leakage Test Manual.

9. Underwriters Laboratories Inc. (UL):

a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
c. 555, Standard for Safety Fire Dampers.
d. 555S, Standard for Safety Smoke Dampers.

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. CFM: cubic feet per minute.
2. FPM: feet per minute.
3. PCF: pounds per cubic foot.
4. WC: water column.

B. Sealing Requirements: For duct systems sealing requirements specified in this section, the following definitions apply:

1. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.

2. Joints, duct surface connections including:

a. Girth joints.
b. Branch and subbranch intersections.
c. Duct collar tap-ins.
d. Fitting subsections.
e. Louver and air terminal connections to ducts.
f. Access door, and access panel frames and jambs.
g. Duct, plenum, and casing abutments to building structures.

1.3 SUBMITTALS

A. Action Submittals:

1. Ductwork Product Data: Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, hangers and supports, seam and construction details, and finishes.

Ductwork Accessories: Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes.

PART 2 PRODUCTS

2.1 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Ductwork material shall be aluminum or galvanized steel, minimum thickness 24 gauge.

C. Duct Sealants: Adhesives, cements, and sealants shall be as recommended by duct manufacturer for industrial applications.

D. Ductwork Interior Surfaces:

1. Smooth.

2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.

3. Seams and joints shall be external.

2.2 SHEET METAL MATERIALS

A. Construct supply and exhaust duct systems from aluminum or galvanized steel construct odor control duct systems from stainless steel as specified herein.

B. Galvanized Steel Ductwork:

1. Comply with ASTM A653/A653M and ASTM A924/924M.

2. Product Name: Steel Sheet, Zinc Coated (Galvanized Steel).

3. Sheet Designation: CS Type B.

4. Applicable Specification: ASTMA653/A653M.

5. (Zinc) Coating Designation: G90.

6. Coating designation in accordance with Test MethodA, ASTM A90/A90M and ASTM A924/A924M.

7. Provide mill-phosphatized finish for ducts exposed to view andfor ducts scheduled to be painted.

8. Provide sheet metal packaged and marked as specified in ASTM A700.

C. Aluminum Ductwork:

1. Comply with ASTM B209.
2. Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.
3. Aluminum Connectors and Bar Stock: Alloy 6061-T6, or equivalent.

D. Stainless Steel Ductwork:

1. Comply with ASTM A167, ASTM A176, ASTM A240/A240M, and ASTM A480/A480M.

2. Stainless Steel Sheet: Type 316/316L, unless indicated otherwise.

3. Gauge shall comply with SMACNA HVAC Industrial Duct Construction Standards manual, unless specified otherwise.

4. Finish: No. 2 B (cold-rolled, bright) finish. Welds shall be grinded smooth and passivated.

5. Longitudinal fusion welded butt seam, flanged fittings, and joints with all seams welded.

6. Elbows: Provide centerline equal to radius 1.5 times elbow diameter.

7. Fittings: Continuously welded along seams.

E. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

F. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.3 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Solvent-Based Sealants:

1. Ultraviolet light resistant.

2. Mildew resistant.

3. Flashpoint: Greater than 70 degrees F, SETACC.

4. Manufacturers and Products:

a. Hardcast, Inc.; Versagrip 102.
b. Rectorseal; AT-33.
c. Childers CP-140.

D. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.

2. Manufacturers and Products:

a. Foster; Series 32.
b. Childers; CP-145A, 146.
c. Rectorseal; Airlok 181.

E. Do not use silicone sealants at odor control ducting. Instead, utilize expanded Teflon (Gortex), or a Hypalon product.

2.4 DUCTWORK FASTENERS

A. General:

1. Rivets, bolts, or sheet metal screws.

2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:

1. Galvanized Steel Ductwork System: Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat- treated carbon steel with zinc electroplated finish.

2. Aluminum Ductwork System:

    a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Type 410 stainless steel, complete with bonded metal and fiber washer for dielectric separation.

    b. Manufacturers:

        1) DB Building Fasteners Inc., Santa Fe Springs, CA.
        2) Clark Craft Fasteners, Tonawanda, NY.

3. Stainless Steel Ductwork System:

    a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated, Type 410 stainless steel.

    b. Manufacturers:

        1) DB Building Fasteners Inc., Santa Fe Springs, CA.
        2) Clark Craft Fasteners, Tonawanda, NY.

2.5 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated as follows:

1. Supply Ducts: 3-inch WC.
2. Return Ducts: 2-inch WC, negative pressure.
3. Exhaust Ducts: 2-inch WC, negative pressure.

B. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 2-inch WC pressure class shall be basis of Contract.

2.6 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

2.7 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:

1. Fit square-turn elbows with vane side rails.

2. Shop fabricate double-blade turning vanes of same material as ductwork.

3. Fabricate with equal inlet and outlet.

4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.

5. Manufacturers and Products:

   a. Elgen; All-Tight.
   b. Duro-Dyne; Type TR.

2.8 RECTANGULAR DUCTWORK BRANCHCONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using factory fabricated fittings with spot welded tap to main duct connections or with factory fabricated, field installed taps, with spin-in or mechanical fastened tap to main duct connections.

2.9 RIGID ROUND DUCTWORK

A. Construct rigid round ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Basic Round Diameter: As used in this Article, is inside diameter of size of round duct.

C. Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction hydraulically equivalent to round ductwork.

D. Fabricate round ducts with spiral seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams.

E. Ductwork seams of Snaplock type shall not be used.

2.10 RIGID ROUND DUCTWORK FITTINGS

A. Construct rigid round ductwork fittings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.

B. 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.

C. Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

D. Elbows:

1. Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two-piece segment elbows are not allowed, except with turning vanes.

2. Segmented Elbows: Fabricate with welded construction.

3. Round Elbows 8 Inches and Smaller:

   a. Stamped elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees configuration.

   b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 3-1/2 inches and 4-1/2 inches) elbows with segmented construction.

4. Round Elbows 9 Inches Through 14 Inches:

   a. Segmented or pleated elbows for 30, 45, 60, and 90 degrees.

   b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 9-1/2 inches and 10-1/2 inches) elbows with segmented construction.

2.11 DUCTWORK FLEXIBLE CONNECTIONS

A. General:

1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.

2. Sheet metal permanently secured to fabric with double fabric fold, double metal crimp.

3. Comply with NFPA 90A and NFPA 90B requirements.

4. Airtight and waterproof.

B. Materials:

1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.

3. Fabric:

   a. Comply with NFPA 701 or UL 214 (except Teflon coated).
   b. Woven polyester or nylon.

C. Construction:

1. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.

2. Standard Metal Edged Connectors: Strip of fabric 3 inches wide attached to two strips of 3-inch-wide sheet metal.

3. Wide Metal Edged Connectors: Strip of fabric 4 inches wide attached to two strips of 4-inch-wide sheet metal.

4. Extra Wide Metal Edged Connectors: Strip of fabric 6 inches wide attached to two strips of 6-inch-wide sheet metal.

D. Manufacturers:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

2.12 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.

2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.

3. Wire hangers are not acceptable.

4. Hanger Spacing:

a. Ducts Up to 60 inches in Largest Dimension: 10 feet, maximum.
b. Ducts Over 61 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

1. Of same material as ductwork.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.

2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.

3. Upper Attachment (Concrete):

    a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.

    b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.

    c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.13 DOUBLE WALL DUCTWORK - (NOT USED)

2.14 MANUAL DAMPERS

A. Butterfly Manual Dampers:

1. Frame: 1-1/2-inch by 10-gauge.

2. Blade: 1/4-inch thick.

3. Elastomer type full circumference seal. Seal fastened to blade with bolted retainer ring.

4. Bearings: Grease lubricated ball bearings mounted outboard of frame with adjustable packing gland shaft seals.

5. Materials of construction: Type 316 stainless steel

6. Hand quadrant operator.

7. Maximum System Pressure: 20 inches WC.

8. Leakage: 1.1 cfm for 12-inch damper based on a pressure differential of 10 inches WC.

9. Damper Manufacturer and Model:

    a. Ruskin CDR192.
    b. Greenheck HCDR-351.
    c. Or equal.

B. Aluminum, Counterbalanced, Standard Duty:

1. Fabrication:

a. Frame: 3 inches by minimum 0.09 inch, 6063-T5 extruded aluminum channel with front flange and rear flange and mitered corners.

b. Blades:

1) Style: Single piece, overlap frame.
2) Action: Parallel.
3) Material: Minimum 0.025-inch (0.6 mm) 6063-T5 formed aluminum.
4) Width: Maximum 6 inches (152 mm).

c. Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.

d. Blade Seals: Extruded vinyl, mechanically attached to blade edge.

e. Linkage: Concealed in frame.

f. Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.

g. Finish: Mill aluminum.

2. Performance Data:

a. Temperature Rating: Withstand minus 40 degrees to 200 degrees F (minus 40 degrees to 93 degrees C).

b. Maximum Back Pressure: 1.5-inch WC or 55 MPH external wind.

c. Maximum Spot Air Velocity: 1,000 fpm (5 mps).

d. Operation of Blades:

1) Start to Open: 0.03-inch WC.
2) Fully Open: 0.1-inch WC.

e. Pressure Drop: Maximum 0.04-inch WC (0.01 kPa) at 1,000 fpm (305 mpm) through 24-inch by 24-inch (610 mm by 610 mm) damper.

3. Accessories:

a. Duct Transition Connection: Rectangular.

b. Factory Sleeve: Minimum 20-gauge (1.0 mm) thickness, minimum 12-inch (305 mm) length.

c. Screen:

1) Type: Bird.
2) Location: Rear with sleeve.
3) Material: Aluminum.

4. Manufacturers and Products:

a. Ruskin; Model BD2A1.
b. Or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.

2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.

3. Joints and seams shall be sealed watertight.

4. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.

5. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.

2. Avoid diagonal runs wherever possible.

3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.

4. In general, install as close to bottom of structure as possible.

5. For ductwork concealed above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.

6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.

2. Clearances:

a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.

b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.

3. Closure Collars:

a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings areinstalled.

b. Fit collars snugly around ducts and insulation.

c. Same gauge and material asduct.

d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vaporbarrier.

e. Use fasteners with maximum 6-inch centers on collars.

4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Coordination with OtherTrades:

1. Coordinate duct installation with installation of louvers, dampers, and ductwork accessories.

2. Ductwork shall be configured, positioned, and installed topermit installation of light fixtures as indicated onDrawings.

3. Coordinate ductwork layout to avoid interference with lighting, bridge crane, suspended ceiling, tanks, generator, electrical panels and all process equipment.

3.2 RECTANGULAR DUCTWORK

A. General:

1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.

2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

B. Low Pressure Taps:

1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tap with a gasket or sealed with sealant as specified for medium pressure ductwork.

2. Determine location of spin-in after outlet location is determined.

3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

C. Fittings:

1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.

2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.

3. Make offsets with maximum angle of 45 degrees.

4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

D. Rectangular Ductwork Transverse Joints:

1. Install each run with a minimum of joints.

2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

3. Mechanical Joint Option:

a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.

b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.

c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.

d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.

e. Conform to SMACNA Class A sealing requirements.

3.3 RIGID ROUND OR OVAL DUCTWORK

A. General:

1. Round ductwork may be substituted in place of rectangular ductwork at locations approved by the Owner. Obtain written approval from the Owner prior to substituting round for rectangular ductwork.

2. Round ductwork shall be installed in lengths as long as possible to minimize joints.

B. Rigid Round or Oval Ductwork Joints:

1. Rigid round ductwork joints shall be in accordance with SMACNA, unless otherwise specified.

2. Single and Double Wall Supply and Return System Joints:

a. Less than 36 Inches: Slip coupling.

b. 36 Inches and Larger: Flanged connector, Van Stone, or welded companion flange type.

3. Single and Double Wall Exhaust and Return System Joints:

a. Spiral Seam Duct: Welded flanged connector.
b. Longitudinal Seam Duct: Van Stone flange connector.

3.4 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:

1. Use between fans and ducts.

2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.

3. For rectangular ducts, lock flexible connections to metal collars.

3.5 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

3.6 DUCT SEALING

A. Seal duct seams and joints as follows:

1. In accordance with SMACNA requirements.

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Provide additional duct sealing as required to comply with Article Ductwork Leakage Testing.

D. Seal all audible leaks.

3.7 DUCTWORK LEAKAGE TESTING

A. General:

1. Tests shall be conducted on completed ductwork systems.

2. Testing of partial installations or limited sections of ductwork will not be acceptable.

3. All ductwork leakage test procedures and results shall be submitted to ENGINEER for review.

4. ENGINEER shall retain the right to witness some or all ductwork leakage testing procedures.

5. Subcontractor shall notify ENGINEER in writing at least 5 working days prior to ductwork testing.

B. Leakage Criteria:

1. Assemble and install ductwork with maximum leakage limited as follows:

2. Odor Control Systems:

a. Odor Control Ductwork:

1) Operating Pressure: 0- to 2-inch WC.

a) Allowable Leakage: 2 percent of design airflow.

2) Operating Pressure: 3-inch and over WC.

a) Allowable Leakage: 1 percent of design airflow.

C. Leakage Testing Method:

1. Subcontractor shall be responsible for providing all necessary test fans and calibrated measuring devices to accomplish ductwork leakage test and to demonstrate that ductwork systems leakage rate is less than maximum rate specified.

2. Pressure testing shall be accomplished using a pressure blower with a calibrated orifice and manometer.

3. Blower shall maintain SMACNA construction pressure classification during test.

4. Perform testing in accordance with procedures given in SMACNA HVAC Air Duct Leakage Test Manual.

3.8 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Subcontractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

END OF SECTION

SECTION 26 05 00 – GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Definitions.
3. Quality Assurance.
4. Submittals.
5. Drawings.
6. Project Site Conditions.
7. Electrical Numbering Systems.
8. Indicating Lamp Colors.
9. Equipment Coordination.
10. Basis of Design.
11. ARC Flash Mitigation Methods.
12. Products.
13. Execution - General.
14. Testing.

1.2 SCOPE

A. SCOPE: This section specifies general requirements for electrical work. Detailed requirements for specific electrical items are specified in other sections but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations.

1.3 DEFINITIONS:

A. WIRING, ELEMENTARY OR SCHEMATIC DIAGRAM: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

B. ONE-LINE DIAGRAM: A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relation- ships are usually disregarded.

C. BLOCK DIAGRAM: A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

D. CONNECTION DIAGRAM: A connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

E. INTERCONNECTION DIAGRAM:

1. Interconnection diagrams shall show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams which interface to the interconnection diagrams. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable.

2. Each wire identification as actually installed shall be shown. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified in the equipment complete with individual terminal identification.

3. All jumpers, shielding and grounding termination details not shown on the equipment connection diagrams shall be shown on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram. Signal and DC circuit polarities and wire pairs shall be shown. Spare wires and cables shall be shown.

F. ARRANGEMENT, LAYOUT, and OR OUTLINE DRAWINGS: An arrangement, layout, and or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.4 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been

discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or other- wise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NFPA-70	National Electrical Code (NEC)
NFPA-70E	Electrical Safety in the Workplace
IBC	International Building Code
WAC	Washington Administration Code

B. IDENTIFICATION OF LISTED PRODUCTS:

1. Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Factory Mutual (FM), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price. Contractor shall comply with Washington Administrative Code regulations concerning Listing requirements for electrical equipment.

C. FACTORY TESTS: Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed on completion of manufacture or assembly. The costs of factory tests shall be included in the contract price.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Catalog cuts of equipment, devices, and materials requested by the individual specification sections. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog

cuts shall be edited to show only the items, model numbers, and information which apply.

2. Interconnection diagram: The Contractor shall prepare interconnection diagrams depicting all cable requirements together with their actual terminations as specified in Section 26 05 00.

3. Conduit layout drawings indicating size, location, and support, for all conduits other than single runs of 1-inch diameter or less cast in concrete construction.

   a. Conduit layout drawings shall illustrate a system which conforms to the requirements of Section 26 05 00.

   b. For layouts that do not conform to 26 05 00, provide engineering design and calculations signed and sealed by a Professional Engineer registered in State of Washington. Engineering design and calculations shall demonstrate that the proposed layout does not impair or significantly reduce the design structural strength.

4. Safety disconnect switch list including legend with equipment tag, equipment description, and power feeder circuit source and location information.

1.6 DRAWINGS

A. Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 11-inch by 17-inch paper, and on CD Rom or USB drive in AutoCAD 2012 or an approved newer software version. Drawings shall be complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing. Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals. Drawings deemed illegible shall be rejected.

B. Where the Contractor is required to provide equipment or system submittal information on drawings as part of the specified work, such drawings shall be prepared on 11-inch by 17-inch paper and shall be included within a three ring binder. Drawings shall be complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing. Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals. Drawings deemed illegible shall be rejected.

1.7 PROJECT/SITE CONDITIONS

A. GENERAL: Unless otherwise specified, equipment and materials shall be sized and derated for the ambient condition of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.

B. HAZARDOUS (CLASSIFIED) AREAS: Hazardous areas identified on the drawings shall be in accordance with the NEC.

1.8 ELECTRICAL NUMBERING SYSTEMS

A. TAGGING: All circuit raceways and armored cables shall be tagged at all terminations, panels, MCCs, pull boxes, junction boxes, etc. in accordance with the assigned numbers on the circuit/raceway schedule and schematic/plan drawings. The tags shall be installed in a clean and high workmanship manner. In addition to tags at the terminations, exposed raceways and armored cables shall be tagged at each side of concealment.

B. PREFIX MODIFIERS: Unless otherwise noted on the drawings or in a circuit schedule, the following prefix modifiers shall be used when scheduling/tagging cables and raceway:

Raceway Prefix	Type of Function
H	Power above 600V
P	Power 120V to 600V
C	Control or power - 120V or less
S	Low level signal (less than 90 volt communication or less than 30 volt instrumentation)
D	Data
PC	Composite of power 120 to 600V and control
F	Optical Fiber
PSP, CSP	Spare power, spare control

C. RACEWAY NUMBERS: Where circuit/raceway numbers have not been assigned, Contractor shall assign raceway numbers in accordance with the system outlined in the drawings.

1.9 CONDUCTOR NUMBERS:

A. WIRE MARKERS: All control and signal conductors in panels, pull boxes, power, instrument, and relay compartments of motor control centers, control cabinets, instrument cabinets, field cabinets and control stations, as well as connections to mechanical equipment, shall be tagged at each end with legible, coded tight fitting wire-marking sleeve showing the complete wire designation. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The figures shall be 1/8 inch high. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation. The sleeves shall be shrunk to fit the conductor with hot air after installation. They shall be T&B, SHRINK-KON HVM or equal. Adhesive strips are not acceptable. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking tab

type. Tabs shall be white plastic with conductor identification number permanently embossed.

B. INTERNAL WIRING:

1. Wiring within a single enclosure shall be marked with the basic wire and terminal number at each end. The wire number shall designate the terminal or equipment number at each end of the wire separated by a slash.

2. Wiring within MCC buckets shall have a simple numbering scheme, and shall use the same number at each end. (1,2,3,4,5, etc.) Wiring which lands on field terminals shall utilize the terminal number for the internal wire number.

C. FIELD WIRING: All field wiring shall have wire labels at each end. The labels shall be marked with the output terminal number at the original equipment (local control panel or MCC) and the remote device terminal # (if applicable) and tag name separated by a slash. Conductors shall be identified with numbers at both ends. Conductor tag numbers shall be the conductor number specified on the control diagram or if not shown, shall follow the convention below.

1. Wires from MCC buckets shall be labeled with [MCC number(086) - bucket number(A4) - terminal number (6)] (MCC3-A4-6)

2. Wires from Local Control Panels shall be labeled with panel number (PNL2000)-terminal number (12)] (PNL2000-12)

3. Wires from PLC panels or remote I/O panels shall have Rack or Bus (1) – Card or Block (7) -Terminal number(A3) only (1-7-A3)

4. Wires from devices, instruments etc. shall have the instrument or device name and terminal number if applicable. Equipment name is typically DEVICE TYPE - NUMBER. (HS2510) (TSH2510) (FIT2562)

D. EXAMPLE for a control cable from the Area Control Panel PNL2000 bus 1, block 1, terminal A4 to the level transmitter (LIT2501) - the wire tag number at both ends shall be LIT2501 / 1-1-A4. (Do not include the panel name, just the bus, block, terminal number.)

E. EXAMPLE for a control cable from the Area Control Panel PNL2000 rack 4, card 5, terminal A4 to the MCC3, bucket D5 terminal 6 the tag number at both ends shall be MCC3-D5-6/4-5-A4

F. EXAMPLE for a control cable from the MCC3 bucket A4 terminal 12 to device HS4030, the wire tag number at both ends shall be MCC3-A4-12 / HS4030. (Do not include the system abbreviation on devices connected to an MCC bucket.)

1.10 INDICATING LAMP COLORS

A. All indicating lamps shall have an integrated lamp-test function for all lamps on a single line-up of equipment (i.e. Motor Control Center, Switchgear).

B. Unless otherwise specified, indicating lights shall be equipped with colored lenses in accordance with the following schedule:

Color	Function	Example
Green	Run, open valve	Equipment operating, motor running
Red	Stopped, Closed valve	Alarm, end of cycle, motor stopped
White or clear	Normal condition, Ready	Control power on, status OK
Amber (yellow)	Abnormal condition	Failure of equipment or status abnormal, fault condition
Green	Breaker Open	Switchgear breaker illuminated pushbutton
Red	Breaker Closed	Switchgear breaker illuminated pushbutton
Amber (yellow)	Breaker Tripped	Switchgear breaker illuminated pushbutton

1.11 EQUIPMENT COORDINATION

A. The Contractor is responsible to coordinate the equipment supplied from various manufacturers and vendors. This includes but is not limited to:

1. Obtaining specific information on equipment ratings and sizes and verifying the electrical components supplied meet, or match the requirements such as voltage, phase, frequency, starter types, etc.

2. Shall provide equipment that will fit within the space allocated and meet OSHA and N.E.C. clearances.

3. Shall provide coordinated electrical installations with the supplied equipment's electrical power and control requirements.

4. Shall provide power and control equipment, wiring, and raceways to meet the requirements of the mechanical equipment supplied.

5. Shall provide all necessary control wiring and components for any special requirements from an equipment manufacturer.

B. The Contractor shall verify as a minimum:

1. Correct voltage, phase and frequency
2. Size and space requirements
3. Mounting requirements
4. Correct motor starter type and NEMA size
5. Proper coordination with the controls and control System Integrator

C. Any discrepancies between the electrical equipment and other equipment shall be brought to the immediate attention of the Owner.

D. The Contractor shall assure that no instrumentation or control interferences are created by the variable frequency drives (VFDs) or load wiring. The Contractor shall coordinate with the VFD manufacturer to provide necessary separation of conductors or shielding and/or filtering equipment as required by the VFD manufacturer. If interferences do occur, the Contractor shall be responsible to take corrective action at no additional cost to the Owner.

E. WIRING FOR VENDOR PACKAGES:

1. Equipment specifications indicate when the Vendor is responsible for providing interconnection wiring between components of a Vendor package that are installed on separate skids or assemblies. In this circumstance, interconnection wiring between skids or assemblies in a Vendor package is scheduled as “Vendor Wiring” in the conduit/cable schedules.

2. Where equipment specifications do not specify Vendor furnished wiring be- tween skids or assemblies in a Vendor package, the Contractor shall provide and install interconnection wiring between skids or assemblies per the Vendor’s interconnection wiring requirements. Interconnection wiring between skids or assemblies in a Vendor package that is furnished and installed by the Contractor is not scheduled in the conduit/cable schedules.

3. Determination of cable requirements.

    a. Coordinate cable/conductor requirements with the selected Vendors to determine the correct wiring required to interconnect the package system components/skids.

    b. Wiring between Vendor furnished components shipped on separate skids or assemblies shall conform to requirements specified in Division 26.

    c. Wiring between the plant control system and Packages system components/skids are specified in the conduit/cable schedules.

d. Wiring between external power supplies and the packaged system components/skids are specified in the conduit/cable schedules.

4. Assign numbers and tagging for unscheduled raceway, and cable between Vendor furnished components on separate skids or assemblies as specified in Section 26 05 00. Coordinate this information in submittals, record drawings, and O&M manuals provided under this contract.

5. Contract documents shall be updated in the record drawing set to include the work provided for wiring the vendor packages.

1.12 BASIS OF DESIGN

A. The basis of the mechanical and electrical design is the installation of equipment and motors as shown in the electrical one-line drawing(s) and load/panel schedules. In the event that different equipment motors are provided in order for the vendor's equipment to meet mechanical performance requirements, the contractor shall coordinate various suppliers, vendors, and subcontractors to change the required electrical conduit, cables, breakers, motor control center sections, starters units and accessories, etc. as necessary to meet the vendor's equipment installation requirements of the National Electrical Code. The traits and characteristics of all provided materials, equipment, and devices shall meet the specifications. These changes to materials, equipment, and devices shall be at no cost to the Owner. Electrical submittal information shall be coordinated with the equipment and motors provided.

1.13 ARC FLASH MITIGATION METHODS

A. The following mitigation method requirements shall apply to all power distribution and utilization equipment supplied for any products supplied on the project and applies to all equipment divisions in the Contract Documents. Refer to the NFPA-70 (NEC) and NFPA-70E (Electrical Safety in the Workplace) for equipment labeling requirements.

1. EQUIPMENT LABELS: Equipment labels shall be installed on the outside of the electrical equipment enclosure, cabinet, and panels to avoid opening the equipment to access the manufacture's data or the equipment ratings.

2. HINGED DOORS: Power distribution equipment shall have hinged rear doors where back access is shown.

3. REMOTE RACKING DEVICES: Switchboards shall be provided with a remote racking device for Electricians to insert or remove rack- mounted breakers, rack-mounted devices, or auxiliary equipment drawers in- to the associated equipment location.

4. INSULATED POWER BUS AND INSULATED CABLE BOOTS:

    a. Provide insulated power bus in power distribution equipment where accessible to installers or maintenance workers.

    b. Provide cable boots for power conductor connections to insulate the exposed power conductor connections.

5. VIEW WINDOWS FOR MONITORING: Provide protected view windows into cabinets that allow infra-red analyzers, monitors, or cameras to monitor hot temperature for unusual heat generated by deteriorating connections. The view windows shall have a method to move the window protector and hold- in-place during the monitoring operation.

6. POWER AND CONTROL EQUIPMENT SEPARATION:

    a. Provide separation between power equipment within an enclosure, cabinet, or panel by the use of barriers, separate access doors, or by other means.

    b. Provide separation barriers between main breaker feeders coming in- to equipment and other termination points or bussing on the load side of the main breaker.

7. AUTOMATIC SHUTTERS: Provide automatic shutters, where possible, to close the access to the power bus when a power device is not engaged.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. GENERAL: Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

B. EQUIPMENT FINISH: Unless otherwise specified, electrical equipment shall be painted by the manufacturer.

C. GALVANIZING: Where specified, galvanizing shall be in accordance with Section 05 50 00.

2.2 WIRE MARKERS

A. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 1 AWG or smaller shall have identification sleeves.

Conductors No. 2 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

B. Conductors shall be identified in accordance with Section 26 05 00. Adhesive strips are not acceptable.

C. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink with figures 1/8 inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

D. Conductor and Wire Marker Manufacture:

1. TMS Thermofit Marker System by Raychem Co
2. Sleeve style wire marking system by W. H. Brady Co.
3. or approved equal.

2.3 MC-HL CABLE AND RACEWAY TAGS

A. Tags shall be:

1. Manufactured of permanent metal or heavy mill plastic.

2. Fastened to the raceways at both ends of the tag with permanent fasteners.

3. Tag numbers shall be 1-inch tall and machine printed. Hand labeled tags are unacceptable.

2.4 NAMEPLATES

A. Nameplates shall be provided on all electrical devices, including but not limited to motor control equipment, MCC cubicles/cells/buckets, control stations, junction boxes, panels, harmonic filters, instruments, disconnect switches, indicating lights, meters, and all electrical equipment enclosures.

B. Nameplates shall also be provided on all electrical panel interior equipment, including but not limited to relays, circuit breakers, power supplies, terminals, contactors, and other devices.

C. Equipment nameplates shall have both the equipment name and number.

D. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic having black letters not less than 3/16” high on white background or as shown on the drawings or other sections of the specifications. Nameplates on the interior of panels shall be White Polyester with printed thermal transfer lettering and permanent

pressure sensitive acrylic; TYTON 822 or approved equal. All nameplates shall include the equipment name and number (and function, if applicable).

E. Provide warning nameplates on all panels and equipment which contain multiple power sources. Lettering shall be white on red background.

F. Nameplates shall be secured to equipment with stainless steel screws/fasteners.

G. Nameplates for disconnect switches shall contain name and number as well as voltage, phases and colors of conductors.

2.5 TERMINAL BLOCKS

A. GENERAL:

1. GENERAL:

a. Terminal Blocks for all contractor supplied equipment and devices shall be manufactured by Allen Bradley, Bussmann, Phoenix Contact, or approved equal.

b. Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as shown on the drawings. Terminal blocks for P-circuits (power 120-600 volts) shall be rated not less than the conductor current rating and shall not be rated less than 600 volts AC. Terminal blocks for C-circuits (control and/or control power 120 volts or less) and S-circuits (signal) shall be rated not less than 20 amperes and shall not be rated less than 600 volts AC. Terminals shall be tin-plated. Insulating material shall be nylon. Terminal blocks shall be in accordance with section 26 27 16 for all electrical equipment.

c. Provide terminals for all wire connections to field wiring and internal power distribution. Analog loops that are 24 VDC powered shall have a knife switch to disable the loop if necessary.

d. Connections shall have compression terminals capable of terminating 2 #14 AWG stranded wires. Terminals shall be DIN rail strip mounted as manufactured by Phoenix Contact, or approved equal. Provide number strips for terminal blocks that are referenced by the wire marker. Provide bridge bars for jumping between terminal blocks. Provide end clamps to separate and terminate terminal block groups. Provide end covers for groups of terminal blocks in sets to match the number points associated with individual I/O cards in the PLC block.

e. Provide Separation Plates on each side of terminals that are at a different potential or polarity than surrounding terminals.

f. Provide clear plastic DIN rail mounted nametag stanchions for each block of terminations. Each nametag shall hold a preprinted label designating the PLC bus and PLC block that terminates to that set of terminals.

g. Terminals shall be mounted such that there is a minimum of 1.5 inches of clear space on both sides of the terminal; for ease of wiring.

h. Mount all terminals strips on 2-inch standoffs.

i. Provide 10 spare terminals or 5% whichever is the greater amount, spare (non-installed) replacement terminals for each type used.

j. Provide wired terminals to match the number of points supplied on each installed I/O card or spare slot in a PLC cabinet.

B. DIGITAL TERMINALS:

1. Terminal Blocks for use in general purpose and digital input terminations shall be Phoenix Contact UK 5, or approved equal. Provide double high terminals for general purpose.

2. Where space is limited for the required number of digital input points double high terminals are permitted if first approved by the Owner.

C. ANALOG TERMINALS:

1. Terminal Blocks for use in analog input terminations shall be knife dis- connect, with socket for analog isolator Phoenix Contact URELG-PMTK, or approved equal.

2. Terminal blocks for analog outputs shall be fused, double high with a separate ground terminal.

3. The wire used for analog inputs and outputs shall be multi-conductor #18 twisted pairs with an overall shield. Provide 4 & 8 pairs to match the in- put or output cards. Wire pairs shall be numbered and colored red for + and black for -. Use BELDEN-M 9520 CMG or approved equal.

D. FUSED TERMINALS:

1. Fuse terminal blocks shall be hinged disconnect level type with “blown fuse” indicators. PHOENIX CONTACT UK 5 HESI series, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. CONSTRUCTION:

1. The work under Division 26 shall be performed in accordance with these specifications.

2. Unless otherwise detailed or dimensioned, electrical layout drawings are diagrammatic. The Contractor shall coordinate the field location of electrical material or equipment with the work of other disciplines and subcontractors. Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

B. HOUSEKEEPING:

1. Electrical equipment shall be protected from dust, water and damage. Motor control centers, switchgear, and buses shall be wiped free of dust and dirt, kept dry, and shall be vacuumed on the inside within 30 days of acceptance of the work.

2. Before final acceptance, the Contractor shall touch up any scratches on equipment.

3. Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be adequately protected.

C. ELECTRICAL EQUIPMENT LABELING:

1. Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.

2. Electrical equipment shall have NFPA 70E labels installed stating the results of the Arc Flash analysis specified in Section 26 05 73.

3. Electrical distribution equipment and utilization equipment shall be provided with field labels to identify the power source and the load as specified. Refer to NEC Article 110.22 for Identification of Disconnecting Means installation criteria. Specific information is required such as the equipment tag number and equipment description of both the power source and the load equipment.

D. SAFETY DISCONNECT SWITCHES: Section 26 09 16.

E. MOTOR CONNECTIONS: Verify that the motors are purchased with the correct size motor termination boxes for the circuit content specified in the conduit and cable schedules or submit custom fabrication drawing indicating proposed motor

termination box material, size, gasket, termination kit, grounding terminal, boot type insulated motor lead connection (T&B type MSC, or approved equal), and motor terminal box connection/support system. Verify the motor termination box location prior to raceway rough-in.

F. CONDUCTOR INSTALLATION: An enclosure containing disconnecting means, overcurrent devices, or electrical equipment shall not be used as a wireway or raceway for conductors not terminating within the enclosure. Provide wireways, raceways, termination boxes, or junction boxes external to the enclosure for the other conductors.

3.2 TESTING

A. GENERAL: Prior to energizing the electrical circuits, insulation resistance measurements tests shall be performed using a 1000-volt megohmmeter to verify the conductor is acceptable for use on the project. The test measurements shall be recorded on the specified forms and provided in accordance with Section 26 05 00.

B. INSULATION RESISTANCE MEASUREMENTS:

1. GENERAL:

a. Insulation resistance measurements shall be made on conductors and energized parts of electrical equipment (600V or less). Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, NEMA or ANSI standards for the equipment or material being tested, unless otherwise specified. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

b. Insulation resistance measurements shall be recorded. Insulation with resistance of less than 10 megohms is not acceptable.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for all circuits' rated 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Solid state equipment shall be disconnected, unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.

3. MOTOR TESTS: An Installed Motor Test Form shall be completed for each motor after installation. Motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.

C. PRE-FUNCTIONAL TEST CHECKOUT: Functional testing shall be performed in accordance with the requirements of Section 26 08 00. Prior to functional testing, all protective devices shall be adjusted and made operative.

1. Submit a description of the proposed functional test procedures prior to the performance of functional checkout.

2. Prior to energization of equipment, perform a functional checkout of the control circuit. Checkout:

   a. Energizing each control circuit.
   b. Operating each control device, alarm device, or monitoring device.
   c. Operate each interlock to verify that the specified action occurs.

D. Verify motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation or momentary energization.

END OF SECTION

SECTION 26 05 05 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.1 DESCRIPTION

A. Verify with the owner all items to be salvaged. All items that are not directed in the field (or by other means) to be salvaged or turned over to the owner shall be considered scrap. Carefully inspect the entire site and verify all items to be removed, to remain, or to be relocated.

B. Demolition work shall be the responsibility of each trade's contractor. Notify the architect at least two days prior to commencing work in a particular area.

C. Coordinate and schedule all work in a careful manner with all necessary consideration for the owner, other contractors and the public, avoiding interference with the use of, and passage to and from, adjacent areas and facilities designated to remain in use during demolition.

D. Maintain all existing circuits to items that remain in use. Reroute and rework all conduits, wiring, etc. as required.

1.2 DEMOLITION

A. Demolish and remove equipment foundation and supports, conduits, wire, and all other existing items designated for removal as indicated on the drawings and in these specifications. Do not use equipment or methods that will cause damage to adjacent construction designated to remain.

B. Existing outlets which are to be removed and have conduits rising from the floor slab shall have the conduits cut below floor level. Abandon or rework as required to provide feedthrough service to other remaining outlets. Pull new wire between remaining outlets affected by feed-through. Patch floor as required to restore to original condition.

C. Abandoned outlet boxes shall be closed with blank cover plates. If equipped with devices, the devices shall be removed and the conductors removed to the adjacent outlet or reconnected as required to provide feed-through service.

D. Disconnect and remove existing conduit and wiring feeding removed lights back to source or to fixtures to remain in use. Disconnect all devices in or on walls to be removed. All existing wiring systems which are disconnected and designated for removal shall be completely removed back to source.

E. Pull conductors from abandoned concealed raceway systems. Any section of raceway system exposed due to remodeling shall be cut flush at exposing surface. Concealed raceways need not be removed except where they interfere with remodeling.

F. Disconnect all electrical connections to equipment designated to be removed by other trades.

G. The drawings indicate the general concept of the demolition to be performed, and are not intended to be totally inclusive. The contractor is responsible to visit the site and fully inform himself of all demolition requirements.

1.3 RELOCATION

A. All existing outlets, equipment and associated wiring and conduit system(s) which interfere with the work of the electrical, general, structural, plumbing, fire protection, or HVAC contractors shall be reworked as required to maintain system operation and facilitate the scheduled work.

B. All electrical equipment devices, and lighting fixtures that are to be relocated shall be carefully removed, stored, installed in new location and reconnected, relamped and cleaned.

END OF SECTION

SECTION 26 05 19 – LOW VOLTAGE CONDUCTORS, WIRES AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Quality Assurance.
3. Definitions.
4. Submittals.
5. Products.
6. Execution - General

1.2 SCOPE

A. This section specifies cables, conductors and fibers including:

B. Stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

C. Copper cables and coax cable rated 300 volt insulation used for data, communication, and signaling.

D. Fiber optic data cable used for data communication.

1.3 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-95-658/ NEMA WC70	Non-shielded 0-2kV Cables
NFPA 70	National Electric Code (NEC)
IEEE 383	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables
ANSI X3.166	Information Systems--Fiber Data Distributed Interface (FDDI)--Token Ring Physical Layer Medium Dependent (PMD)
EIA RS232D	Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange
EIA RS422	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
EIA RS485	Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
IEEE 802	IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture
IEEE 802.3	Information Processing Systems--Local and Metropolitan Area Networks--Part 3: Carrier Sense Multiple Access with Collision
IEEE 802.3k	Supplement to ISO/IEC 8802-3, Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer
IEEE 802.4	Information Processing Systems--Local Area Networks--Part 4: Token-Passing Bus Access Method and Physical Layer
ANSI/NFPA 72	Installation, Maintenance, and Use of Protective Signaling Systems
ANSI/NFPA 72H	Testing Procedures for Signaling Systems

B. DEFINITIONS

1. LOW LEVEL ANALOG: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.

2. DATA OR DIGITAL CODE: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized, such as EIA RS422.

3. PULSE FREQUENCY: Counting pulses such as those emitted from speed transmitters.

4. HIGH LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mA transmission.

5. MODULATED SIGNALS: Signals emanating from modems or low level audio signals. Normal signal level is plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.

6. DISCRETE EVENTS: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.

7. LOW VOLTAGE CONTROL: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

8. HIGH LEVEL AUDIO SIGNALS: Audio signals exceeding plus 4 dBm, including loudspeaker circuits.

9. RADIO FREQUENCY SIGNALS: Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

2. Catalog cuts showing information of the conductors and cables to be sup- plied under this section.

3. Field test reports showing conductor and cable insulation resistance test results.

4. Provide engineering pull calculations for all 600V main feeders run underground outside building footprints.

PART 2 PRODUCTS

2.1 GENERAL

A. UNSCHEDULED CONDUCTORS AND CABLES:

1. With the exception of lighting and receptacle circuits, the type, size and number of conductors shall be as specified on the drawings or schedules. 120V panel circuit conductors mentioned above that are unscheduled and shall be sized by the Contractor in accordance with the breakers specified and the NEC to limit voltage drop to 3 percent. Minimum size of power, lighting, and receptacle circuits shall be 12 AWG. Number and types of communication, paging, and security cables shall be as required for the particular equipment provided. Power, lighting, and receptacle circuit conductors shall be provided in accordance with CABLESPEC "XHHW," unless otherwise specified.

2. Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified herein. Unscheduled conductors shall be sized by the Contractor in accordance with NEC tables and to limit voltage drop to 3 percent.

3. Unscheduled conductors with insulation shall be provided in accordance with the CABLE SPECIFICATIONS in TABLE 2 according to the purpose.

B. CABLE SPECIFICATION SHEETS (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets.

2.2 COLOR CODING

A. POWER AND CONTROL CABLES:

1. Wire coloring shall conform to the color code shown in the table below.

2. Insulation on phase conductors run in conduits sizes #10 AWG and smaller shall be colored, #8 AWG and larger may have black insulation with plastic tape of the appropriate color from the table below.

3. Insulation on the grounded conductor (neutral) sizes #8 AWG and smaller shall be colored, #6 AWG and larger may have black insulation with plastic tape of white or gray in accordance with the table below.

Description	120/208V	277/480V	Control
Phase A (Left)	Black	Brown	--
Phase B (Center)	Red	Orange	--
Phase C (Right)	Blue	Yellow	--
Neutral	White	Gray	White
Ground	Green	Green	Green
120 VAC Control	--	--	Red
120 VAC Control Neutral	--	--	White
DC Control (+)	--	--	Blue
DC Control (-)	--	--	White/Blue Stripe
Signal (+)	--	--	Red
External Source	--	--	Yellow
Computer/Signal Ground	--	--	Green/yellow stripe

4. All control wiring in control panels or other enclosures that is powered from an external source and is not disconnected by the control panel disconnect shall be terminated at a disconnecting terminal block upon entering the enclosure. The color of the wire shall then be changed to yellow to identify it as being powered from an external source. Provide identification nameplate on exterior of enclosure to indicate sources of external power.

5. All wiring in industrial machines and equipment shall be in accordance with NFPA 79. Notify owner of any deficiencies noted during installation.

6. Multi-conductor power cable colors shall be manufacturer's standard.

7. Cables sized No. 6 AWG and larger may be black with colored 3/4-inch vinyl plastic tape applied in 3-inch lengths around the cable at each end. The cables shall be tagged at terminations and in pull boxes, hand holes and manholes.

B. SIGNAL AND DATA CABLES: Unless otherwise specified, cables shall be color coded black and white for pairs or black, red, and white for triads.

2.3 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. SINGLE CONDUCTOR: Single conductor cable shall be stranded copper and shall be used in conduits for power and control circuits. Single conductor cable shall be provided in accordance with CABLESPEC "XHHW" type of conductors unless otherwise specified.

B. MULTI-CONDUCTOR CABLE: Provide multi-conductor power cable and multi-conductor control cable where identified on the drawings. Multi-conductor cables shall be in accordance with CABLESPEC "TC" type cables.

2.4 SIGNAL, DATA AND INSTRUMENTATION CABLES

A. GENERAL:

1. Signal cable shall be provided for instrument signal transmission, alarm, communication, and other circuits as specified. Circuit shielding shall be provided in addition to cable shielding.

2. Single circuit signal cable shall be provided in accordance with CABLESPEC "INS," unless otherwise specified for hazardous locations type "SP-OS" (ITC/PLTC). Multi-circuit signal cable shall be provided in accordance with CABLESPEC "INS/M," unless otherwise specified for hazardous locations type "SP-OS" (ITC/PLTC).

3. Terminal blocks shall be provided at cable junction for running signal leads and shield drain wires. Each conductor shall be identified at such junctions.

   a. Shields shall not be used as a ground path.

   b. Shields shall be grounded at one end only. Refer to I drawings for grounding location.

   c. Signal, data, and communication cables shall be terminated and spliced on terminal strips properly mounted and labeled in accordance with this Section and Section 26 05 00. No exceptions.

4. CABLE SPECIFICATION SHEETS (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in Section 26 05 19-3.07.

B. FIBER OPTIC CABLE: Fiber optic cable shall be Multi Mode as shown on the drawings and as specified in the CABLESPEC descriptions.

C. COMMUNICATION, PAGING, AND SECURITY SYSTEM CABLES: Voice communication, paging, and security system cables shall be specified in their respective specification sections.

2.5 WIRE MARKERS

A. 600 VOLT AND 300 VOLT RATED CONDUCTORS:

1. Per 26 05 00 section 2.02.

B. FIBER OPTIC:

1. Provide Markers for labeling each end of a fiber optic cable. Fiber optic markers must have space for typed or machine printed text.

2. Provide Markers for Individual fiber optic strands, jumpers, and patch cables. Fiber optic markers must have space for typed or machine printed text. Fiber optic markers shall be attached to the fiber using tie wrap or other approved method of securing the marker Listed.

2.6 SPLICING AND TERMINATING MATERIALS

A. 600-VOLT AND 300-VOLT RATED CONDUCTORS:

1. Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-spade terminals. Connectors for wire sizes No. 8 AWG and larger shall be one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable.

2. In-line splices and taps shall not be used. All circuits shall be continuous though all junction boxes, wireways, pull boxes, etc. until the circuit conductors are terminated at suitable terminal strips within motor control centers, PLC cabinets and panels, distribution panels, local control stations, etc.

3. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors. Connections shall be insulated with Thomas and Betts (T&B), MSC series Motor Stub Splice Insulators and sealed with the appropriate tape for the motor voltage. (Example 480V = Scotch 33)

2.7 CORD GRIPS

A. Cord grips shall be provided where specified on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless-steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

2.8 VFD WIRING

A. Shielded power cables (TYPE VFD2/3) shall be used for load-side wire between the VFDs and the motors.

PART 3 EXECUTION

3.1 GENERAL

A. Conductors shall be identified at each connection terminal and at splice points. The identification marking system shall comply with Section 26 05 00.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacture recommended and UL Listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

C. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

D. Provide tin-plated bus bar. Scratch-brush the contact areas and tin plate the connection where flat bus bar connections are made with un-plated bar. Bolts shall be torqued to the bus manufacturer's recommendations.

3.2 600-VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing is not necessary in plastic panel wiring duct or wall mounted steel raceway used above countertops. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

B. Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

C. Slack shall be provided in junction and pull boxes, hand holes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure. Provide dedicated electrical wireways and insulated cable holders mounted on unistrut in manholes and hand holes.

D. Raceway fill limitations shall be as defined by NEC and the following:

1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power and control conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.

2. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems. Install in separate raceways.

3. Splices and terminations are subject to inspection by the Owner prior to and after insulating.

4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.

5. In-line splices and tees, where approved by the Owner, shall be made with tubular compression connectors and insulated as specified for motor terminations. Splices and tees in underground hand holes or pull boxes shall be insulated using Scotch-cast epoxy resin or Raychem splicing kits.

6. Terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating forked compression connectors and terminal strips within a termination/junction box.

7. Terminations at valve and gate motor actuators shall be made directly into the actuator where possible. Power termination shall be made in the actuator power disconnect. Control and signal cable may be routed to a termination box near the actuator on 20-ampere rated terminal strips with label identification for the control and signal conductors. Single wire control conductors and analog cable (INS or INS/M) then installed in flexible conduit to the actuator control and signal termination compartments.

8. Solid wire shall not be used.

9. Sharing neutrals for power circuits is unacceptable.

10. Conductor and cable markers shall be provided at splice points.

3.3 SIGNAL CABLE

A. Circuits shall be run as individually shielded twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required. Terminal blocks shall be provided at instrument cable junctions, and circuits shall be identified at such junctions unless otherwise specified. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Shields shall not be used as a signal conductor.

C. Common ground return conductors for two or more circuits are not acceptable.

D. Unless otherwise specified, shields shall be bonded to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

E. Cable for communication systems shall be installed and terminated in compliance with the equipment manufacturer's recommendations and applicable NEC requirements.

F. Cable for data circuits and operating at greater than 10 kHz, shall be run continuously from node to node without splices or intermediate terminal blocks unless otherwise specifically specified or shown.

G. Cable for low-level instrumentation circuits shall be run continuously between final terminations without splices or intermediate terminal blocks unless otherwise specifically shown or specified.

H. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes. Shield drain wires for spare circuits shall not be grounded at either end of the cable run.

I. Terminal boxes shall be provided at instrument cable splices. If cable is buried or in raceway below grade at splice, an instrument stand shall be provided as specified with terminal box mounted approximately 3 feet above grade.

3.4 INSTALLATION

A. Raceway fill shall be as scheduled, and shall not exceed NEC limitations.

B. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:

1. Where specifically indicated on the drawings.

2. Where field conditions dictate and written permission is obtained from the Owner.

3. Control circuits shall be isolated from the feeder and branch power and instrumentation circuits but combining of control circuits with power is permitted as noted below.

a. The combinations shall comply with the following:

1) 12 VDC, 24 VDC and 48 VDC may be combined.
2) 125 VDC shall be isolated from all other AC and DC circuits.
3) All AC circuits shall be isolated from all DC circuits.

4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.

    a. The combinations shall comply to the following:

        1) Analog signal circuits may be combined.
        2) Digital circuits may be combined but isolated from analog signal circuits.

5. Multiple branch circuits for lighting, receptacle and other 120 VAC circuits are allowed to be combined into a common raceway.

    a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NEC, including but not limited to:

        1) Up sizing conductor size for required Ampacity de-ratings for the number of current carrying conductors in the raceway.

        2) The neutral conductors may not be shared.

        3) Up sizing raceway size for the size and quantity of conductors.

C. Pulling wire and cable into conduit or cable trays shall be completed without damaging or putting undue stress on the cable insulation. Only UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed.

D. Whenever a cable leaves a raceway, a cable support shall be provided. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct. Conductors crossing hinges shall be bundled into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

E. Slack shall be provided in junction and pull boxes, hand holes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box. Amount of slack shall be equal to largest dimension of the box. Where plastic panel wiring duct is provided for wire runs, lacing is not required. Plastic panel wiring duct shall not be used in manholes and hand holes.

F. Do not exceed cable manufacturer's maximum recommended pulling tension. Use dynamometer or break-away swivel on pulls exceeding 150 feet.

G. Observe manufacturer's minimum recommended pulling and training radii.

H. Where data cables are installed in cable trays, provide barriers in the tray to separate data cables from power and/or control cables.

I. At each end of the run leave sufficient cable for termination. Coil sufficient cable in each manhole, handhold, or pull box to permit future splice.

J. In-line splices and tees are not allowed.

K. Splices shall not be permitted in any coaxial, twin-axial, or data cable runs.

L. Ground cable shields at one end only. Unless otherwise specified, ground the shields at the panel end.

M. Protect all cables against moisture during and after installation.

N. Install and ground token passing bus cable in accordance with IEEE 802.4. Attach trunk cable to walls and ceilings with PVC clamps with clamp backs at 4- foot intervals.

O. Install and ground Ethernet cable in accordance with IEEE 802.3. Attach trunk cable to walls and ceilings with PVC clamps with clamp backs at 4-foot intervals.

P. Signal and control cable suspended into the wet well shall be provided with heavy duty wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Strain relief system shall be suitably anchored.

Q. Circuits provided under this Section shall not be direct buried.

3.5 NOT USED

3.6 TERMINATIONS

A. Terminations shall be on terminators as identified in Section 26 05 00.

B. Each conductor shall be identified with a wire marker at each terminal to which it is connected. The marking system shall comply with Section 26 05 00.

C. Stranded conductors shall be terminated as described in Section 26 05 19, except where terminals will not accept such terminations. Compression lugs and connectors shall be installed using manufacturer's recommended tools. Where terminal blocks will not accept lugged conductors, the conductors shall be tinned using 60 percent tin, 40 percent lead alloy non-corrosive resin core solder before insertion into pressure terminals.

D. Electrical spring connectors (wire nuts) shall not be used for any purpose on any cable specified under this Section except for receptacle and lighting circuits. Lugs and connectors shall be installed with a compression tool.

E. All splices and terminations are subject to inspection by the Owner prior to and after insulating.

F. Terminations at solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self-insulating forked compression connectors and terminal strips within a termination/junction box.

G. Provide tool-crimp N connectors at coaxial cable terminations except trunk runs.

H. Provide tool-crimp TRN connectors at twin-axial cable terminations.

I. Conductor and cable markers shall be provided at splice points.

J. Fiber Optic Connectors: Active and spare fiber optic cables fibers shall be provided with a breakout kit, and terminated with ST type terminations. ST connectors shall feature:

1. Bayonet Style latch
2. Keyed insertion
3. Spring loading for positive contact

3.7 TESTING

A. GENERAL:

1. The Contractor shall test conductors and cable in accordance with Section 26 08 00. Instrument and Data Cables shall be subjected to additional tests as specified in this section.

B. INSTRUMENT CABLE:

1. Each signal pair or triad shall be tested for electrical continuity. Any pair or triad exhibiting a loop resistance of less than or equal to 50 ohms shall be deemed satisfactory without further test. For pairs with greater than 50 ohm loop resistance, the Contractor shall calculate the expected loop resistance considering loop length and intrinsic safety barriers if present. Loop resistance shall not exceed the calculated value by more than 5 percent.

2. Each shield drain conductor shall be tested for continuity. Shield drain conductor resistance shall not exceed the loop resistance of the pair or triad.

3. Each conductor (signal and shield drain) shall be tested for insulation resistance with all other conductors in the cable grounded.

4. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500 volt megohmmeter shall be used for insulation resistance measurements.

C. FIBER OPTIC DATA CABLE:

1. Test all data cables, including fiber-optic, with time-domain reflectometer prior to installation.

2. Test all data cables, including fiber-optic, with time-domain reflectometer and transmission impairment analyzer after installation.

3. Test fiber-optic system PMD to FDDI requirements for the following:

4. Transmit power levels

5. AC extinction ratio

6. Optical wave shape

7. Duty cycle distortion

8. Data dependent jitter

9. Random jitter

10. Transmit frequency

11. Minimum optical input

12. Receiver jitter tolerance

D. FIBER OPTIC TESTING: The Owner shall be notified a minimum of 5 days prior to tests and reserve the right to witness field tests.

E. TEST EQUIPMENT:

1. Test equipment shall be traceable to NIST standards. Use the following to perform the pre-installation and post-installation cable tests:

2. Optical time domain reflectometer (OTDR) shall be laser precision, ALT, Inc. Model 5200 LRFL or approved equal.

F. PRE-INSTALLATION TESTS:

1. Perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes. Perform tests on all reels of cable. Cable shall not be installed until the Owner has reviewed the test report.

2. Verify continuity and attenuation or loss for each fiber on each reel and document results of physical inspections to identify any cable and reel damage conditions, and any deviations from the manufacturer's specifications.

3. Notify the Owner 5 days prior to tests. Document test results and submit the report to the Owner for review. Documentation shall consist of both hard copy and electronic disk complete with application software.

G. POST-INSTALLATION TESTS:

1. OTDR: Conduct the following tests on each cable segment with an OTDR each optical fiber in the fiber cable. Tests shall be conducted at both 1310 and 1550 nm. No splice loss shall have a loss of 0.15 dB or greater with fiber attenuation measured in dB/km.

2. Excess Fiber Coefficient (EFC) Test shall be made as part of the cable testing. The following procedure shall be performed from both ends on each fiber provided.

   a. Prior to stripping the cable for splicing, record the meter marks to determine the physical cable length.

   b. Record the fiber Index of Refraction (IOR) from the cable data submitted by the Manufacturer.

   c. With the OTDR, set to the proper IOR and record the OTDR fiber length.

   d. Calculate the excess fiber coefficient (EFC) according to the following formula: EFC = OTDR length/Sheath length.

H. OLTS FIBER ATTENUATION:

1. Measure the attenuation of each optical fiber in both directions using an Optical Loss Test Set (OLTS) at both 1310 nm and 1550 nm. Test shall be conducted per TIA/EIA 526-7. Provide a reference power level measured with a patch cord and connectors of the same types used on the fiber cable. Measure and record the reference power level of the Laser Light Source. Measure and record the received power level of each optical. Repeat the same measurements in the other direction.

2. The measured insertion loss shall be no greater than the loss calculated in the formula below:

   $$IL = 2(Ls) + 2(Lc) + (La)(Length) + 0.5$$

   where:

   IL = Insertion Loss

Ls	=	Splice losses at the pigtails (maximum 0.15 dB)
Lc	=	Connector face loss (maximum 0.6 dB)
La	=	Manufacturer's cable attenuation (dB/km)
Length	=	Fiber length (km)

I. CABLE ACCEPTANCE:

1. Pigtail splices shall have a loss no greater than 0.15 dB, as determined by either a Profile Alignment System (PAS) or Light Injection (LID) splice loss estimate, at the time the splice is made. Splices with an optical loss of greater than 0.15 dB shall be redone.

2. OTDR traces at both 1310 nm and 1550 nm wavelengths display no unexplained losses, reflectance events, or other discontinuities.

3. The insertion losses measured at both 1310 nm and 1550 nm wavelengths and in both directions do not exceed the maximum allowed values. After cable tests, the cable installation shall be subject to a physical inspection to verify the remaining fiber optic specification requirements have been met. If any test requirements are not met, or in the event of fiber test failure of one or more fibers, splice or replace cable as necessary until tests pass.

J. FIBER OPTIC SYSTEM ACCEPTANCE:

1. Perform the inspection and establish a punch-list of the following:

   a. Fiber splices: neatly organized.
   b. Connectors: capped and undamaged.
   c. Cabling: organized with no excessive bending.
   d. Specified coiled cable present in the splice cabinet.
   e. Cable entrances to the cabinets secured.
   f. Unused cable delivered to the Owner.

2. Identify cables with the directories installed in each fiber cabinet. Discrepancies found during the inspection of the fiber system installation shall be listed and provided on the punch-list. Inform the Owner upon resolution and completion of the punch-list items

3.8 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. GENERAL: Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC SHEETS.

B. CABLESPEC SHEETS: The following CABLESPEC sheets are included in this section:

CABLESPEC	Volts	Product	Purpose
TC	600	Multi-conductor armored power and control cable	Power and control conductors for use in cable trays and hazardous areas.
XHHW	600	Single conductor cross-linked polyethylene power and control cable	Power and control conductors for use in conduit raceways.
VFD2	600	Shielded motor cable for VFD drives for large HP motors	Feeding motors fed from VFD drive for use in Conduit raceways and Cable Tray.
VFD3	600	Shielded motor cable for VFD drives	Feeding motors fed from VFD drive for use in Conduit raceways and Cable Tray.
CORD	600	Rubber Jacketed multi-conductor cable.	Temporary power cable.
INS	600	Single Pair/Triad #18 ST plus overall shield,	Instrumentation
INS/M	600	Multiple Pair/Triad #18STP plus overall shield,	Instrumentation
NC2	300	Category 6 Ethernet cable, 4 pairs, non-armored	Gigabit Ethernet cable
NC3	300	Category 6 Ethernet cable, 4 pairs, Shielded	Gigabit Ethernet cable
FOT-MM	--	Fiber optic cable – multi-mode	Data Network
IT	300	350 MHz Enhanced Cat 6	Gigabit Ethernet, LAN cable.

Cable System Identification:	TC
Description:	Multiconductor Power Cable and Multiconductor Control Cable:14 AWG and larger stranded conductors; Cable tray rated.
Power Cable:	Insulated green grounding conductor sized per the NEC.
Ground Conductor Size:	Multiple sets of multiconductor power cable: Oversize the grounding conductor per NEC 250.
Control Cable Type:	ICEA Method 1, E-2, without white neutral conductor or green ground conductor
Control Cable Identification:	Conductors color coded per ICEA and conductors numbered
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8, coated per ASTM B33
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, cross-linked polyethylene in accordance with NEMA WC7, UL 44 and ICEA S-66-524.
Jacket:	Cross-linked Polyethylene (XLP)
Flame Resistance:	IEEE 383
Manufacturer(s):	Okonite, Southwire, General Cable, or approved equal.
Execution:	
Installation:	Install in accordance with this Section.
Testing:	Test in accordance with accordance with this Section and Sections 26 05 00 and 26 08 00.

Cable System Identification	XHHW
Description:	Single conductor Cross-linked polyethylene power and control cable for sizes No. 14 AWG and larger.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, cross-linked polyethylene in accordance with ICEA S-95-658/NEMA WC70.
Jacket:	None.
Flame Resistance:	N/A
Manufacturer(s):	Okonite, X-Olene; Durasheath XLP; or approved equal
Uses Permitted:	Power, control, lighting, receptacle and appliance circuits
Execution:	
Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with this Section and Sections 26 05 00 and 26 08 00.

Cable System Identification:	VFD2
Description:	Shielded motor cable for VFD drives.
Voltage:	600V
Conductor Material:	Finely stranded tinned copper Class 5 stranded: 16-8 awg, and Class K stranded: 2, 4 & 6 awg.
Insulation:	90 degree C dry or wet, cross-linked polyethylene XPLE in accordance with NEMA.
Assembly:	Individual conductors cabled together with barrier tape, 100% shielding with foil tape and tinned copper braid (85% coverage) inside specially formulated PVC black jacket.
Jacket:	PVC black jacket UL listed to -25 deg F, UL TC-ER listed.
	Minimum bend radius of 7.5x overall cable diameter.
Flame Resistance:	IEEE 383
Manufacturer(s):	Olflex VFD XL, or approved equal.
Uses Permitted:	Cable tray, conduit, exposed in normal or Class 1, Div 2 per NEC 336, 392 and 501 environment.
Execution:	
Installation:	Install in accordance with this Section.
	Provide cable seals where required by NEC 501.
Testing:	Test in accordance with this Section and Sections 26 05 00 and 26 08 00.

Cable System Identification:	VFD3
Description:	Large HP shielded motor cable for VFD drives.
Voltage:	600V
Conductor Material:	Class B finely stranded tinned copper 1 awg through 500 kcmil.
Insulation:	90 degree C dry or wet, cross-linked polyethylene XPLE in accordance with NEMA.
Assembly:	ndividual conductors cabled together with barrier tape, longitudinal copper tape inside specially formulated PVC black jacket.
Jacket:	PVC black jacket UL listed to -20 deg F, UL TC-ER listed. Minimum bend radius of 15x overall cable diameter. UL 1277, UL 44 listed.
Flame Resistance:	IEEE 383
Manufacturer(s):	Olflex VFD Symmetrical, or approved equal.
Uses Permitted:	Cable tray, conduit, exposed in normal or Class 1, Div 2 environment.
Execution:	
Installation:	Install in accordance with this Section. Provide cable seals where required by NEC 501.
Testing:	Test in accordance with this Section and Sections 26 05 00 and 26 08 00.

Cable System Identification:	CORD
Description:	Portable Cord, 3-conductor with ground, extra hard usage, oil, weather and water resistant. 10 AWG and smaller, UL listed, type SOOW; larger than 10 AWG, UL listed type G
Voltage:	600 volts
Conductor Material:	Type G - Flexible rope lay stranded per ASTM B189 and B33. Type SOOW – Soft bare annealed copper per ASTM B-3, flexible bunch strand per ASTM B-174.
Insulation:	Insulation shall be ethylene propylene (EPR) as per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
Jacket:	Black chlorinated polyethylene (CPE) rubber ICEA S-98-658.
Manufacturer(s):	Type SOOW - Houston Wire HW250, Southwire Viper, or approved equal Type G – Houston Wire HW258, Southwire Type G, or approved equal
Execution:	
Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with Sections 26 05 19 and 26 08 00.
Sizing Cables:	Cables shall be sized for loads to be served.

Cable System Identification:	INS
Description:	Single twisted, shielded pair or triad, 18 AWG, instrumentation cable, rated for wet and dry locations.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with B8
Insulation:	PVC/Nylon
Shield:	100 percent, 1.35 mil aluminum-Polyester tape with 20 AWG 7-strand tinned copper drain wire
Jacket:	48 mil flame-resistance polyvinylchloride
Flame Resistance:	UL 1685, ICEA T-29-520 and IEEE 1202.
Manufacturer(s):	Single Pair: BELDEN 1120A, or approved equal. Single Triad: BELDEN 1121A, or approved equal.
Execution:	
Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with this Section and Sections 26 05 00 and 26 08 00.

Cable System Identification:	INS/M
Description:	Multiple twisted, shielded pairs or triads, instrumentation cable, rated for wet and dry locations.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Lay:	Length 2.5 inches
Insulation:	PVC/Nylon
Shield:	100 percent, 1.35 mil aluminum-Polyester tape with 18 AWG 7-strand tinned copper drain wire
Jacket:	48 mil or 68 mil or 84 mil flame-resistance polyvinylchloride
Flame Resistance:	UL 1685and IEEE 1202.
Manufacturer(s):	2 pair: BELDEN 1048A, or approved equal. 4 pair: BELDEN 1049A, or approved equal. 12 pair: BELDEN 1051A, or approved equal 4 triad: BELDEN 1093A, or approved equal. 12 triad: BELDEN 1095A, or approved equal.
Execution:	
Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with this Section and Sections 26 05 00 and 26 08 00.

Cable System Identification:	NC2
Description:	Paired – DataTwist Enhanced Category 6e, gigabit Ethernet, 100BaseTX, 4 pair cable, non-armored
Voltage:	300V rms
Conductor Material:	Tinned copper 24 AWG
Insulation Material:	Polyolefin (PO)
Shield:	Unshielded
Jacket:	Polyvinyl chloride (PVC), 0.220-inch diameter
Flame Resistance:	UL 1685
Electrical Characteristics:	350 MHz, 53.2 dB/100 meters Manufacturer(s): Belden, Okonite, or approved equal.
Uses Permitted:	Conduit. Execution:
Application:	Data Network Communications – Ethernet.
Installation:	Install in accordance with this Section and associated equipment manufacturer's instruction.
Testing:	Test in accordance with this Section.

Cable System Identification:	NC3
Description:	Category 6e, gigabit Ethernet, 4 pair cable, shielded
Voltage:	300V rms
Conductor Material:	Solid bare copper 24 AWG
Insulation Material:	Polyolefin (PO)
Shield:	Shielded, overall Beldfoil 100 percent coverage with stranded drain wire
Jacket:	Polyvinyl chloride (PVC), 0.260-inch diameter
Flame Resistance:	UL 1666 riser
Electrical Characteristics:	100 MHz, 22.0 dB/100 meters Manufacturer(s): Belden, Okonite, or approved equal
Uses Permitted:	Conduit. Execution:
Application:	Data Network Communications – Shielded Ethernet.
Installation:	Install in accordance with this Section and associated equipment manufacturer's instruction.
Testing:	Test in accordance with this Section.

Cable Identification:	FOT-MM
Description:	Multimode fiber-optic cable; Tight-buffer, Dual Layer, with 6-strand or 12-strand fibers as shown on drawings: Outdoor/Indoor; Riser Rated; Cable Tray Rated Loose tube construction. Optical fibers shall not adhere to the inside of the buffer tube. Fibers and buffer tubes shall be color coded with distinct and recognizable colors in accordance with EIA/TIA-598.
Jacket:	Jacket: PVC extruded under high pressure directly over the cable core such as to produce cusped ridges that interlock with the subcables Color: Black Mark the exterior sheathing with the manufacturer's name, month and year of manufacture, and sequential meter or foot markings for easily determining the length of the cable at all points along the cable run.
Type:	OFNR with industrial cable tray rating and IEEE 383 Chapter 8 flame test rated Fiber Type: Multimode Clad Diameter: 125 ± 0.7 µm Coating Diameter: 245 ± 5 µm Core Diameter: 62.5 µm Attenuation: ≤ 0.35 db/km @ 1310 nm ≤ 0.25 db/km @ 1550 nm Operating Temperature Range: -50 to +75 Deg C Maximum Tensile Loading: 670/270 lbs (Installation/Operating) Minimum Cable Bending Radius: 5.7”/3.8” (Installation/Operating)

Manufacturers:	Optical Cable Corporation BX-series or approved equal

Fiber Optic cable shall be suitable for installation in conduit runs within buildings.

Fiber Optic cable shall be suitable for installation between buildings in outdoor conduit runs which share vaults with 600 volt cable.

The contractor shall use zip cord jumper cables between patch/breakout panels and communications equipment.

Fiber shall be terminated with ST style connectors unless otherwise shown on drawings or required by the submitted equipment manufacturer.

Fiber Optic cables shall have number of fibers as shown in the documents.

The cable that connects PLC to the Fiber Optic interface shall be Belden 9841 or approved equal.

Execution:

Application:	Data communication.
Installation:	Install in accordance with this Section and associated equipment manufacturer's instruction.
Testing:	Test in accordance with this Section.

Cable System Identification:	IT
Description:	DataTwist Enhanced Category 6e, gigabit Ethernet, 100BaseTX, 4 pair cable, non-armored
Voltage:	300V rms
Conductor Material:	Bare copper 23 AWG solid.
Insulation Material:	Fluorinated Ethylene Propylene (FEP)
Shield:	Unshielded
Jacket:	Fluorinated Ethylene Propylene (FEP), 0.214-inch diameter
Flame Resistance:	UL 723, NFPA 262
Electrical Characteristics:	250 MHz, 32.8 dB/100 meters Manufacturer(s): Belden 7931A, or approved equal.
Uses Permitted:	Conduit. Tray, Execution:
Application:	Data Network Communications – Ethernet.
Installation:	Install in accordance with this Section and associated equipment manufacturer's instruction.
Testing:	Test in accordance with this Section.

END OF SECTION

SECTION 26 05 26 – GROUNDING SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. System Requirements.
3. Sizing.
4. Quality Assurance.
5. Submittals.
6. Products
7. Installation.

1.2 SCOPE

A. This section specifies the system for grounding electrical distribution and utilization equipment, including but not limited to cabinets, motor frames, manholes, instrumentation, metal surfaces of process/mechanical equipment that contain energized electrical components, metal structures and buildings, outdoor metal enclosures, fences and gates.

1.3 SYSTEM REQUIREMENTS

A. Provide equipment grounding conductors in all electrical raceways. The conductors shall be sized in accordance with the National Electrical Code.

B. Underground, rebar, and building steel ground connections shall be via exothermic weld or hydraulically die crimped cold weld.

C. Bond building's rebar and building steel attributes to form a ground mat. Bond all site ground mats via exothermic weld or hydraulically die crimped cold weld.

D. Provide cable tray grounding and bonding in accordance with these project specifications and the drawings.

1.4 SIZING

A. SIZING: The minimum size of the Equipment Grounding Conductors installed with the circuit conductors shall be per the National Electrical Code Table 250.122. The circuit grounding conductor size routed with a feeder or branch circuit conductors is as shown on the drawings.

1.5 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE Std 81.2-1991	Guide to Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
NETA - ATS	Inter-National Electrical Testing Association Inc. - Acceptance Testing Specifications
NFPA 70	National Electric Code (NEC) Article 250

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

2. Marked product literature for ground rods, test wells, and equipment ground plate.

3. Grounding system test data.

PART 2 PRODUCTS

2.1 PROCESS EQUIPMENT GROUNDS

A. The contractor shall coordinate with the equipment supplier to provide an equipment ground lug and contractor provided ground cable and terminations to bond the equipment to the grounding electrode system. Ground cable shall be sized in accordance with this specification. Provide cables, exothermic welds, hydraulic die crimp connections and equipment bolted connections as necessary.

2.2 GROUND CONDUCTORS

A. The System Ground Conductor shall be soft-drawn, bare annealed copper, concentric stranded, as specified. The minimum sizes shall be as follows, where American Wire Gage (AWG) conductor sizes are not shown or specified:

15 kV-5 kV transformers	4/0 AWG
480V switchboards	4/0 AWG
480V MCC	4/0 AWG
ATS and MTS	2/0 AWG
Cable tray	2/0 AWG
Lighting & Power panels	2 AWG
Exposed metal cabinets	2 AWG
Electrical & Process equipment	2 AWG
Buildings and enclosure	2 AWG
Fences and gates	2 AWG
Motors 25 HP to 250 HP	2 AWG
Motors 1 HP to 25 HP	6 AWG

2.3 GROUND RODS

A. Ground rods shall be copper covered steel, 3/4-inch diameter and 10-feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

2.4 CONNECTORS

A. COMPRESSION CONNECTORS: Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or approved equal.

B. BOLTED CONNECTORS: Bolted connectors shall be Burndy, O. Z. Gedney, Thomas and Betts, or approved equal.

C. EXOTHERMIC WELDED CONNECTORS: Exothermic welding products shall be Erico's Cadweld Plus system with a remotely operated battery powered electronic ignition device and moisture resistant weld metal cup for the required mold, or approved equal.

D. COLD WELDED CONNECTORS: Hydraulically die crimped cold weld connectors shall be cast copper compression cross grid type as manufactured by Burndy, or approved equal.

2.5 TEST WELLS

A. CONCRETE BOXES:

1. Material: High density reinforced concrete box with non-settling shoulders positioned to maintain grade and facilitate back filling with steel checker plate screw down cover.

2. Product and Manufacturer: Provide box assembly from one of the following:

a. Concrete Box: Christy Concrete Products, Inc. Model #B1017 or Approved Equal.

b. Steel Cover: Christy Concrete Products, Inc. Model # B1017-51JH labeled "GROUND" or Approved Equal.

B. EXTERIOR TEST WELL: Provide concrete test well with cover and connect the ground grid extension using a removable connector.

2.6 EQUIPMENT GROUND BARS

A. Ground bars required in power distribution equipment shall be tin plated copper and sized in accordance with manufacturer's standard.

B. Copper equipment ground bars shall be Erico Eritech EGB Series or approved equal, sized as required for the installation.

C. Ground bars shown in electrical rooms or adjacent to electrical equipment shall be tin plated copper and shall be wall mounted at 18 inches above finished floor on isolation standoffs. Unless otherwise specifically sized, the ground bars shall be 30 inches long, 4 inches tall and ¼ inches thick. Bars shall have pre-drilled 7/16" holes for termination of lugged conductors. Ground bars shall be Storm Copper, Alpha Equipment Company isolated ground bar assembly, or approved equal.

2.7 EXECUTION

A. Embedded and buried ground connections shall be made by exothermic or irreversible cold weld connectors. Above grade ground connections shall be made by exothermic weld or by utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Tools and dies shall be approved for this purpose; dimple compressions are not acceptable. Compression connections shall be prepared in accordance with the manufacturer's instructions. Exposed ground connections to equipment shall be made by bolted clamps unless otherwise specified. No solder shall be used in any part of the ground circuits.

B. Embedded ground cables and fittings shall be exothermically or cold weld bonded to concrete reinforcing steel. Ground wires shall also be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement.

C. Grounding conductors, which are extended beyond concrete surfaces for equipment connection, shall be extended a sufficient length to reach the final connection point without splicing. Minimum extension shall be 3 feet. Grounding conductors, which project from a concrete surface, shall be located as close as possible to a corner of the equipment pad, protected by non-metallic conduit, or terminated in a flush grounding plate. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals or less. Grounding conductors for future equipment shall be terminated using a two-hole copper flush mounted grounding plate.

D. Ground conductors, except signal conductor shields, entering enclosures shall be bonded together to the enclosure if it is metallic and to metallic raceways within or terminating at the enclosure. Prior to making ground connections or bonds, the metal surface at the point of connection shall be cleaned.

E. Compression-type lugs shall be used in accordance with manufacturer’s recommendations.

F. Grounding conductor shall not be used as a system neutral. Grounding conductor shall not be used as a system neutral.

G. Surge arresters shall be directly connected to the ground system using copper conductors, sized as specified.

H. Metallic sheaths or shields of shielded power cable shall be terminated by a copper grounding strip provided with cable connection for connection to the grounding system. Grounding strip shall be sized to withstand available fault current for specimen to be terminated.

I. Furnish an equipment grounding conductor in all conduit runs sized in accordance with the NEC.

J. Grounding system shall be provided in compliance with the NEC.

K. Metallic sheaths or shields of shielded power cable shall be terminated by a copper grounding strip provided with cable connection for connection to the grounding system.

L. Bond building service piping systems to ground within three feet of entering the building.

2.8 RACEWAY GROUND

A. All service, feeder and branch circuit raceways shall contain a green insulated ground conductor sized per applicable NFPA 70 National Electrical Code (NEC) tables:

1. T250.66 - Grounding Electrode Conductor for Alternating-Current Systems or

2. T250.122 - Minimum Size Equipment Grounding Conductors for Grounding Raceways and Equipment.

B. Metallic conduits terminating at concentric knock-outs or reducing washers shall be bonded using insulated grounding bushings. Grounding bushings shall be connected to the grounding system using conductors sized in compliance with NEC.

C. Provide equipment grounding conductors in all power and control circuit raceways.

2.9 EQUIPMENT AND ENCLOSURE BONDING

A. Electrical distribution and utilization equipment enclosure ground bus, motor frames, manholes, metal structures and buildings, outdoor metal enclosures, fences and gates shall be bonded to the grounding system with conductor sizes as specified.

B. Connect the conductor to the metal enclosure using a UL listed connector, where the enclosure does not contain an internal ground bus

C. Non-electrical equipment with metallic enclosures that are located outdoor, and without a cover or a shade, shall be connected to the grounding system.

2.10 ISOLATED GROUNDING

A. An isolated ground system shall be installed where required by an equipment manufacturer. The isolated ground conductor shall have green insulation with a yellow stripe and shall be run in the same raceway as the power and neutral conductors. The isolated ground bus shall be kept isolated from neutral and grounding buses.

B. Where specifically directed by the Owner and required by an equipment manufacturer, the Contractor shall provide an additional isolated ground conductor from the service or separately derived system to an isolated ground bus bar at each associated distribution point.

C. The neutral conductor from the ultra-isolation transformers shall be grounded only at the single point ground bus in the automatic transfer switch.

2.11 SERVICE AND SEPARATELY DERIVED SYSTEM BONDING

A. A neutral bonding jumper shall be installed in only one location for each service or separately derived system. The bonding jumper shall be located at the service source or the first immediate distribution point downstream from the source. The neutral and ground buses shall be kept isolated from each other accept where the bonding jumper is installed.

B. GROUNDING SYSTEM TESTS

1. The Contractor shall test the facility grounding system and the building grounding system to determine the ground resistance. The grounding test shall be IEEE Standard 81 using the NETA Fall-of-Potential procedure. A plot of ground resistance readings for each isolated ground rod, ground mat, or ground bus shall be submitted on 8-1/2 x 11 inch size graph paper. Point-to-point resistance measurements are not acceptable.

2. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test or as recommended by IEEE Standard 81. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

3. A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded.

4. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm requirement. Additional ground rods will be paid for as extra work where the required numbers exceed that specified when authorized and approved by the Construction Manager.

5. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Quality Assurance.
3. Submittals.
4. Products
5. Installation & Inspection

1.2 SCOPE

A. This Section specifies requirements for design, furnishing and installation of support systems for electrical raceways, cables and enclosures.

1.3 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI C80.1 ANSI C80.3 ASTM A48 REV A ASTM F512 FEDSPEC WW-C-581E FEDSPEC W-C-1094A NEMA ICS 6 NEMA TC2	Rigid Steel Conduit-Zinc Coated Electrical Metallic Tubing-Zinc Coated Gray Iron Castings Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated Conduit and Conduit Fittings, Plastic, Rigid Industrial Control and Systems Enclosures Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA VE1	Cable Tray Systems
NEMA VE 2	Cable Tray Installation Guidelines
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70	National Electrical Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery
UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 360	Liquid Tight Flexible Electrical Conduit
UL 651	Rigid Nonmetal Electrical Conduit
UL 797	Electrical Metallic Tubing

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

2. Supports, seismic bracing, and other electrical system mounting elements are generally not shown on the plan drawings. Hangers, supports, seismic restraints, and other electrical system mounting elements shall be factory fabricated or field-fabricated according to these specifications and detail drawings provided in the Contract Documents.

PART 2 PRODUCTS

2.1 RACEWAY SUPPORTS

A. CONDUIT SUPPORTS:

1. Framing channel with end caps and straps shall be provided to support groups of conduit. Individual conduit supports shall be one-hole pipe straps used with clamp backs and nesting backs where required. Material as specified herein.

2. Conduit supports for PVC coated rigid steel and PVC conduit systems shall be one-hole PVC coated rigid steel clamps or oversized stainless-steel clamps.

B. CEILING HANGERS: Ceiling hangers shall be adjustable steel rod hangers and fittings. Provide J-Type conduit support for single conduit. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise shown, hanger rods shall meet ASTM A193 and be sized as 3/8-inch up to 2-inch conduit and shall be 1/2 inch all-thread rod over 2-inch conduit. Material as specified herein.

C. SUSPENDED RACEWAY SUPPORTS AND RACKS:

1. Suspended raceway supports shall consist of concrete inserts, steel rod hangers, and jamb nuts supporting framing channel or lay-in pipe hangers as required. Framing channel shall be a minimum of 12-gauge. Material as specified herein.

2. Hanger rods shall be a minimum of 1/2-inch diameter all-thread rod and shall meet ASTM A193. Suspended raceway supports and racks shall be braced for seismic forces as specified in Section 26 05 00.

D. MATERIALS: Table A specifies the type of raceway supports required for each location and application.

Table A

Location	Framing Channel and Accessories	Threaded Rod, Hardware, & Fittings
Indoor Dry	Zinc Plated Steel	Zinc Plated Steel
Indoor, Wet	316 Stainless Steel HDG Steel	316 Stainless Steel
Outdoor	316 Stainless Steel PVC Steel	316 Stainless Steel
Submerged	316 Stainless Steel PVC Steel	316 Stainless Steel
Headspace	316 Stainless Steel PVC Steel	316 Stainless Steel
Chemical Corrosive	316 Stainless Steel PVC Steel	316 Stainless Steel
Process Corrosive	316 Stainless Steel PVC Steel	316 Stainless Steel

HDG = Hot Dip Galvanized Finish PVC = PVC COATED

2.2 EQUIPMENT SUPPORTS

A. Equipment supports shall be installed where shown on the drawings and as required to support the panels and enclosures being installed.

B. Equipment supports shall be installed per details in the Construction Documents.

2.3 ANCHOR BOLTS

A. Anchor bolts shall be as specified in Section 05 50 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Hangers and supports shall be installed with spacing between support points in compliance with all applicable codes.

B. The cut ends of support channels shall be smoothed and without burrs left from cutting.

END OF SECTION

SECTION 26 05 33 – RACEWAYS, BOXES, AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Quality Assurance.
3. Submittals.
4. Products.
5. Installation.
6. Raceway Specification Sheets.

1.2 SCOPE

A. This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, electrical vaults, hand holes, and fittings. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.3 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC WW-C-581E	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC W-C-1094A	Conduit and Conduit Fittings, Plastic, Rigid
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

2. Manufacturer's descriptive literature for all materials provided under this section.

PART 2 PRODUCTS

2.1 RACEWAY

A. General requirements for raceway materials specified in this section are listed in the RACESPECS sheets at the end of this section. The type of raceway to be used for any given area and application shall conform to the requirements of Table A in this section.

2.2 BOXES AND FITTINGS

A. PULL BOXES AND WIRING GUTTERS: Indoor boxes above grade and in unclassified indoor areas shall be NEMA 12 with hinged doors. Similar enclosures for below grade and outdoors shall be rated NEMA 4X (Type 316 stainless steel) with hinged doors. Boxes in hazardous classified areas shall be rated for the classification, NEMA 7. Box covers shall be provided with hinged doors with quick release latches and oil resistant gaskets. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code. Bolt-on junction and pull box covers are not allowed.

B. TERMINAL CABINETS: Terminal cabinets located indoors and in unclassified indoor areas shall be NEMA 12. Cabinets located below grade, outdoors, and in corrosive or damp areas shall be NEMA 4X (Type 316 stainless steel). Cabinets in hazardous

classified areas shall be rated for the classification, NEMA 7. Cabinets shall be provided with hinged doors with quick release latches. Adjustable terminal strip mounting accessories shall be provided. Cabinets shall be provided with channel mounted terminal blocks rated 30 amperes, 600 volt AC. Terminals shall be No. 8 minimum strap-screw type, suitable for ring tongue or locking spade terminals. Hoffman type CHQR, or approved equal.

C. PULL/JUNCTION BOXES:

1. Indoor boxes above grade and in unclassified indoor areas shall be NEMA 12 with hinged doors. Similar enclosures for below grade and outdoors shall be rated NEMA 4X (Type 316 stainless steel) with hinged doors. Boxes in hazardous classified areas shall be rated for the classification, NEMA 7. Pull and junction boxes for use in raceway systems with conduits 1-1/4" or larger shall be hinged boxes with 2 screw driver operable or quick release latches. Minimum depth of box shall be 5.3", the minimum size shall be as shown on the drawings or as required for the application or NEC. Hoffman type CH or approved equal. For damp, below grade, outdoor, or corrosive applications provide Hoffman type CHFNFSS or approved equal.

2. For Hazardous areas provide Cast copper free aluminum box with neoprene gasketed screw on cover. Crouse-Hinds GUE, GUB, or approved equal.

D. ELECTRICAL VAULTS:

1. Electrical vaults shall be precast concrete with covers designed for H-20 loading. Dimensions shall be as specified on the standard details. Electrical vaults shall be provided with precast solid concrete slab bottoms with sumps as indicated, and a 3 inch by 2 foot long copper ground bar. Electrical vaults shall be constructed of 3000 psi reinforced concrete. Manhole covers shall be engraved "ELECTRICAL", "CONTROL" or "SIGNAL" as applicable.

2. Manhole covers shall be hinged and watertight unless otherwise indicated on the drawings. Hinged covers shall be made of aluminum and provided with a locking latch. Covers shall be made for easy opening and latching and be provided with a mechanism that shall hold the cover in the open position at 90 degrees, and provided with spring-assist openers. Manhole covers shall be bonded to ground bar via flexible copper braid or self-grounding connections.

3. Electrical vaults shall be provided with pulling irons and galvanized cable racks on each wall. Cable racks shall utilize porcelain cable supports. Cable racks shall be installed on spacings of not greater than 36 inches and shall be bolted to permanent wall surfaces with anchors or continuous slot concrete inserts.

4. Electrical vaults shall be per the size indicated in the contract drawings and include a H-20 loading where shown on the drawings. Oldcastle or approved equal.

E. HAND HOLES:

1. Hand holes shall be per the size indicated in the contract drawings and include a H-20 loading where shown on the drawings. Hand holes shall be engraved with “ELECTRICAL”, “CONTROL” or “SIGNAL” as applicable.

2. Unused conduits shall be provided with conduit seal caps.

2.3 RACEWAY SUPPORTS

A. All support systems for electrical systems shall be as specified in Section 26 05 29.

2.4 CONCRETE ENCASED DUCT BANKS

A. Concrete used for duct banks shall be Class E with red oxide added as specified in the Cast-in-Place Concrete section. Rebar shall be as indicated on the drawings.

2.5 UNDERGROUND MARKING TAPE

A. Underground marking tape shall be for early warning protection of digging around reinforced concrete duct banks. Tape shall be low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness. The plastic color shall be red. A warning shall be imprinted continuously along the length, with message reading similar to “CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW.” Tape shall be Brady “Identoline,” Services and Materials “Buried Underground Tape,” Somerset (Thomas & Betts) “Protect-A-Line,” or approved equal.

B. Underground marking tape for directly buried cables and conduits shall be 6-inch wide metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. The message shall be clearly printed with black over red tape and shall read “CAUTION ELECTRIC LINE BURIED BELOW.”

2.6 NAMEPLATES

A. Nameplates shall be provided for all pull and junction boxes in accordance with the requirements of Section 26 05 00. Nameplate numbering shall be as indicated on the drawings. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate or as required by the Engineer and Owner. Any nameplates provided where the wording is not specified shall first be approved by the Engineer and Owner.

2.7 FIRESTOPS

A. Raceway penetrations through masonry walls shall be mortared to seal penetration’s air gaps. Raceways penetrations through other walls shall utilize an approved elastomer product to seal up all air gaps.

PART 3 EXECUTION

3.1 GENERAL

A. Table A specifies the type of raceway required for each location and application by RACESPEC sheet. Unscheduled conduit, (i.e. lighting, convenience outlets, etc.), not shown on the drawings shall be in accordance with Table A below.

Table A

Location	Application/Condition	RACESPEC
Indoor Dry	Exposed	GRS
Indoor Wet	Exposed	PGRS
Outdoor	Exposed	PGRS
Concealed	Power circuits embedded in concrete structure or beneath slab-on-grade	PVC4
Concealed	Instrumentation, communications and data signals encased in concrete, duct bank	PGRS
Underground	Power circuits encased in concrete, duct bank	PVC4
Underground	Instrumentation, communications and data signals directly buried	PGRS
Nonhazardous	Final connection to equipment and light fixtures	LFS
Hazardous corrosive	Exposed	PGRS
Architecturally finished areas	Final connection to light fixtures	FLEX

3.2 CONDUIT

A. GENERAL:

1. The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

2. Conduit runs shall be limited to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

3. Provide pull and junction boxes per code. When shown on drawings, box or manhole sizes shall be considered to be minimum sizes and shall be upsized by the Contractor for ease of pulling wire or if required by NEC.

B. INDOOR AND OUTDOOR CONDUIT SYSTEMS:

1. In general, Contractor shall be responsible for determining conduit routing that conforms to the specified installation requirements:

   a. Conduits for lighting and outlets: exposed
   b. Conduits for lighting and outlets: concealed

c. Conduits for process equipment: exposed
d. Conduit inside structures: exposed
e. Conduit concealed inside water chambers slabs and walls: not permitted.

2. Existing conduit installations may be utilized provided the installation meets the following requirements:

   a. The installation meets the project specifications.
   b. The raceway meets the minimum National Electrical Code (NEC) requirements.
   c. The raceway is re-labeled per the project raceway schedules.

3. Conduit installation shall conform to the requirements of the RACESPEC sheets and the following specified installation requirements:

   a. Exposed conduit: Install parallel or perpendicular to structural members and surfaces. Install conduit horizontally and allow minimum headroom of 7 feet.

   b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.

   c. Maintain minimum spacing between exposed parallel conduit and piping runs in accordance with the following when the runs are greater than 30 feet:

      1) Between instrumentation and telecommunication: 1 inch

      2) Between instrumentation and 125 VDC, 48 VDC, and 24 VDC: 2 inches

      3) Between instrumentation and 600 VAC and less power: 6 inches

      4) Between instrumentation and 600 VAC and greater power: 12 inches

      5) Between telecommunication and 125 VDC, 48 VDC, and 24 VDC: 2 inches

      6) Between telecommunication and 600 VAC and less power: 6 inches

      7) Between telecommunication and 600 VAC and greater power: 12 inches

      8) Between 125 VDC, 48 VDC, and 24 VDC and 600 VAC and less power: 2 inches

      9) Between 125 VDC, 48 VDC, and 24 VDC and 600 VAC and greater power: 2 inches

      10) Between 600 VAC and less power and 600 VAC and greater power: 2 inches

      11) Between process, gas, air and water pipes: 6 inches

d. Space exposed conduit installed on supports not more than 10 feet apart. Space multiple conduits in parallel and use framing channel.

e. Comply with the requirements of Section 26 05 00 and herein, where conduits are suspended from the ceiling.

f. Secure conduit rack supports to concrete walls and ceilings with cast-in-place anchors or framing channel concrete inserts.

g. Install conduits at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degree C.

h. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces.

i. Place conduits under the reinforcement in slabs with only a single layer of reinforcing steel. Separation between conduits, conduits and reinforcement, and conduits and surfaces of concrete shall be maintained in accordance with IBC.

j. Route conduit clear of structural openings and indicated future openings.

k. Provide conduits with flashed and watertight seals routed through roofs or metal walls.

l. Grout conduits into openings cut into concrete and masonry structures.

m. Cap conduits or plug flush conduits during construction to prevent entrance of dirt, trash, and water. Cap or plug empty conduits designated as “future”, “spare”, or “empty” and include a pulling line accessible at both ends. Use anti-seize compound on cap and plug threads prior to installation.

n. Determine concealed conduit stubup locations from the manufacturer’s shop drawings. Terminate concealed conduit for future use in specified equipment.

o. Install conduit flush with structural surfaces with galvanized couplings and plugs. Caps and plugs shall match the conduit system.

p. Provide concealed portions of conduits for future equipment where the drawings indicate future equipment. Match the existing installation for duplicate equipment.

q. Terminate conduits that enter enclosures with fittings that match the NEMA rating of the enclosure.

r. Underground metallic or nonmetallic conduit that turn out of concrete, masonry or earth: Install a 90-degree elbow of PVC- coated rigid steel conduit before emergence above ground.

s. Provide O-Z Gedney “Type DX” or Crouse-Hinds “Type XD” bonded, weather-tight expansion and deflection fitting for the conduit size where conduit across structural joints that allows structural movement.

C. UNDERGROUND CONDUIT SYSTEM: Excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:

1. Underground conduits shall be reinforced concrete encased under roadways or where otherwise exposed to possible damage or where adequate cover does not exist.

2. Concrete encased conduit shall have minimum concrete thicknesses of 2 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches between reinforcing and earth, unless shown otherwise in an electrical detail.

3. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

4. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers and shall be not less than 3 feet elsewhere.

5. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads protected. Steel surfaces shall be given two coats of epoxy paint.

6. Underground conduits and conduit banks shall have 2 feet minimum earth cover unless otherwise shown.

7. Underground conduit banks through building walls shall be cast-in-place or installed with concrete into boxouts with water stops on all sides of the boxout. Water-stops shall be as specified in the Cast-in-Place Concrete section. Extend the horizontal reinforcement from the duct bank into the boxout terminating with J-hook bends.

8. Conduits not encased in concrete and passing through walls with one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

9. Thoroughly swab conduits and raceways on the inside, immediately upon completion of pouring concrete.

10. After the concrete has set and before backfilling, pull a mandrel through each conduit. The mandrel shall have a diameter equal to the nominal conduit inside diameter minus 1/2 inch and shall not be less than 4 inches long.

11. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.

12. Provide manufactured plastic conduit spacers anchored to prevent movement during the concrete pour. Manufacture: Carlon, PW Pipe, Underground Devices, or equal.

13. Backfill duct banks with clean fill compacted to 90-percent in 6-inch lifts after concrete has cured. Refer to Section 03 30 00 for concrete requirements including minimum 7 days of cure time prior to backfill over duct banks.

14. Provide PVC threaded adapter with female threads where PVC conduit is joined to steel conduit. Procedure:

    a. Before assembly: Double coat steel conduit with Red-Robroy, Green-Permacote, Blue-Ocal or approved equal product.

    b. After assembly: Seal with 65-mil thick, 2-inch wide mastic sealing tape to 1/2-inch beyond threads. Products: 3M Scotch 2228; Plymouth 02625; or approved equal.

    c. Cover with 20-mil corrosion protection tape applied in 1/2-lap layers to 2-inch beyond threads. Products: 3M Scotchwrap 51; Plymouth Plywrap 12; or approved equal.

15. Provide PVC conduit with bell ends where duct banks terminate at walls, electrical vaults, or hand holes. Install bell ends flush with finished concrete.

16. Provide PVC conduit with bell ends where conduit rise below grade into a floor mounted electrical panel, electrical cabinet, MCC, or switchboard.

17. Separate power conduits from signal conduit within the same duct bank by 12” or greater separation, as shown. Refer to the drawings or schedules for signal to be installed in metal conduits instead of PVC ducts.

18. Separate high voltage duct banks from low voltage duct banks, where shown.

19. Provide wireways for transition from underslab conduits rising into wall- mounted panels where the number of conduits exceed the NEC allowable panel space in the bottom of the panel. Provide conduit sleeves or fitting for panel transition. Continuous thread or all-thread is prohibited.

D. ELECTRICAL VAULTS: Unless otherwise specified, electrical vaults installation shall be as follows:

1. Electrical vaults shall be provided in accordance with the drawings

2. Electrical vaults shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.

3. Electrical vaults shall be set plumb, so that water shall drain properly to the sump.

4. Unless installed within a roadway, manhole pre-cast covers, unless otherwise specified, shall be set at 1 to 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.

5. All metallic hardware inside electrical vaults shall be grounded by connection to the ground plate. Connections shall be made using bolted connections, bonding jumpers and grounding bushings.

6. Electrical vaults shall be supplied with a ground rod in accordance with 26 05 26.

7. Electrical vaults for medium voltage cabling shall require all racked MV cabling in vault to complete a 360 degree wrap around inside of vault before exiting.

E. CONDUIT IN BLOCK WALLS:

1. Install multiple runs of conduit that stub-up into a block wall and connect to recessed electrical panels with adequate space for the conduit. Coordinate the electrical work with the structural work and block installers to provide a chase to install the conduit. Install conduit in the cells that do not contain structural reinforcement. Install conduits in the center of the cell to avoid affecting the structural integrity of the wall.

2. Avoid conduit and electrical boxes installation that blocks the cell from being grouted or that blocks the cell reinforcing bars from being grouted. Avoid conduit in the first cell adjacent to doors, windows, corners and wall intersections and install conduits in the center of the first available cell a minimum of 1’-0” from the edge of these openings.

3. Where solid grouting of masonry walls is specified, install conduit and electrical boxes so as to provide sufficient space for grout to flow pass the boxes and conduit in order to fully fill the space beneath and behind. Where boxes need to be held in place, secure the boxes from the face of the block wall. Do not place items behind or next to electrical boxes to hold in place.

4. Coordinate split-face, slump and scored block installation with the masonry contractor to supply smooth face block at the location of receptacles and switches

so that the device covers install flush to the wall. Install translucent weather-proof sealing material under device covers on outdoor or wet area locations.

F. CONDUIT SEAL-OFF FITTINGS:

1. Conduits passing:

a. Between Class I, Division 1 area and Class I, Division 2 area; provide sealing fittings located at the boundary in accordance with NEC Article- 500.

b. From hazardous or corrosive area into a non-hazardous or non-corrosive area.

c. Install the seal-off material in the conduit seal-off fittings after inspection.

G. CONDUIT SEALING MATERIAL: Provide HYDRA-SEAL® Handi-Polyurethane-Foam or approved equal product to seal conduits and inner ducts.

1. Sealing product required features

a. Compatible with common cable jacket materials.
b. ASTM E-84 flame spread requirements and UL Classified.
c. Pre-pressurized, portable, one-component closed-cell foam sealing system.
d. Dries tack-free within 15 minutes and cures within 24 hours.
e. Reacts with applied moisture or with ambient humidity.
f. Remove over-spray with acetone and remove cured foam mechanically.

2. Application Criteria:

a. Apply in ambient temperatures between 60° to 100° F.
b. Apply bead onto clean surface.

3.3 ELECTRICAL VAULTS AND HANDHOLES

A. Unless otherwise specified, manhole and hand hole installation shall be as follows:

1. Electrical vaults shall be provided in accordance with the drawings.

2. Electrical vaults, hand holes, and pull boxes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.

3. Electrical vaults and hand holes shall be set plumb so that water shall drain to the sump.

4. Manhole covers shall be hinged and flush with the manhole lid. Manhole lids shall be set at 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.

5. Metallic hardware inside electrical vaults and hand holes shall be bonded to the ground plate or ground bus using bolted connections, bonding jumpers and grounding bushings.

6. Electrical vaults shall be supplied with a ground rod in accordance with 26 05 26.

3.4 RACEWAY NUMBERING

A. Each conduit shall be provided with a number tag at each end and in each manhole, hand hole, or pull box.

B. Within electrical vaults, glue raceway tag to manhole wall next to raceway penetration.

3.5 RACEWAY SCHEDULE

A. GENERAL: Raceways are scheduled on the drawings.

B. UNSCHEDULED RACEWAY:

1. With the exception of lighting and receptacle circuits, the type and size of raceway shall be as specified on the drawings or schedules.

2. Unscheduled lighting and receptacle raceways shall be sized by the Contractor in accordance with the NEC. Minimum size shall be 3/4 inch for exposed and 1 inch for embedded raceway.

3.6 RACESPEC SHEETS

A. The following RACESPECS are included in Section 3.7.

1. FLEX
2. GRS
3. LFS
4. PGRS
5. PVC4

3.7 RACEWAY SPECIFICATION SHEETS (RACESPEC)

A. RACEWAY SPECIFICATION SHEETS (RACESPEC) – FLEX

Raceway Identification	FLEX
Description	Flexible Steel Conduit
Application	Final connection to equipment subject to vibration or adjustment.
Compliance	UL 1
Construction	Spirally wound galvanized steel strip with successive convolutions securely interlocked
Minimum size	½ inch
Fittings	Compression type
Other	FLEX shall be provided with an internal ground wire.

B. RACEWAY SPECIFICATION SHEETS (RACESPEC) – GRS

Raceway Identification	GRS
Description	Galvanized Rigid Steel Conduit (GRS).
Application	Final connection to equipment subject to vibration or adjustment.
Compliance	ANSI and UL
Finish	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Minimum size	Unless otherwise specified, ¾ inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings	
Locknuts, Rings, Hubs	Hot-dip galvanized insulated throat with bonding locknut or ring. The hubs shall utilize a neoprene "O" ring and provide a watertight connection. O-Z Gedney, CHM-XXT, or approved equal.
Unions	Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or approved equal. Threadless fittings are not acceptable.
Conduit Bodies	40% Oversized conduit bodies (Similar to T&B Form 8): Ferrous alloy type with screw taps for fastening covers to match the conduit system. Gaskets shall be made of neoprene.
Boxes	
Indoor	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
Outdoor	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
Corrosive	NEMA 4X stainless steel or nonmetallic, as specified.
Hazardous	NEMA Class 7 cast ferrous.

(contd. below)

Elbows	
¾ '' thru 1 ½''	Factory fabricated or field bent
2'' thru 6''	Factory fabricated only
Conduit Bodies (Oversized)	
¾ '' thru 4''	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for conduit entrances
5'' and 6''	Electro-galvanized iron or cast iron box
Expansion Fittings	Expansion fittings in embedded runs shall be watertight with an internal bonding jumper. The expansion material shall be neoprene allowing for 3/4-inch movement in any direction
Manufacturers	Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or approved equal
Installation	Rigid steel conduit shall be made up tight and with conductive thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs or framing channel. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

C. RACEWAY SPECIFICATION SHEETS (RACESPEC) - LFS

Raceway Identification	LFS
Description	Liquidtight Flexible Steel Conduit.
Application	Final connection to equipment subject to vibration or adjustment.
Compliance	UL 360.
Construction	Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum size	¾ inch, except for instruments where ½ inch is acceptable.
Fittings	Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral O-ring seals around the conduit and box connection and insulated throat Provide forty-five and ninety degree fittings where applicable Provide PVC coated flexible conduit and fittings where the conduit system is PVC coated
Installation	Length of flexible liquidtight conduit shall not exceed 36 inches in length. Use conductive thread compound.

D. RACEWAY SPECIFICATION SHEETS (RACESPEC) – PGRS

Raceway Identification	PGRS
Description	Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated. Provide factory made and coated elbows.
Compliance	ANSI and UL. The PVC coated rigid galvanized steel conduit shall meet NEMA RN1-2005 and UL-6 PVC adhesion performance requirements.
Finish	PGRS shall be hot-dip galvanized rigid steel conduit as specified in 26 05 33-7.03 GRS, with a PVC Coating. The PVC coating shall be gray, minimum 40 mils thick, bonded to the outside and continuous over the entire length of the conduit except at the threads, and be free of blisters, bubbles, or pinholes. Thread protectors shall be used on the exposed threads of the PVC coated conduit A 2-mil coat of urethane enamel coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat.
Minimum size	¾ inch
Fittings	Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company Conduit and fittings shall be coated by the same company. Male threads on elbows and nipples, and female threads on fittings or conduit couplings shall be protected by application of urethane coating.
Covers	PVC coated covers shall have a NEMA 4X rating and stainless steel hardware.
Conduit Bodies	40% Oversized conduit bodies with covers as specified above.
Hubs	Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded cast ferrous alloy. Hubs shall have the same PVC coating as the conduit and insulating grounding bushings. Hubs shall utilize a neoprene “O” ring and shall provide a watertight connection.

Boxes

Nonhazardous	Type FD cast ferrous with PVC coating for all device boxes and for junction boxes less than 6 inches square.
Hazardous	NEMA Class 4X stainless steel or nonmetallic for junction boxes 6 inches square and larger.
Manufacturers	Ocal Blue, Robroy Industries, Plasti-Bond, Perma-Cote, KorKap or approved equal.
Installation	Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the PVC-coated conduit manufacturer. Exposed conduit threads shall be covered by a plastic overlap coated and sealed per manufacturer's recommendations. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable. PVC coated conduit shall be supported away from the structure using PVC coated conduit wall hangers or PVC coated conduit mounting hardware. Damaged work shall be replaced.
Training	Installers shall be trained and certified in the proper installation techniques provided by the PVC-coated conduit system manufacture. Proof of certification shall be provided under paragraph 26 05 33

E. RACEWAY SPECIFICATION SHEETS (RACESPEC) – PVC4

Raceway Identification	PVC4
Description	Rigid Nonmetallic Conduit.
Application	Heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.
Compliance	NEMA TC2, UL 651
Construction	Schedule 40, high-impact, polyvinylchloride (PVC).
Minimum size	¾ inch exposed; 1 inch embedded or encased
Fittings	PVC solvent weld type.
Boxes	
Indoor	NEMA Class 4, nonmetallic
Outdoor and corrosive	NEMA Class 4X stainless steel or nonmetallic for junction boxes 6 inches square and larger.
Manufacturers	NEMA Class 4X, nonmetallic
Installation	PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O ring. Joints shall be made with standard PVC couplings. PVC conduit shall have bell ends where terminated at walls and boxes.

F. RACEWAY SPECIFICATION SHEETS (RACESPEC) - WW

Raceway Identification	WW
Description	Wireway and Auxiliary Gutter: Match the conduit or raceway system specified and shown on the drawings. Minimum: Flanged, oil-tight type with hinged covers
Application	As shown on the drawings.
Compliance	JIC EMP-1
Finish	NEMA-1 and NEMA-12: Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces. NEMA 4X: Type 316 Stainless Steel. Smooth finished surfaces.
Sizes as shown	4 in x 4 in, 6 in x 6 in, 8 in x 8 in
Fittings	PVC solvent weld type.
Indoor non-corrosive area	NEMA-1, NEMA-12 or as shown on the drawings.
Outdoor and corrosive area	NEMA-4X or as shown on the drawings.

END OF SECTION

SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Quality Assurance.
3. Submittals.
4. Products.
5. Testing.
6. Functional Checkout.

1.2 SCOPE

A. This section specifies the acceptance testing of electrical materials, equipment, and systems. Provide all labor, tools, material, power, and other services necessary to provide the specified tests. All testing described in this section shall be coordinated with the requirements of Section 01 75 16.

1.3 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or other- wise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI/NETA ATS-2009	Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems

B. APPLICATION: Where testing in accordance with this section and other Division 26 Sections is required, the required tests, including the retesting after the correction of

found defects must be complete, and the submittal of final test reports to the Owner for review shall be completed prior to the energizing of material, equipment, or systems.

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

2. Proposed testing procedures including proposed test report forms.

3. Test reports including documentation for all tests performed. Test reports shall be submitted for review prior to the equipment being energized.

4. Execution plan including schedule.

5. All testing required herein and the test results shall also be submitted and documented as required under Sections 01 75 16, 26 05 00, and where identified within the specific sections.

6. Test results for a specific piece of equipment shall also be included in the operation and maintenance manual(s).

PART 2 PRODUCTS

2.1 TESTING EQUIPMENT AND INSTRUMENTS

A. The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology. The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

2.2 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00 and Section 01 75 16:

1. Defects: Notify the Owner of any material or workmanship found defective within 24 hours of discovery.

2. Short circuit analysis and protective device curves.

3. Test reports: Provide the report required in NETA ATS-2009 paragraph 5.4. Results shall be placed on the forms specified in this Section. Test reports shall also be part of the operation and maintenance manuals.

PART 3 EXECUTION

3.1 TESTING

A. GENERAL

1. Ensure that all testing performed is in strict conformance with the electrical acceptance tests specified in Section 26 08 00. Contact the Owner 10 days prior to the testing to allow witnessing of all tests.

2. The test measurements shall be recorded on specific forms for the subject test.

3. Testing shall be per ANSI/NETA ATS 2009. Provide testing data sheet for the following:

    a. Switchboard assemblies.

    b. Transformers – Small Dry-type, air cooled (600 VAC and below, 30 kVA and larger)

    c. Cables – Low voltage (600 VAC maximum)

    d. Circuit breakers – Low voltage (Insulated Case/Molded Case)

    e. Protective Relays

    f. Instrument Transformers

    g. Metering and Monitoring Equipment

    h. Grounding Systems

    i. Ground Fault Protection Systems

    j. Rotating Machinery

    k. Motor Control

    l. Variable Speed Drive Systems

    m. Outdoor Generator Systems

n. Uninterruptable Power Systems

o. Manual and Automatic Transfer Switches

B. FUNCTIONAL CHECKOUT:

1. Functional testing shall be performed in accordance with the requirements of this Section. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energizing the equipment, perform a functional checkout of the control circuits. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. Submit a description of proposed functional test procedures prior to the performance of functional checkout.

2. Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor after confirming that neither the motor nor the driven equipment will be damaged by reverse operation.

END OF SECTION

SECTION 26 09 16 – MISCELLANEOUS ELECTRICAL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Quality Assurance.
3. Submittals.
4. Products
5. Execution

1.2 SCOPE

A. This section specifies miscellaneous electrical control and power devices disconnect switches, and overcurrent protection. Enclosed over current devices and safety switches shall be labeled for arc-flash conditions in accordance with Section 26 05 73.

1.3 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. NOTE – No reflective materials may be used on the exterior of buildings and structures. Alternatives to devices that would otherwise be Stainless Steel will be required.

3. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA ICS-1	General Standards For Industrial Controls and Systems
NEMA ICS-2	Industrial Control Devices, Controllers, and Assemblies
NEMA KS 1	Enclosed Switches

B. SHIPMENT AND STORAGE

1. Materials and equipment shall be stored in a manner to keep them dry and clean. Equipment and materials to be located indoors shall be stored indoors and sealed with plastic film wrap. Electrical and electronic equipment found stored or staged outdoors over night or in inclement weather shall be considered grounds for equipment rejection and shall be replaced without cost to the Owner.

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

2. Catalog cuts of equipment, devices, and materials installed under this section. Catalog information shall include technical specifications and application information, including electrical ratings, dimensions, weight, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

3. Operation and maintenance data as specified in Section 01 33 00 including approved submittal manufacturer's catalog data, as-built drawings, and instructions for all configurable or programmable components.

4. Manufacturer's catalog data for all material provided under this section shall be assembled in a folder with each page clearly marked with the item and reference number to the specification.

PART 2 PRODUCTS

2.1 CONTROL DEVICES

A. OPERATOR INTERFACE DEVICES: Unless specified otherwise on the drawings, all operator interface devices mounted on the panel front shall be rated for the environment in which they will be located. In general, devices mounted on indoor panels shall be NEMA 13 rated. Operator devices mounted outdoors, below grade, or in wet or corrosive environments shall be NEMA 4X rated. Devices located in hazardous areas shall be rated for hazardous environments in addition to previous requirements.

B. HAND STATION (CONTROL STATION) ENCLOSURES: Hand station enclosures shall be NEMA 4X Type 316 stainless steel with stainless steel hardware. Devices located in

hazardous areas shall be rated for hazardous environments in addition to previous requirements.

C. SELECTOR SWITCHES:

1. Unless specified otherwise on the drawings, selector switches shall be NEMA 13, or NEMA 4X as required by mounting location. Selector switches shall be 2, 3, or 4 position as required by the application. Selector switches shall have standard knob operator. Units shall be heavy duty type, Allen-Bradley 800H or 800T, or approved equal. Devices located in hazardous areas shall be rated for hazardous environments in addition to previous requirements.

2. For contact blocks used for 24Vdc switching, provide bifurcated contacts.

D. PUSHBUTTONS AND INDICATING LIGHTS: Unless specified otherwise on the drawings, pushbuttons and indicating lights shall be NEMA 12 oil-tight, dust-tight or NEMA 4X heavy duty type with detachable contact blocks. Indicating lights shall be press-to-test 120VAC LED type as required. Units shall be Allen-Bradley 800T or 800H, or approved equal. Devices located in hazardous areas shall be rated for hazardous environments in addition to previous requirements.

2.2 3-POLE SAFETY DISCONNECT SWITCHES

A. Safety disconnect switches shall be heavy-duty safety type rated 600 volts AC. Disconnect switches shall be fused or non-fused type in accordance with the drawings. Where a fuse size in not indicated the contractor shall size the fuse in accordance with the NEC. Unless otherwise specified, enclosures installed indoors, outdoors, below grade, or corrosive areas shall be NEMA 4X, Type 316 stainless steel; and enclosures installed in hazardous areas shall be NEMA 7. Switch enclosures located in classified areas shall be suitable for the specified classification. The operating handle shall be capable of being padlocked in the "off" position. The operator shall be a positive, quick-make, quick-break mechanism and furnished with auxiliary contacts for remote monitoring of open/close status.

B. Switches shall be horsepower rated for motors and shall comply with NEMA KS-1. Switches shall be provided with defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position. Switches shall have line terminal shields. Switches shall be Eaton Mill-Duty rated, Heavy-Duty Type GCL; General Electric Mill-Duty rated, Heavy Duty Type TH; or approved equal.

C. Fuse clips shall be Class R rejection type and sized for UL Class R, one-time, time- delay fuses. Fuse assembly shall have a minimum short circuit capacity of 100,000 amps symmetrical. Provide fuses as shown and one set of spare fuses with each switch.

2.3 SINGLE POLE SAFETY DISCONNECT SWITCHES

A. GENERAL: 30 amp rated 500 volts AC. Disconnect switches shall be non-fused type with a non-metallic enclosure. The operating handle shall be capable of being padlocked in the “off” position. The operator shall be a positive, quick-make, quick-break mechanism, (Hubbell HBL781OD & HBL13R23D or approved equivalent).

2.4 OVERCURRENT PROTECTION

A. CIRCUIT BREAKERS: Unless specified otherwise on the drawings, Circuit breakers shall be thermal magnetic, molded case type with the ampere rating as specified. Unless otherwise specified or indicated, circuit breaker interrupting rating shall be 22,000 amperes symmetrical for service at 240 volts and below and 42,000 amperes symmetrical for service above 240 volts.

B. FUSES: Unless specified otherwise on the drawings, Provide Class R fuses and fuse holders where shown on the plans or where required for proper protection of equipment.

2.5 TERMINAL STRIPS, BLOCKS, AND DEVICES

A. POWER WIRING: Provide back plate mounted terminal strips rated at 600 Vac.

B. CONTROL WIRING: Provide a DIN rail with spring powered contact rated at 300 Vac, 24 ampere with pluggable terminals.

C. Terminal identification standard to the product provided.

D. MANUFACTURER:

1. Standard: Allen Bradley, or approved equal.
2. Standard: DIN rail: Phoenix Contact, Weidmuller Z-Series, or approved equal.

2.6 THERMOSTATS

A. Thermostats shall be line voltage type with motor current rated contact and 70- degree to 140-degree Fahrenheit set point range.

1. Manufacturer: Honeywell T631A-1022 or approved equal.

2.7 NAMEPLATES

A. Nameplates for all control stations, relays, timers, motor contactors and disconnect switches shall be provided in accordance with the requirements of Section 26 05 00.

2.8 ENABLE /DISABLE PUSHBUTTONS

A. Unless specified otherwise on the drawings, Enable/Disable pushbuttons shall be 2-position, push-pull/twist release type with red jumbo mushroom head. The devices shall be NEMA 13 or NEMA 4X rated with DPST, normally closed contacts and 120VAC LED indicating light that is energized when the button is depressed. Units shall be Allen-Bradley 800T or 800H, or approved equal. Devices located in hazardous areas shall be rated for hazardous environments in addition to previous requirements.

PART 3 EXECUTION

3.1 GENERAL

A. Control stations, contactors and safety disconnect switches shall be mounted 48 inches above the floor, ground, or slab to center of device.

B. Provide support structure for hand stations and control stations when not mounted on wall.

C. Miscellaneous electrical devices shall be tested in accordance with Section 26 05 00 and Section 26 08 00.

END OF SECTION

SECTION 26 27 16 – LOCAL CONTROL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Quality Assurance
3. Submittals
4. Products
5. Execution

1.2 SCOPE

A. This section specifies local control panels used for housing electrical power and control equipment. Local control panels that include motor controllers and control devices/instruments shall have a physical barrier separating the components into two compartments.

B. Vendor and Manufacturer panel requirements are specified in the related Sections for packaged equipment and in this Section. Contractor custom panels are specified herein and shown on the drawings.

C. Panels shall be labeled with fault current rating per NEC article 409.110 and arc flash warning label per NEC Article 110.16

D. The Vendor / Manufacturer package equipment and Contractor custom field panels shall adhere to the requirements in specifications Section 26 09 16 for motor starters, controllers, and devices and the circuits shall be arranged for Fail-Safe wiring and electrical operation, as defined hereinafter.

E. Refer to Section 40 67 00 for additional requirements.

1.3 QUALITY ASSURANCE

A. REFERENCES:

1. This section contains references and information from the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).

3. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NFPA 79	NFPA 79 Electrical Standard for Industrial Machinery
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 6	Industrial Control and Systems: Enclosures
NFPA 70	National Electrical Code (NEC)
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

B. ASSEMBLY:

1. The assembled panels and individual components shall be UL Listed and labeled.

2. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 26 05 00 or UL recognized.

3. The control panels shall have factory applied UL 508A labels.

4. The intrinsic safety barriers required within a control panel shall be provide per UL 698A with factory applied labels as required by UL.

C. TESTING:

1. As required per Part 3 of this specification section.

D. SHIPMENT, PROTECTION AND STORAGE:

1. Equipment shall be delivered, stored and handled to prevent damage.

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Submittal drawings required:

   a. Arrangement drawings of the panel enclosure indicating the front door and panel equipment arrangement and dimensions, and enclosure type.

   b. Sections showing clearances between face and rear mounted equipment.

   c. Internal wiring connection diagrams

   d. External wiring interconnection diagrams including interlocks.

2. List of materials and components with the layout drawings.

3. Nameplate schedule with character size and nameplate size.

4. Heat load calculations for each cabinet based on the highest ambient temperature for the area in which the subject panel will be located.

5. Power supply calculations.

6. Manufacturer's operation and maintenance information. Manual shall include final reviewed submittal redlined to show AS BUILT conditions; and separate record of all final configuration, jumper, and switch settings.

PART 2 PRODUCTS

2.1 GENERAL

A. Panels shall comprise cabinet enclosures with power products, control products, and instrumentation products as specified in other sections and herein. Provide:

1. Separation between the power components (over 120 Vac) and the control/instrument components (120 Vac and less) by locating the power components and the control/instrument components in separate sections of the cabinet enclosure.

2. Power cabinet section and the control/instrument cabinet section with separate door handles.

3. Separation between the power components and the control / instrument components using barriers.

4. External lockable circuit breaker handle for the main panel disconnect.

5. Individual power and control components with internal circuit breakers, as required.

6. Displays with door-in-door construction accessible by opening the cabinet outer door.

7. Face-mounted equipment flush or semi-flush with flat-black escutcheons.

8. Panel tops of wall-mounted panels: mounted at the same elevation.

9. Panel inner door contains a copy of the record drawings.

10. Panel inner door contains a drawing holder.

11. Panel drawings enclosed in a transparent, protective jacket.

12. Panel functions as specified.

13. Panels with floor stands, to raise the top of the panel to 60 inches above the floor or work platform.

14. Wall mounting of panel weighs less than 100 pounds, where wall space is available.

2.2 ENCLOSURES

A. GENERAL: Panel enclosures shall comply with the requirements of NEMA 250.

B. MANUFACTURER: The enclosures shall be made by:

1. Hoffmann Enclosures, Inc.
2. Rittal.
3. Bulletin A
4. E. M. Wiegman and Co., Inc.
5. Or Approved Equal

C. ENCLOSURES: Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application.

1. All Exterior Mounted Enclosures on this project site must be non-reflective. Use of Polycarbonate or Painted Mild Steel enclosures in place of Stainless is acceptable for Exterior locations

Table A

Location	Enclosure Material and NEMA Rating
Indoor, non-process areas	NEMA 12: mild steel
Indoor, process areas	NEMA 12: mild steel when specified with mounting pad or legs for minor splash resistance) or NEMA 4X: 316 Stainless Steel
Outdoor	NEMA 4X: 316 Stainless Steel
Process Corrosive	NEMA 4X: 316 Stainless Steel
Hazardous Area:	NEMA 7: Galvanized Malleable Iron or Aluminum or NEMA 4X and UL listed or FM Approved for the Hazardous Area.
Hazardous and Corrosive Area	NEMA 4X/7: Iron or Aluminum with factory applied corrosion resistant coating or NEMA 4X and UL listed or FM Approved for the Hazardous Area.

D. SIZE: The minimum enclosure area, height by width, shall be twice the sum of the area of the individual components mounted on the back panel. The enclosure depth shall depend on the type of components used but shall be no less than 6 inches.

E. BOXES AND HAND STATIONS (IN NON-HAZARDOUS AREA)

1. All terminal, pull and junction boxes, and hand stations installed indoors in dry areas shall be NEMA 12 non-metallic. Those installed in damp, or corrosive or outdoor areas shall be NEMA 4X Type 316 stainless steel. AB bulletin 800H or equal.

2. Screws, bolts, and other hardware shall be stainless steel. Hinges shall have stainless steel pins. All enclosures with covers more than 1 square-foot total area shall be hinged.

3. Small boxes and control stations shall have 2 screw driver or hand operated latches.

F. BOXES AND HAND STATIONS (IN HAZARDOUS AREAS):

1. All terminal, pull and junction boxes, and hand stations installed in hazardous areas shall be rated for the area installed and shall be made of aluminum or non-metallic. Those in damp, outdoor, or corrosive environments shall be provided with corrosion resistant materials.

2. Provide stainless steel hinges, screws, bolts, and other hardware. Provide with neoprene gaskets.

3. Provide CROUSE-HINDS GUA, GUB, GUE, preferred. CROUSE-HINDS EJB with hinges are also acceptable. Or approved equal.

G. WIREWAYS: Provide molded plastic wireways, slotted for wire connections for all wiring in the panels. They shall be complete with covers. Wireways shall be manufactured by Panduit, Taylor, or approved equal.

H. PANEL LIGHT, SWITCH, and CONVENIENCE OUTLET: Provide a light fixture with automatic “door activated” switch for every door unless noted otherwise in the drawings. Provide outlets in all panels in accordance with the drawings. Receptacles shall be 120VAC, 20A. Internal power supplies and receptacles shall be as indicated in the drawings. The lighting and receptacle circuits shall be on a separate dedicated circuit.

I. COLOR:

1. Exterior: ANSI 61 grey; NEMA Type 4X stainless steel unpainted with smooth, brushed finish.

2. Interior: White.

2.3 PANEL WIRING

A. INTERNAL WIRING:

1. Internal wiring shall be single conductor 90 degree C copper wire and UL listed for panel wiring. Wire size shall be in accordance with NEC.

2. Internal wiring shall be color coded as specified in Section 26 05 19.

B. WIRE MARKERS: Wire markers shall comply with the requirements specified in Section 26 05 00.

C. WIRING METHODS:

1. Plastic wireway with covers shall be used to route groups of wires. Wireway fill shall be sized to provide 40% maximum fill. Plastic spiral wrap shall be used for exposed wires.

2. Wires that cross door hinges shall be enclosed in plastic spiral wrap.

D. FAIL-SAFE WIRING: Provide fail-safe wiring of control relay or other on/off device or instrument to ensure that upon loss-of-power or internal failure in the device, the relay is de-energized and the control relay contact operation provides for equipment failing in a safe mode.

2.4 ALARM AND TROUBLE DETECTION

A. The equipment control system shall incorporate a non-energized, open-state, output contact to activate on an alarm or trouble condition or on loss-of-power. Detection of a critical alarm or trouble condition shall cause the control system to initiate the shutdown or the operation of the equipment’s con- trolled components to achieve a "Fail-Safe" condition.

B. Devices that signal an alarm or a trouble conditions shall latch in the alarm position and require a manual reset at the equipment control panel.

C. Alarm and trouble output shall:

1. Open an output dry-contact rated at 120 VAC at 2 amps.

2. Remain open until manually reset.

3. Not indicate abnormal condition when the equipment shutdown manually or automatically.

4. Indicate the alarm at the equipment control panel.

D. Fail-Safe Design and Operation:

1. Failure of part of a system shall not result in the failure of the rest of the system.

2. Failure of equipment or process shall not propagate beyond the failing device or equipment component.

3. Control design and operation shall prevent improper system functioning due to a circuit malfunction or operator error.

4. Control system design shall cause the controlled equipment to operate in a safe mode in the event of loss-of-power or the failure of a control system component.

2.5 CONTROL DEVICES

A. Control devices shall comply with Section 26 09 16.

2.6 INDICATING LIGHTS

A. Indicating lights shall be equipped with colored lenses as specified in Section 26 05 00, and conform to 26 09 16.

2.7 SURGE PROTECTION

A. Surge protectors shall be provided at panel external terminal blocks signal circuits which extend to field devices, as shown on the drawings. Surge protectors shall be Joslyn Model 1663-08, Taylor 1020FA, Transector, or equal.

2.8 TERMINAL BLOCKS

A. Terminal blocks shall be provided in accordance with Section 26 05 00 and Section 26 09 16. The terminal block assembly shall be mounted on channel standoffs. Provide 15 percent, but no less than 8, spare terminals available for future use.

2.9 LABELING AND NAMEPLATES

A. LABELING:

1. Panel components shall be labeled to match the description on the elementary diagram. Internal components of the panel on the back side of the door shall be labeled with the same description as provided on the front side.

2. Labeling shall be permanently marked on or near each component. Plastic embossed labels such as “Dymo” tape will not be accepted.

B. NAMEPLATES: External door-mounted components and the panel description shall be identified with plastic nameplates provided in accordance with Section 26 05 00.

2.10 GROUNDING

A. Panels shall be provided with two copper ground bars:

B. One bar bonded to the panel frame and to the station ground system, typically located in the power section.

C. Second (signal) ground bar mounted on insulated stand-offs and bonded to the frame ground bar at one point only, typically located in the control section and bonded to the signal ground bar:

1. Signal circuits
2. Signal cable shields
3. Low-voltage direct current (24Vdc) power supply commons

D. Surge protectors and separately derived AC power supplies, such as 120Vac receptacles, shall be bonded to the frame ground bar. In panel line-ups exceeding 30-inches width, ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel.

E. Neutrals of locally derived control circuits shall be grounded to the mounting plate using a copper bus or grounding lug.

F. Provide a grounding lug for a size No. 2 AWG bare copper conductor to connect the panel to the facility ground grid system.

PART 3 EXECUTION

3.1 GENERAL

A. Field verify the following:

1. Panel control circuits grounded with one terminal of each load device connected to the grounded conductor.

2. Panel signal and control wiring separated and installed in separate wireways with barriers between the power wiring and the signal and control wiring.

3. Panel connected to the plant grounding system as specified.

4. Panel tops of wall-mounted panels shall be mounted at the same elevation.

5. Panel inner door contains a copy of the record elementary and wiring diagrams.

6. Panel inner door contains a drawing holder.

7. Panel drawings enclosed in a transparent, protective jacket.

8. Panel functions as specified.

9. Panel mounted with stainless steel uni-strut, fittings, and fasteners.

3.2 MOUNTING

A. Control panels supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding and mounted where shock or vibration will impair its operation.

B. Support systems shall not be attached to handrails, process piping or mechanical equipment. Control panels supported directly by concrete or concrete block walls shall be spaced out from the wall to provide for air circulation around the panels.

C. Steel used for support of equipment shall be Type 316 stainless steel. Support systems including panels shall be designed to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

D. Floor-mounted cabinets, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

E. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

F. Terminals and terminal blocks shall be sprayed with a silicone resin similar to Dow Corning R-4-3117 conformal coating, after all terminations and testing have been completed.

3.3 FACTORY TESTING

A. The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment.

B. The Owner shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner at least two weeks in advance prior of the scheduled functional shop test.

3.4 FIELD TESTING

A. Panels shall be tested in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 27 26 – WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Quality Assurance.
3. Submittals.
4. Products
5. Execution - General

1.2 SCOPE

A. This Section specifies wiring devices consisting of receptacles, plugs, switches and appurtenances

1.3 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA WD-1	General Requirements for Wiring Devices
NEMA WD-6	Wiring Devices - Dimensional
NFPA 70	National Electrical Code (NEC)
UL 20	General-Use Snap Switches
UL 498	Attachment Plugs and Receptacles
UL 514A	Metallic Outlet Boxes
UL 894	Switches For Use In Hazardous (Classified) Locations
UL 943	Ground-Fault Circuit Interruptors
UL 1010	Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00:

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

2. Catalog cuts of equipment, devices, and materials installed under this section. Catalog information shall include technical specifications and application information, including electrical ratings, dimensions, weight, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

PART 2 PRODUCTS

2.1 GENERAL

A. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captive binding screws.

B. Provide devices colored to conform to manufacturer's or industry standard for special use such as orange for isolated ground receptacles, blue for surge suppression receptacles, and red for emergency power receptacles. Unless shown otherwise on the Drawings or Schedules, normal use devices shall be brown, except those located in finished areas shall be ivory.

2.2 RECEPTACLES AND PLUGS

A. GENERAL: Receptacles shall be grounding type.

B. 120V RECEPTACLES:

1. INDOOR, CLEAN AREAS: Unless shown otherwise on the Drawings or Schedules, receptacles shall be duplex 20 amp, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Where the manufacturer of cord connected equipment requires an isolated ground, a receptacle with isolated ground shall be provided.

a. Manufacturers: Hubbell 5362, 5362-AI or approved equal.

b. Isolated ground receptacle manufacturers: Hubbell IG-5362, Arrow- Hart IG5362, or approved equal.

c. Receptacles shall be white in occupied areas with white faceplate.

d. Receptacles shall be grey in un-occupied areas with chrome faceplate.

e. Receptacles shall be mounted at 18 inches above floor unless otherwise indicated on plan drawings.

2. OUTDOOR, PROCESS OR CORROSIVE AREAS: Receptacle shall be duplex, 20 ampere, NEMA 5-20R, IP65/66/67, and shall accept NEMA 5- 15P and 5-20P plugs. Receptacle and plug shall be corrosion resistant, watertight, marine duty with yellow polycarbonate weatherproof lift covers.

a. Manufacturers: Hubbell 60W33H/15W33H, or approved equal.

3. INDOOR/OUTDOOR, GROUND FAULT CURRENT INTERRUPTING: receptacle shall be duplex, 20 ampere, NEMA 5-20R and shall accept NEMA 5-15P and 5-20P plugs. Receptacle shall have LED indication of device fault and tripped condition. Receptacles shall meet the 2006 UL 943 standard for surge testing (3kA, 6kV) and requirement for "no power to face when miswired."

a. Manufacturers: Hubbel GF20xx.

C. 250V RECEPTACLES: Receptacles shall be duplex 20 amp, NEMA 6-20R, and shall accept NEMA 6-20P plug caps. Receptacles shall be Hubbell 60W48H, or approved equal.

D. PLUG CAPS: Male plug caps for 120 volt and 250 volt receptacles shall be of the cord grip armored type with heavy phenolic housing, of the same manufacture as the receptacle. Plug caps shall be rated 15 amps. One plug cap shall be provided for every four receptacles furnished, with a minimum of two plug caps being provided. Plug caps shall be delivered to the Owner.

E. THREE PHASE RECEPTACLES AND PLUGS: Receptacles shall be suitable for 480 volt, 3-phase, 4-wire service, with ampere ratings as specified. Receptacles and plugs shall be designed so that the grounding pole is permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, and a gasketed screw-type, weather tight cap with chain fastener. Each receptacle shall be provided with one plug.

1. Manufacturers: Crouse-Hinds "Arktite," Appleton "Powertite," or approved equal.

F. RECEPTACLES FOR HAZARDOUS AREAS: Receptacles for use in hazardous areas shall be rated in accordance with NEC for the area in which they are to be located and shall be factory sealed. Receptacles shall be designed so the plug must be inserted and turned before load is energized. Receptacles shall be provided with mounting box, sealing

chamber, and compatible plug. Voltage and current ratings shall be 120 Vac, 20-ampere.

1. Manufacturers: Appleton “U-Line,” Crouse-Hinds “Ark-Gard 2,” or approved equal.

2.3 SWITCHES

A. GENERAL PURPOSE (INDOOR, OCCUPIED AREAS): General purpose switches shall be rocker type, quiet AC type, specification grade, back and side wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings or Schedules. Switches shall match receptacles in color. Voltage and current ratings shall be 120VAC, 20 ampere.

1. Manufacturers: General Electric, Hubbell, or Owner accepted substitute.

B. GENERAL PURPOSE (INDOOR, UNOCCUPIED AREAS): General purpose switches shall be toggle type, quiet AC type, specification grade, back and side wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings or Schedules. Switches shall match receptacles in color. Voltage and current ratings shall be 120VAC, 20 ampere.

1. Manufacturers: General Electric, Hubbell, or Owner accepted substitute.

C. SWITCHES FOR HAZARDOUS AREAS: Switches for control of lighting and small single-phase power loads in hazardous areas shall consist of a factory assembled and sealed combination general purpose type switch in an explosion- proof housing. The switch shall be rated in accordance with NEC for the area in which it is to be installed. The external operating mechanism shall consist of a wing-type handle having the “ON” and “OFF” positions visible from the front.

1. Manufacturers: Crouse-Hinds EDS2129 series, Appleton EDS175 series, or approved equal.

D. SWITCHES FOR OUTDOOR AND CORROSIVE AREAS: Switches shall be 20- ampere with weatherproof/ corrosion resistant neoprene plate. Switches shall be mounted in “FD” type cast ferrous or cast ferrous PVC-coated boxes as specified.

1. Manufacturers: Hubbell or Arrow-Hart as follows:

Type	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single-pole	1281	2991
Double-pole	1282	2992
3-way	1283	2993
4-way	1284	2994

2.4 DEVICE PLATES

A. RECEPTACLES AND SWITCHES (Occupied areas): Device plates shall be oversized, white, thermoplastic provided with switches. Lighting and exhaust fan switches located on the same wall shall share device plate.

B. RECEPTACLES AND SWITCHES (Un-Occupied areas):

1. In non-corrosive un-occupied indoor areas, device plates shall be made of sheet steel, zinc electroplated with chrome finish as manufactured by Crouse-Hinds, Appleton, or approved equal.

2. In corrosive indoor areas device plates shall be corrosion-resistant/marine- duty type. Plates shall be of the same manufacturer as the receptacle or switch.

3. In outdoor or wet areas receptacle covers shall provide while-in-use protection, rated NEMA 3R with cover closed. Covers shall be powder- coated cast zinc, with self-closing lid and stainless steel hinges as manufactured by Leviton M5979 or approved equal.

4. Device plates for explosion-proof equipment shall be factory provided with the equipment.

C. Device plates shall be provided with engraved laminated phenolic nameplates with 1/8-inch white characters on black background.

1. Nameplates for switches shall identify panel and circuit number and area served (if remotely switched).

2. Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

2.5 PRODUCT DATA

A. In accordance with Section 01 33 00, the Contractor shall provide catalog cuts for all materials provided under this section.

PART 3 EXECUTION

3.1 GENERAL

A. Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

B. Receptacles and switches installed in sheet steel boxes shall be flush mounted. Flush mounted receptacles shall be located 18 inches above the floor unless otherwise indicated. Switch boxes shall be mounted 48 inches above the floor. Receptacles installed in cast device boxes shall be located 48 inches above the floor.

C. Wiring devices shall be tested for correct connections.

END OF SECTION

SECTION 33 11 50 - EXISTING PIPE ABANDONMENT

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the removal of existing exposed piping and abandonment in place of existing buried piping.

B. Section includes:

1. Pipe removal.
2. In-place abandonment of pipe.

1.2 RELATED SECTIONS

A. Section 03 60 00, Grouting.

1.3 SUBMITTALS

A. Provide all submittals in accordance with Section 01 33 00, Submittal Procedures.

B. Piping Abandonment Plan:

1. Identify locations specified for pipe abandonment.

2. Provide method to be utilized to abandon the pipe, including whether the pipe will be left in place or removed in its entirety.

C. Non-Shrink Grout: Product data in accordance with Section 03 60 00, Grouting.

D. Controlled low-strength material (CLSM): Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the work described herein.

B. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of workmen, other persons, and property in the vicinity of the work and requirements of the General Provisions.

1.5 PROTECTION OF EXISTING WORK

A. Carefully examine the Contract Documents to determine the extent of the work of this Section.

B. Carefully coordinate the work of this Section with all other work and construction.

C. Take all necessary precautions to prevent damage to existing facilities or utilities which are to remain in place and be responsible for any damages to existing facilities or utilities, which are caused by the operations.

1.6 REPAIR OF DAMAGE

A. Work procedures shall provide for safe conduct of the work; careful removal and disposition of materials and equipment; protection of facilities, utilities and property which are to remain undisturbed; coordination with existing facilities and utilities to remain in service.

B. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired to acceptance of Engineer.

C. Damaged items shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.

1.7 EXISTING CONDITIONS

A. If the pipe material contains any hazardous materials, such as asbestos, requiring special handling upon removal, it is the responsibility of the Contractor to remove and dispose of the material in accordance with all applicable federal, state, and local regulations.

PART 2 PRODUCTS

2.1 OWNERSHIP OF EXISTING MATERIALS

A. All materials, equipment, miscellaneous items and debris involved, occurring or resulting from pipe removal work shall become the property of the Contractor at the place of origin, unless otherwise specified in the Drawings or by the Engineer.

PART 3 EXECUTION

3.1 PIPE REMOVAL

A. Where identified on the Drawings, remove and dispose of all pipe material and associated appurtenances.

B. All exposed ends of pipes and fittings to remain in service shall be capped or plugged with an appropriate cap or plug, restrained as necessary based on the pipe material and method used to attach the cap or plug.

1. A pipe shall be considered in service if it is possible to flood the pipe with liquid by opening valves in the system that supplies the pipe.

3.2 IN-PLACE ABANDONMENT OF PIPING

A. Where identified on the Drawings, abandon pipe in place.

B. All exposed ends of pipes being abandoned in place shall be cut and plugged with a minimum of 2 feet of non-shrink grout.

C. Prior to placing grout, roughen interior pipe surface and apply epoxy bonding agent.

3.3 CLEANUP

A. During and upon completion of work of this Section, promptly remove all unused tools and equipment, surplus materials and debris.

B. Adjacent areas shall be returned to their existing condition prior to the start of work.

END OF SECTION

SECTION 40 05 00 - PIPE IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work necessary to furnish and install identifying devices for pipe identification systems.

1.2 RELATED SECTIONS

A. Section 10 14 00 - Signage

1.3 SUBMITTALS

A. Submit as specified in Section 01 33 00 - Submittal Procedures.

B. Submit following:

1. Product data.

2. Samples.

3. Manufacturer's installation instructions.

4. Submit following:

a. Operation and Maintenance Data.
b. Warranty.

PART 2 PRODUCTS

2.1 ABOVE GROUND AND IN-CHASE PIPE IDENTIFICATION

A. Manufacturers:

1. One of the following or equal:

a. Seton, Opti Code Pipe Markers.
b. Lab Safety Supply.
c. Marking Services, Inc.

B. Materials:

1. Pipe markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5 inches	1/2-inch
1.5 inches to 2 inches	3/4-inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

b. Marker colors:

Service	Lettering	Background
Flammables, hazardous chemicals, toxic chemicals	Black	Yellow
Nontoxic solutions or low hazard liquids	White	Green
Water	White	Blue
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

2. Pipe identification tags: Aluminum or stainless steel with stamped-in 1/4-inch high identifying lettering.

3. Pipe identification tag chains: Aluminum or stainless steel.

4. Snap-on markers: Markers with 3/4-inch high letters for 3/4 to 4-inch pipe or covering, or 5-inch high letters for 5-inch or larger pipe or cover:

a. Manufacturers: One of following or equal:

1) Brady BradySnap-On B-915.
2) Seton Setmark.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.
B. Verify that conditions are satisfactory for installation and application of products.

3.2 PREPARATION

A. Prepare surface in accordance with product manufacturer's instructions.

3.3 ABOVE GROUND AND IN-CHASE PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Lettering and flow direction arrows:

1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4-inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.

2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 20 feet in straight runs of pipe.

C. Where pipes are painted and scheduled to have bands, space 6-inch wide bands along pipe at 5-foot intervals. Color bands shall not be installed on pipe systems not scheduled to be painted.

D. Label chemical tank fill pipelines at locations which are visible from chemical fill stations.

E. Metal tags:

1. Where outside diameter of pipe or pipe covering is 5/8-inch or smaller, provide metal pipe identification tags instead of lettering.

2. Fasten pipe identification tags to pipe with chain.

3. Where tags are used, color code pipe as scheduled.

3.4 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self-adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers, and number markers where piping passes through walls or floors, at piping intersections and at maximum 10-foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

3.5 PIPING COLOR CODE AND MARKER SCHEDULE

Service Fluid	Pipe Color	Marker Legend	Color of Bands	Marker Text
Chemical Drain	Yellow (Safety Yellow SW 4084)	CHEMICAL DRAIN	None	Black on Orange
Chemical Overflow	Yellow (Safety Yellow SW 4084)	CHEMICAL OVERFLOW	None	Black on Orange
Chemical Vent	Yellow (Safety Yellow SW 4084)	CHEMICAL VENT	None	Black on Orange
Sodium Hypochlorite	Yellow (Safety Yellow SW 4084)	HYPOCHLORITE (POST, PRE or MID, as required)	Nonce	Black on Orange
Aluminum Chlorohydrate	Yellow	ALUMINUM CHLOROHYDRATE SOLUTION	Orange (Safety Orange SW 4083)	Black on Orange
Sodium Fluorosilicate	Yellow (Safety Yellow SW 4084)	SODIUM FLUOROSILICATE SOLUTION	Green (Safety Green SW 4085)	Black on Orange

END OF SECTION

SECTION 40 05 07 - PIPE SUPPORTS AND HANGERS

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install supports for all pipe, fittings, valves, and appurtenances. Contractor is responsible for sizing and layout of all pipe supports whether shown on the drawings or not.

B. Pipe support information contained in the Drawings as typical details are for guidance only. The Contractor shall be responsible for locating all required pipe supports, whether specifically called out or not, and designing pipe supports for all applicable loads.

C. Contractor shall be responsible for coordinating the location of typical pipe supports with the Engineer.

1.2 REFERENCES

A. The following standards may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.

2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.

3. ASTM International (ASTM):

   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

4. International Code Council (ICC):

5. International Building Code (IBC).

6. International Mechanical Code (IMC).

7. Manufacturers' Standardization Society (MSS):

   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.

b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.3 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger and 4 inches and smaller. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number. Show coordination of support system materials to match specified materials.

2. Revisions to existing support systems resulting from changes in related piping system layout or addition of flexible joints.

B. Informational Submittals:

1. Maintenance information on piping support system.

1.4 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.

2. Mixing stainless steel with other steel types in a pipe support system is unacceptable.

3. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Materials

1. Pipe supports for non-metallic piping:

a. Inside the ground floor of the Chemical Building: FRP

b. Inside the second floor of the Chemical Building: Stainless Steel Type 316 or FRP

c. Inside the Soda Ash Building: Stainless Steel Type 316 or FRP

d. Exterior locations:

1) Steel galvanized per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M; or

2) Steel factory coated with fusion bonded epoxy or vinyl copolymer.

2. Anchors and fasteners:

a. All anchors and fasteners used within the ground floor of the Chemical Building shall be Hastelloy-C, or a non-metallic material compatible with the chemicals in that room.

b. All anchors and fasteners used within the second floor of the Chemical Building, within the Soda Ash building and in exterior locations shall be Stainless Steel Type 316.

C. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.

2. Maximum Support Spacing:

a. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.

b. Support piping larger than 2-inches on horizontal and vertical runs at maximum 10 feet on center, unless otherwise specified.

c. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.

d. For tubing, PVC pipe 1-inch and smaller, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose, support at intervals short enough to prevent sagging greater than 1/4-inch between supports.

e. Do not suspend or support valves, pipe and fittings from another pipe or conduit

3. Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.

D. Design, size, and space support anchoring devices – including anchor bolts, inserts, and other devices used to anchor support –to withstand shear and pullout loads imposed by loading and spacing on each support.

E. Vertical Sway Bracing: 10-foot maximum centers or as shown.

F. Existing Support Systems: Use existing support systems to support new piping only if Contractor can demonstrate the existing supports are adequate for the additional load, or if the existing supports are strengthened to accommodate the additional load.

PART 2 PRODUCTS

2.1 GENERAL

A. When specified items are not available, fabricate pipe supports from the correct material and in accordance with the general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.2 HANGERS

A. Clevis: MSS SP 58, Type 1:

B. Pipe clamps: MSS SP-58, Type 4:

C. Heavy pipe clamp: MSS SP-58, Type 4:

D. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

E. Adjustable ring hangers: MSS SP-58, Type 7 or Type 9

F. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

G. Pipe Rollers and Supports: MSS SP 58, Type 44:

H. Eye bolts:

1. For stainless steel piping:

a. Type 316 stainless steel, welded and rated equal to full load capacity of rod.

2. For all other piping:

a. Welded and rated equal to full load capacity of rod.

I. Welded eyebolt rod:

1. For stainless steel piping:

a. Nibco-Tolco, Figure 101.
b. FM Stainless Fasteners.

2. For all other piping:

a. Anvil International, Figure 278.

b. Bergen-Power, Figure 93.
c. Cooper B-Line Systems, Inc., Figure B3210.

J. Spring hangers:

1. For stainless steel piping:

a. Bergen-Power, Figure 920.

2. For all other piping:

a. Anvil International, Figure B-268, Type G.
b. Bergen-Power, Figure 920.

K. Welded beam attachment: MSS SP-58, Type 22:

2.3 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 32 with back plate (medium-duty, rated for 1,500 pounds):

B. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

C. Adjustable "J" hanger MSS SP 58, Type 5:

D. Offset Pipe Clamp:

1. For stainless steel piping:

a. Nibco-Tolco, Figure 8.
b. Cooper B-Line Systems, Inc., Figure 3148.

2. For all other piping:

a. Anvil; Figure 103.
b. Cooper B-Line Systems, Inc., Figure B3148.

E. Adjustable Offset Pipe Clamp:

1. For stainless steel piping:

a. Nibco-Tolco, Figure 4.
b. Cooper B-Line Systems, Inc., Figure B3149.
c. FM Stainless Fasteners, Figure 63.

2. For all other piping:

a. Anvil; Figure 100.

b. Cooper B-Line Systems, Inc., Figure B3149.

F. Channel Type, to match pipe support material:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.4 PIPE SADDLES

A. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.

2. Nonadjustable Saddle: MSS SP Type 37 with U-bolt.

a. For stainless steel piping:

1) Nibco-Tolco, Figure 318.
2) FM Stainless Fasteners, Figure 59.

b. For all other piping:

1) Anvil International, Figure 259.
2) Bergen-Power, Figure 125.
3) Cooper B-Line Systems, Inc., Figure B3090.

c. Threaded pipe stand support stanchion. Match pipe support material.

1) Anvil International, Figure 63T.
2) Bergen-Power, Figure 138.
3) Cooper B-Line Systems Inc., Figure B3088ST.

d. Adjustable Saddle: MSS SP 58, Type 38 without clamp. Match pipe support material.

1) Anvil; Figure 264.
2) B-Line; Figure B3092.

2.5 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Material type to match specified pipe support material.

E. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).
6. Or equal.

2.6 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.

2. Fire Retardant: ASTM E84.

3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.

2. Identify and highlight in Shop Drawing any non-FRP fasteners or components.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.
4. Or equal.

2.7 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. For stainless steel piping:

a. Cooper B-Line Systems, Inc., Figure B3373.
b. FM Stainless Fasteners, Figure 61.

2. For all other piping:

a. Anvil International, Figure 261.
b. Bergen-Power, Figure 126.
c. Cooper B-Line Systems, Inc., Figure B3373.

2.8 ELBOW AND FLANGE SUPPORTS

A. Material type to match specified pipe support material.

B. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

C. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

D. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.9 INTERMEDIATE PIPE GUIDES

A. Material type to match specified pipe support material

B. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, or equal.

C. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. For stainless steel piping:

a. Nibco-Tolco, Figure 110.
b. Cooper B-Line Systems, Inc., Figure B3188.
c. FM Stainless Fasteners, Figure 37.

2. For all other piping:

a. Anvil International, Figure 137 or Figure 137S.

b. Bergen-Power, Figure 283.
c. Cooper B-Line Systems, Inc., Figure B3188 or Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

A. Material type to match specified pipe support material

B. Type: Spider.

C. Manufacturers and Products:

1. Anvil; Figure 255.
2. B-Line; Figure B3281 through Figure B3287.
3. Or equal.

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.
B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B, or equal.

2.12 ACCESSORIES

A. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.

2. Manufacturer and Products:

a. B-Line; B1999 Vibra Cushion.
b. B-Line; Iso Pipe, Isolation Tape.
c. Or equal.

B. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.

2. Manufacturers and Products:

a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.
c. Or equal.

C. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.

2. Manufacturers and Products:

a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.

b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.
c. Or equal.

D. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.

2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger, or equal.

E. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

1. Hanger Rods:

a. For stainless steel piping:

1) Bergen-Power, Figure 94.
2) FM Stainless Fasteners.

b. For all other piping:

1) Anvil International, Figure 146.
2) Bergen-Power, Figure 94.

2. Hanger rods, continuously threaded: Sized to match suspended pipe hanger:

a. For stainless steel piping:

1) Bergen-Power, Figure 94.
2) FM Stainless Fasteners.

b. For all other piping:

1) Anvil International, Figure 146.
2) Bergen-Power, Figure 94.

F. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.

2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

3. Welded Beam Attachment: MSS SP 58, Type 22.

a. Anvil; Figure 66.

b. B-Line; Figure B3083.

4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.

5. Concrete Attachment Plates:

a. Anvil; Figure 47, Figure 49, or Figure 52.
b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.

2. Install pipe hanger rods plumb, within 4 degrees of vertical.

3. Support, suspend, or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, overstressing, or movement of piping; and to prevent thrusts or loads on or against connected pumps and other equipment.

4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.

5. Support no pipe from pipe above it.

6. Support pipe at:

a. Any change in direction.
b. Both sides of flexible pipe connections.
c. Base of risers.
d. Floor penetrations.
e. Connections to pumps, blowers, and other equipment.
f. Valves and appurtenances.

7. Do not use adhesive anchors for attachment of supports to ceiling or walls.

8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.

10. Install lateral supports for seismic loads at changes in direction.

11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.

12. Repair mounting surfaces to original condition after attachments are completed.

13. Field verify support location, orientation, and configuration to eliminate interferences prior to fabrication of supports.

14. Carefully determine locations of inserts. Anchor to formwork prior to placing concrete.

15. Coordinate location of concrete pipe pedestals with floor slab rebar drawings.

16. Use flush shells only where indicated on the Drawings.

17. Do not use anchors relying on deformation of lead alloy.

18. Do not use powder-actuated fasteners for securing metallic conduit or steel pipe larger than 1-inch to concrete, masonry, or wood.

19. Suspend pipe hangers from hanger rods and secure with double nuts.

20. Install continuously threaded hanger rods only where indicated on the Drawings.

21. Use adjustable ring hangers or adjustable clevis hangers for 4-inch and smaller diameter pipe.

22. Use adjustable clevis hangers for pipe larger than 4 inches in diameter.

23. Secure pipes with double nutted U-bolts or suspend pipes from hanger rods and hangers.

24. Stainless steel pipe supports must consist of all stainless steel materials.

25. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

26. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

27. Provide elbows or tees supported from floors with base fittings where indicated on the Drawings.

28. Support base fittings with metal supports or when indicated on the Drawings support on concrete piers.

29. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

30. Support plumbing drainage and vents in accordance with plumbing code.

31. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plated, copper throughout, or isolated with neoprene or polyvinyl chloride tape.

32. Where pipe is insulated, install over-sized supports and hangers.

33. Install insulation shield in accordance with MSS SP-58, Type 40. Shield shall be galvanized steel unless otherwise specified or indicated on the Drawings.

34. Install riser clamps at floor penetrations and where indicated on the Drawings.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:

   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.

2. Horizontal Piping Supported from Walls:

   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.

   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.

   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.

3. Horizontal Piping Supported from Floors:

   a. Saddle Supports:

      1) Pedestal Type, elbow and flange.
      2) Provide minimum 1-1/2-inch grout beneath baseplate.

   b. Floor Mounted Channel Supports:

      1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.

2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.

3) Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Insulated Pipe:

a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.

b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).

c. Wall-mounted pipe clips not acceptable for insulated piping.

5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:

a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).

b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

1) These lines include air operated diagram pumps and other lines

2. Steel Beams: I-beam clamp or welded attachments.

3. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.

4. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.

5. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.

2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.

3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

E. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.

2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.

3. Dielectric Barrier:

a. Provide between painted or galvanized carbon steel members and copper pipe.

b. Stainless steel piping and stainless steel supports should not be in contact with any other ferrous material to provide a need for a dielectric barrier.

c. Install rubber wrap between submerged metal pipe and oversized clamps.

END OF SECTION

SECTION 40 05 31 - THERMOPLASTIC PIPE AND TUBING

PART 1 GENERAL

1.1 SUMMARY

A. Work under this Section applies to the furnishing and installation of thermoplastic pressure pipe fittings and special items for exposed service, including insulation for all pipe located outside of conditioned spaces buildings. The Contractor shall furnish and install thermoplastic pressure pipe, fittings and all appurtenant work, complete in place, in accordance with the requirements of the contract Documents.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. B16.12 - Cast Iron Threaded Drainage Fittings.

B. ASTM International (ASTM):

1. D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.

2. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

3. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.

4. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

5. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

6. D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.

7. F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

8. F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

9. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

10. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

11. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.

C. American Water Works Association (AWWA):

1. C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches to 12 Inches, for Water Transmission Distribution.

D. NSF International (NSF).

1.3 ABBREVIATIONS

A. CPVC: Chlorinated polyvinyl chloride.
B. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

A. Submit as specified in Section 01 33 00 - Submittal Procedures.

B. Product data: Submit manufacturer's catalog information for each product specified: pipe, fittings, gaskets, and solvent cement.

1. Provide information demonstrating products meet or exceed specified requirements.
2. Submit manufacturer installation instructions, including any special procedures.

3. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

4. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 QUALITY ASSURANCE

A. Provide pipe and tubing bearing NSF seal.

B. Plastic pipe shall be marked with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required in accordance with ASTM and AWWA standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle all thermoplastic pipe and fittings in accordance with manufacturer's published recommendations and instructions.

PART 2 PRODUCTS

2.1 MATERIALS

A. For extruding and molding, use only virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings shall be the same material as the pipe and of equal or greater pressure rating.

1. Where indicated on the drawings, provide long radius fittings.

2. For chemical applications, use only socket and flanged connections.

a. Sodium Hypochlorite

1) Viton or Teflon gaskets.

b. Coagulant, fluorosilicate and polymer

1) Viton, EPDM or Teflon gaskets.

C. Unions 2-1/2 inches and smaller: Socket end screwed unions.

D. Unions 3 inches and larger: socket flanges with 1/8-inch full-face soft gasket. Gasket materials shall be EPDM or Viton gasket, as appropriate for fluid being transported in accordance with 2.1.B of this section.

2.2 PVC PIPING, SCHEDULE TYPE

A. Materials:

1. PVC Pipe:

a. Designation PVC 1120 in accordance with ASTM D1785:

b. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454 material in accordance with ASTM D1784.

c. PVC Pipe: Schedule 80, unless otherwise indicated on the Drawings.

2. Fittings:

a. Fittings shall be supplied by the pipe manufacturer.
b. Pressure fittings: In accordance with ASTM D2466 or ASTM D2467.

3. Solvent cement:

a. In accordance with ASTM D2564:

b. Chemical service: For CPVC or PVC pipe in chemical service, provide the following primer and cement, or equal certified by the manufacturer for chemical service:

1) Primer: IPS Corp., Type P70.
2) Cement: IPS Corp., Type 724 cement or

2.3 CPVC PIPING

A. Materials:

1. CPVC pipe: Schedule 40 or Schedule 80, as specified, in accordance with ASTM F441 and Appendix, CPVC 4120:

a. Pipe: Extruded from Type IV, Grade 1, Class 23447 material in accordance with ASTM D1784.

b. Manufacturers:

1) Charlotte Pipe and Foundry Co.
2) Eslon Thermoplastics, Inc.
3) GF Harvel.
4) Or equal

2. Fittings:

a. In accordance with ASTM F438 or ASTM F439 for pressure fittings, as appropriate to the service and pressure requirement:

b. Fittings shall be supplied by the same manufacturer as the pipe.

c. Manufacturers: One of the following or equal:

1) Spears Manufacturing Co.
2) Colonial Engineering.
3) Eslon Thermoplastics, Inc.

4) Chemtrol.

3. Solvent cement: In accordance with ASTM F493:

a. For CPVC pipe in chemical service, utilize IPS Corp., Type 724 cement or another cement certified by the manufacturer for high strength hypochlorite service.

2.4 PFA TUBING AND FITTINGS

A. Materials:

1. Small bore PFA tubing: ASTM D 3307 Type II, Natural color, OD copper tubing size.

a. Plastic tubing inside diameter (ID) shall be as follows:

1) For nominal 1/4 inch, ID of 0.188 inch.
2) For nominal 5/16 inch, ID of 0.250 inch.
3) For nominal 3/8 inch, ID of 0.313 inch.
4) For nominal 1/2 inch, ID of 0.438 inch.
5) For nominal 3/4 inch, ID of 0.625 inch.
6) For nominal 1 inch, ID of 0.875 inch.
7) For nominal 1-1/8 inch, ID of 1 inch.

b. Fittings: Compression fittings.

c. Manufacturers:

1) Altaflo, Altraflour 400
2) Parker Hannifin Corp., 104 Series Heavy Wall.
3) Or equal

2.5 ACCESSORIES

A. Camlock Style Fittings

1. Provide male fittings with a tight fitting, leak proof cap.

2. Materials:

a. Sodium Hypochlorite

1) PVC or 316 stainless steel with Viton or Teflon seals.

b. Coagulant

1) PVC, polypropylene, or PVDF with Viton, EPDM, or Teflon seals.

3. Manufacturers:

    a. Banjo Corp.
    b. Bee Valve, Inc.
    c. Or equal

2.6 INSULATION

A. All exposed piping, valves and fittings located outside a heated space shall be provided with insulation, minimum one-inch thickness.

B. All components of the insulation, including covering, mastics and adhesives shall have a flame spread rating of not over 25, and a smoke development rating of not over 50. Ratings shall be as established by tests in accordance with ASTM E 84 and Federal Specification standards. Insulation shall be applied in strict accordance with the manufacturer's instructions.

C. Pipe insulation shall be molded-type pipe covering made of fibrous glass with a minimum K-factor of 0.23 at 75°F mean temperature.

D. Insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of Kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn.

E. Fittings and valves shall be covered with the same material as the pipe. Material shall be cut in segments to fit snugly without open spaces and held in place with stainless steel wire or an adhesive specified as compatible with the insulation material by the manufacturer. Insulated fittings and valves covered with insulation shall then be covered with the same jacketing material as the pipe.

F. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket. Pipe insulation and vapor-barrier shall be continuous through hangers and supports.

G. Where insulation protection shields are provided, the top half section of pipe insulation at support locations shall be of the same specified density; and the bottom half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb./cu. ft.

H. All insulation shall be covered with smooth, aluminum weatherproof metal or plastic preformed jacketing with a factory-attached moisture barrier. The jacket for the fittings shall consist of precision-formed smooth-sided sections and shall be sized to cover and protect the insulated fitting. Each section shall be manufactured from aluminum or PVC and all joints shall be sealed with silicon mastic or solvent welding to provide a continuous, air and weathertight joint. Strapping shall be 1/2-inch wide or stainless steel.

I. Manufacturers, or Equal

1. Armstrong Contracting and Supply Corporation
2. Certain-Teed Corporation
3. Manville
4. Owens-Corning Fiberglass Corporation
5. PPG Industries, Inc.

2.7 SOURCE QUALITY CONTROL

A. PVC piping, Schedule Type:

1. Mark pipe and fittings in accordance with ASTM D1785.

B. PVC piping, Class Type:

1. Hydrostatic proof testing in accordance with AWWA C900: Test pipe to withstand, without failure, two times the pressure class of the pipe for a minimum of 5 seconds.

C. CPVC piping:

1. Pipe and fittings shall be marked in accordance with ASTM F441.

PART 3 EXECUTION

3.1 GENERAL

A. 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, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill, and encasement, to provide a functional installation.

B. Pipe shall be installed in accordance with good trade practice. The methods employed in handling and placing of pipe, fittings, and equipment shall be such as to insure that after installation and testing they are in good condition. Should damage occur to the pipe, fitting or equipment, repairs satisfactory to the Engineer shall be made.

C. Wall penetrations: Seal exterior wall penetrations watertight with mechanical sleeve seals or grout, as shown in the Drawings.

3.2 INSTALLATION

A. General:

1. Install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.

2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.

3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.

4. Provide serrated nipples for transition from plastic pipe to hose or tubing.

B. Installation of PVC piping, Schedule Type:

1. Solvent weld joints in accordance with ASTM D2855:

a. For PVC pipe in chemical service use IPS Corp., Type 724 cement in accordance with manufacturer's instructions.

2. Install piping in accordance with manufacturer's published instructions.

C. Installation of CPVC piping:

1. Clean dirt and moisture from pipe and fittings.

2. Bevel pipe ends in accordance with manufacturer's instructions with chamfering tool or file. Remove burrs.

3. Use solvent cement and primer formulated for CPVC:

a. For CPVC pipe in chemical service use IPS Corp., Type 724 cement in accordance with manufacturer's instructions.

4. Use primer on pressure and non-pressure joints.

5. Do not solvent weld joints when ambient temperatures are below 40 degrees Fahrenheit or above 90 degrees Fahrenheit, unless solvent cement specifically formulated for the conditionis utilized.

D. Installation of PFA Tubing:

1. Install small bore tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.

2. Bundle tubing in groups of parallel tubes within protective sheath.

3.3 CLEANING, TESTING, AND DISINFECTION

A. Flush all lines prior to testing. Use available plant water for flushing. To prevent introduction of construction debris into plant unit operations, flush lines in the reverse direction. Convey all flush water to a sanitary sewer.

B. Piping shall be hydrostatically tested in accordance with manufacturer's recommendations. Slowly fill each line being tested with water to the highest point, allowing any air in the system to escape as the water rises in vertical sections. Expel all air trapped in the system prior to the beginning the test. Replace any joints that cause failure of a hydrostatic test, then retest the line.

C. Disinfect the fluorosilicate line after cleaning and hydrostatic testing.

END OF SECTION

SECTION 40 05 59.23 – INSTALLATION OF OWNER-FURNISHED SLIDE GATE

PART 1 GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall install an Owner-furnished slide gate, complete and operable, as shown on the Drawings and specified herein.

B. OWNER shall provide to CONTRACTOR the slide gate manufacturer's shop drawings, written installation instructions and a list of the components supplied by the gate manufacturer.

C. OWNER shall furnish attaching bolts and anchor bolts provided by the gate manufacturer. CONTRACTOR shall furnish all other appurtenances necessary for the installation of the gate and shall conduct field testing to confirm proper operation after installation.

1.2 ACTION SUBMITTALS

A. Product Data: Manufacturer's product information for any appurtenances necessary for the installation of the gate not provided by OWNER.

B. Dewatering Plan: CONTRACTOR shall submit a detailed plan for plugging the pipe between the raw water canal and the valve pit and for maintaining dewatered conditions within the valve pit and the raw water clearwell. Dewatering plan shall ensure the safety of all personnel throughout the process of installing the gate and inspecting the installed gate.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 INSTALLATION

A. Slide gate shall be installed in accordance with the plans and specifications, and in full conformity with the written instructions and recommendations of the equipment manufacturer.

3.2 TESTING

A. Operational testing of the slide gate will be performed after the CONTRACTOR has completed the installation of all necessary equipment for proper operation. The

field tests will demonstrate that the leakage rate is below the manufacturer's maximum.

END OF SECTION

SECTION 40 05 60 - MISCELLANEOUS VALVES AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes: Miscellaneous valve for the chemical systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

1.3 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:

1. Plastic body ball valves on plastic pipelines.

B. Do not use metal body ball valves in sodium hypochlorite or sodium bisulfite systems.

C. Products shall meet the requirements of NSF 61.

1.4 SUBMITTALS

A. Submit as specified in Section 01 33 00 - Submittal Procedures.

B. Product data:

1. Submit manufacturer's latest published literature. Include illustrations, installation instructions and parts lists.

2. Operation and maintenance manual.

C. Commissioning submittals:

1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section– 01 75 16 Testing, Training and System Start-Up.

1.5 WARRANTY

A. Provide warranty as specified in the Contract Documents

PART 2 PRODUCTS

2.1 PLASTIC BODY BALL VALVES

A. Manufacturers: One of the following or equal:

1. Asahi America.
2. Chemtrol Division, NIBCO, Inc.
3. Georg Fischer Piping Systems.
4. Hayward Flow Control.
5. Plast-O-Matic Valves, Inc.

B. General:

1. Type: Non-lubricated and capable of sealing in either flow direction.
2. End connections: True union; solvent or heat welded to piping.
3. Operator handle: Lever.
4. Vented ball required for all valves used for hypochlorite service.

C. Materials:

1. Body: Polyvinyl chloride (PVC).

2. Ball: Polyvinyl chloride (PVC).

3. Seats and O-rings:

a. 15% Sodium Hypochlorite

1) Viton or Teflon.

b. 50% Aluminum Chlorohydrate

1) Viton or Teflon.

2.2 ELECTRIC ACTUATORS FOR BALL VALVES

A. Manufacturers: One of the following or equal:

1. Hayward Flow Control – Model HZSN1
2. Asahi America – Series 17

B. Requirements:

1. High efficiency reversing DC brush-type, class B motor.
2. NEMA 4X enclosure.
3. Quarter turn

4. Voltage: 120 V
5. Torque: up to 266 in-lbs.

C. Control:

1. Open/closed control with limit switch to send open/closed status signal.
2. Actuator override to allow manual valve operation.

2.3 SOLENOID VALVES

A. 2-way solenoid valves:

1. Manufacturers: One of the following or equal:

a. Automatic Switch Co., Series 8210.
b. Skinner Electric Valve Division, Series C.

B. Design:

1. Valves: Suitable for service under the following conditions:

a. Fluid; Water.
b. Temperature of fluid: 50-75 degrees Fahrenheit.
c. Piping test pressure: 150 pounds per square inch gauge.

2. Unless otherwise indicated on the Drawings, provide valves that meet the following requirements:

a. Minimum NEMA Type 4 enclosure.
b. 120 VAC operation.
c. Suitable for use as indicated on the Drawings.
d. Minimum Class F coil insulation.

3. 2-way valves: Furnish with openings of size equal to or larger than the nominal size designation of the valve.

4. Furnish with manual/bypass operators.

C. Materials:

1. Body: Brass or bronze.
2. Seats: Resilient material.

2.4 PLASTIC BALL CHECK VALVES

A. Manufacturers: One of the following or equal:

1. Chemtrol Division of Nibco.
2. Georg Fischer Piping Systems.
3. Plast-O-Matic Valves, Inc.
4. Hayward Flow Control.
5. Asahi America

B. Valves: Ball type:

1. Material: Polyvinyl chloride.
2. End connection: Double-or single-union-type.

C. Valve body material:

1. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), Polypropylene (PP) or polyvinylidene fluoride (PVDF), as best suited for each individual service condition.

D. Union connections material:

1. Socket ends conforming to ASME B16.5 pipe flanges and flange fittings, Class 150.

E. Seats and seals material:

1. 15% Sodium Hypochlorite
    a. Viton or Teflon.
2. 50% Aluminum Chlorohydrate
    a. Viton or Teflon.

F. Maximum inlet pressure rating:

1. PVC, CPVC, or PVDF: 150 pound per square inch at 77 degrees Fahrenheit.
2. PP: 100 pounds per square inch at 77 degrees Fahrenheit.

2.5 WATER PRESSURE REDUCING VALVES

A. Water pressure reducing valves, 2 1/2 inches and smaller:

1. Manufacturers: One of the following or equal:
    a. Watts Regulator, Series LF223.

b. Wilkins, 500 Series.

2. Direct operated, single seat type pressure reducing valve.

3. Materials:

a. Body and spring cover: Bronze.
b. Valve seat: Series 300 stainless steel.
c. Diaphragm: Reinforced Buna Nitrile.
d. Disk: EPDM.

2.6 PLASTIC BODY DIAPHRAGM VALVES

A. Manufacturers: One of the following or equal:

1. Asahi America.
2. Plast-O-Matic Valves, Inc.
3. Approved equal

B. General:

1. Type: weir, with rising stem
2. End connections: flanged, unless specified otherwise on the Drawings.
3. Operation: manual, handwheel.

C. Pressure Rating: 150 PSI.

D. Materials:

1. Body: Polyvinyl chloride (PVC), unless specified otherwise on the Drawings.

2. Bonnet: Polyvinyl chloride (PVC).

3. Diaphragm, seats and O-rings:

a. 15% Sodium Hypochlorite

1) Viton or Teflon.

b. 50% Aluminum Chlorohydrate

1) Viton or Teflon.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Special techniques:

1. PVC ball valves for hypochlorite service:

a. Provide valve with factory drilled 0.125-inch hole in the upstream side of the ball.

b. Provide an engraved plastic tag permanently attached to the valve stem stating "One side of ball drilled for hypochlorite service".

3.2 COMMISSIONING

A. As specified in Section 01 75 16 Testing, Training and System Start-Up and this Section.

B. Functional testing:

1. Valves:

a. Test witnessing: Witnessed.

b. Conduct pressure and leak test.

END OF SECTION

SECTION 40 61 13 – PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies general requirements which are applicable to providing instrumentation and controls for the process system

B. The requirements of this section are applicable to all work to be completed by the System Integrator and as specified in all sections of 40 67 00, 40 70 00, 40 72 23, 40 72 76, and 40 80 00.

C. Electrical requirements applicable to this work are specified in Division 26.

D. Section includes:

1. Quality Assurance.
2. Submittals.
3. Performance Requirements.
4. Functional Requirements.
5. Products.
6. Installation.
7. Testing.
8. Manufacturers Services.

1.2 SCOPE

A. The work consists of a qualified System Integrator to provide the requirements on this specification section as well as those listed or referenced herein.

1. New primary process measurement devices, instrumentation and new process auxiliary devices.

2. New SCADA system hardware including digital process controllers (PLC based) IO modules, power modules, and communication modules.

3. New custom control panels, control stations, junction boxes, and control power distribution panels.

4. Process control system networking.

5. Modification of existing instrumentation and control for process systems.

6. Submittal documentation for process systems instrumentation and control including schedules, drawings, product manuals.

7. Maintaining construction RECORD/AS BUILT of submittal documentation and incorporating interconnection detail from other sections submittals to show accurately process systems instrumentation and control wiring as complete from circuits start and end connections.

8. Configuration set up, calibration, testing process systems instrumentation and controls.

9. Training.

10. Collaboration with System Programmer to provide or modify a fully integrated PLC based SCADA system.

11. Assemble process control hardware into customized fabricated process control panel(s).

12. Factory test process control panel customized fabrication(s).

13. Deliver and install process control panel customized fabrication(s) on site.

B. PROGRAMMING: The Owner's Programmer provides process control system PLC, SCADA and OIT application programming under a separate contract.

1.3 DEFINITIONS

A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

B. VENDOR PACKAGE PROCESS CONTROL SYSTEM: A system of equipment and hardware provided by a vendor used for control, monitoring process conditions, control feedback and process performance for an associated vendor package equipment system which interfaces to the control system.

C. TWO-WIRE TRANSMITTER: An instrument which derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit from a 24-volt direct current driving potential and a maximum circuit resistance of 600 ohms. A two-wire transmitter is also referred to as looped power.

D. FOUR-WIRE TRANSMITTER: An instrument which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120Vac or 24Vdc input power supply.

E. GALVANIC ISOLATION: Electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs which are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

F. PANEL: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems including consoles, cabinets and racks. Panels provide mechanical protection, electrical isolation, and protection from dust, dirt, moisture, and chemical contaminants which may be pre- sent in the atmosphere.

G. DATA SHEETS: Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.

H. SIGNAL TYPES:

1. LOW-LEVEL ANALOG: Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.

2. HIGH-LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.

3. PULSE FREQUENCY: Counting pulses emitted from speed or flow transmitters.

4. DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits typically rated for 120 volts AC or 24 volts DC.

I. SYSTEMS INTEGRATOR: A firm engaged in the business of detailed control system design and engineering, custom panel fabrication, instrumentation component purchase, instrumentation tuning, system and panel assembly, and testing the specified process control and industrial automation systems.

J. SYSTEMS PROGRAMMER: The Owner's hired programmer providing the PLC and SCADA application programming.

K. OIT: Acronym for Operator Interface Terminal

L. SCADA: Acronym for Supervisory Control And Data Acquisition

M. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project

1.4 QUALITY ASSURANCE

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of

conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or other- wise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

1.5 SYSTEMS INTEGRATOR RESPONSIBILITY

A. GENERAL

1. The specified control system and instrumentation integration including panel modifications, instrument calibration, testing, startup, operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.

2. The control system components shall, as far as practical, be of one manufacturer.

3. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.

4. The specified system performance shall be demonstrated to and accepted by the Owner, the Systems Programmer and the Engineer.

B. PRE-SUBMITTAL CONFERENCE:

1. Schedule a pre-submittal conference with the Owner and Engineer within 30-calendar days after Contract award to discuss the work equipment, submittal format, and establish the framework for project coordination and communication.

   a. Provide materials 10-days prior to the conference:

b. Instrument Schedule with manufacturer and model number added.

c. Product descriptive literature with a statement that the item is as specified.

d. Proposed equal products with comparative listing of the published specifications for the specified item and the proposed item.

e. A copy of this specification section, with addendum up- dates 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.

2. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

C. PROCESS EQUIPMENT COORDINATION

1. Systems Integrator shall provide wiring interconnect diagrams for the plant process control system to interface with submitted vendor equipment panels and devices. The wiring diagrams shall be a complete representation of the process control requirements for specific equipment. Systems Integrator coordinates to collect equipment wiring information from other Sections to show a totally wired integrated control system.

2. Integrate, furnish, and install equipment in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.

3. Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.

5. Systems Integrator shall provide installation supervision for the duration of the project.

6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Owner for resolution before proceeding.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

    a. Mark data sheets to clearly show exact product and options being provided.

2. Manufacturer's installation instruction excerpts that apply to this project:

    a. Mounting requirements
    b. Electrical connection diagrams
    c. Calibration procedures
    d. Operation and maintenance information
    e. Warranty information

C. SUBMITTAL DRAWINGS

1. GENERAL

    a. Prepare drawings in AutoCAD version 2018 or later with borders and titleblocks identifying the project and system.

    b. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers

    c. The drawing numbers and file names are to be based on equipment tag numbers

    d. Provide the following submittal drawings

        1) Arrangement and layout drawings

            a) Contract document’s drawings are typical illustrations of panel hardware/component arrangement and layouts representing one or more than one panel with similar interconnection requirements. Provide the unique panel arrangement, layout and outline drawings. Show arrangement and layout to scale. Add components and wiring to the unique panel drawings as required to complete a fully integrated operation. Include on the drawings a Bill of Material that identifies all components in the arrangement and layout.

        2) Schematic diagrams

            a) Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices

include IO module layout connections. Show terminal blocks used for internal wiring or field wiring, identified as such

3) Loop diagrams

a) Provide the unique loop diagram for each piece of equipment.

4) Network block diagram

a) A network block diagram is a diagram of the control system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols].

PART 2 PRODUCTS

2.1 GENERAL

A. MATERIALS AND QUALITY:

1. Provide process control hardware new, free from defects, and industrial- grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.

2. Electronic process control hardware shall be of solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.

B. ENCLOSURES: NEMA rating for the location and application shown herein and as specified in Section 40 67 16, 40 67 19, Division 26, and as shown on the drawings.

Location	Enclosure Material and NEMA Rating
Indoor Dry	NEMA 12: mild steel
Indoor Wet	NEMA 12: mild steel when specified with mounting pad or legs for minor splash resistance) or NEMA 4X: 316 Stainless Steel
Outdoor	NEMA 4X: 316 Stainless Steel
Process Corrosive	NEMA 4X: 316 Stainless Steel
Chemical Corrosive	NEMA 4X: 316 Stainless Steel
Hazardous Area:	NEMA 7: Galvanized Malleable Iron or Aluminum or NEMA 4X and UL listed or FM Approved for the Hazardous Area.

2.2 NAMEPLATES

A. Provide nameplates for all field mounted instrument, analyzer, or equipment. Include the equipment title, the equipment tag number, and power source(s) in the nameplate inscription. Provide machine engraved laminated black phenolic nameplates with white lettering for equipment identification with 1/8-inch high lettering.

2.3 SPARES:

A. Provide 10% spare for most components or at least one spare for each panel component unless a larger specific requirement is listed herein.

1. Power Supplies – 1 of each type used
2. Terminal Blocks – 5 of each type used
3. Fuse – 5 of each type used
4. Circuit Breakers – 2 of each type and size used
5. Surge Protection Devices – 1 of each type used
6. Relays – 2 of each type used
7. Relays Bases – 1 of each type used
8. UPS - 1 of each type used
9. PLC Modules – 1 of each type used

PART 3 EXECUTION

3.1 INSTALLATION

A. Install process control hardware in locations that are accessible for operation and maintenance services. Process control hardware not accessible shall be reinstalled at no cost to the Owner.

B. Install process control hardware in accordance with product manufacturer's requirements.

C. Ensure process control hardware is grounded per NEC and manufacturer's requirements.

D. Provide proper clearance for process control hardware for heat dissipation and access.

E. Ensure UL/FM or equal listings/markings/labels are viewable after installation.

F. Provide secure mounting of all process control hardware (such as DIN rail mount).

G. Provide electrical circuit protection for process control hardware if not integral.

3.2 TESTING

A. DELIVERY INSPECTION: Notify the Owner upon arrival of any material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner may inspect such items.

B. REQUIREMENTS: Section 40 80 00.

3.3 MANUFACTURER'S SERVICES

A. TRAINING: Provide a factory-trained manufacturer's representative or System Integrator skilled in equipment use at the Site for the following activities. Specified durations do not include travel time to or from the Site.

B. Coordinate training with operations and maintenance staff schedules to ensure all required staff can attend.

C. Training to include configuration, operation, trouble shooting, wiring, calibration, testing, installation, safety, and warranty coverage for each process control hardware type.

D. Certify completion of training.

END OF SECTION

SECTION 40 67 00 – CONTROL SYSTEM PANELS AND HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Panel Information
3. Panel Design
4. Quality Assurance
5. Submittals
6. Performance Requirements
7. Products
8. Execution

1.2 SCOPE

A. This section specifies requirements for process control panels and hardware required for custom fabrication.

B. Provide the instrument, control, and monitoring features indicated on the electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels for Hazardous (Classified) Locations shall bear the appropriate UL 698A label.

C. Panels that contain programmable logic controllers (PLC) are as shown on the drawings.

D. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier’s facility for corrections, testing, relabeling and inspection.

E. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.

F. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that include motor controllers,

combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.

G. Label panels with fault current rating per NEC article 409.110.

1.3 PANEL INFORMATION:

A. Panel information is provided on drawings. The drawings indicate enclosure NEMA rating required, panel nameplate inscription, and other accessories, etc.

1.4 PANEL DESIGN

A. GENERAL: Panel control system hardware is specified in other Division 40 sections and as shown on the drawings.

B. CONTROL POWER DISTRIBUTION: Panel containing 120-volt powered equipment use the din-rail power distribution method with fuses and blown fuse indication. Power is restricted to 120 Vac and 24 Vdc.

C. POWER SUPPLIES: Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments contain direct current power supply system as specified herein or shown on the drawings.

D. ELECTRICAL CONTROL DEVICES: Comply with requirements of Section 26 09 16 and the drawings for pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section.

E. UNINTERRUPTIBLE POWER SUPPLIES: Panel mounted 120 Vac input, 120 Vac and 24 Vdc outputs are specified herein or shown on the drawings

1.5 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

B. LISTED PRODUCTS

1. Equipment and components to be Underwriters Laboratory (UL) listed for the purpose per Section 26 05 00 or UL recognized.

2. Provide factory applied UL 508A labels for control panels. Where intrinsic safety barriers are used within a control panel, provide UL 698A factory applied label as required by UL.

C. TESTING:

1. As required per Part 3 of this specification section.

D. SHIPMENT, PROTECTION AND STORAGE:

1. Equipment shall be delivered, stored and handled to prevent damage.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Submittal drawings required:

a. Arrangement drawings of the panel enclosure indicating the front door and panel equipment arrangement and dimensions, and enclosure type.

b. Sections showing clearances between face and rear mounted equipment.

c. Internal wiring connection diagrams

d. External wiring interconnection diagrams including interlocks.

2. List of materials and components with the layout drawings.

3. Nameplate schedule with character size and nameplate size.

4. Heat load calculations for each cabinet based on the highest ambient temperature for the area in which the subject panel will be located.

5. Power supply calculations.

6. Manufacturer's operation and maintenance information. Manual shall include final reviewed submittal redlined to show AS BUILT conditions; and separate record of all final configuration, jumper, and switch settings.

PART 2 PRODUCTS

2.1 FABRICATION

A. GENERAL

1. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring, and/or piping required to make the control panels and/or enclosures complete and operational.

2. Identify face-mounted devices with nameplates including tag number and equipment description. Mount instruments for access to components and ease of removal. Components for installation on panel exterior locate a minimum of 36 inches above the operating floor level and no greater than 60 inches above the operating floor level. Blank off cutouts for future equipment with suitable covers. Identify device tag numbers on the panel rear as well as the panel front.

3. Install face-mounted devices flush or semi-flush with flat-black escutcheons. Face-mounted devices that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel support underneath at the rear by a 1-inch x 1/8-inch thick steel angle.

4. Provide panels less than 60 inches high with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Wall mount panels that weigh less than 100 pounds.

5. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

6. Locate and install all devices and components so that connections can be easily made and ample room is provided for servicing each item. Provide at least 20 percent internal free space inside the panel.

7. Terminate all wiring to panel connections from field instruments, devices, and other panels at master numbered terminal strips.

8. Provide copper grounding bars.

9. Panel doors shall be hung on full-length continuous hinges. Panel hardware (door hinges, screw clamps, door handles, latches, hasps, fasteners, etc.) shall be Type

316 stainless steel. Three-point latch hardware shall be provided for doors exceeding 30 inches height.

10. Face-mounted devices shall be the same NEMA rating as the associated panel.

11. Panels shall be arranged to separate control and instrument devices from power wiring. AC, DC, and digital circuits shall be arranged to be physically separated inside the panel. Digital circuits shall follow the network installation protocol requirements.

12. Provide a minimum of 2 ½ inches between wire ways and terminals.

13. Provide corrosive gas and moisture inhibitors in all panels.

B. PANEL LAYOUT:

1. Provide 20 percent spare contiguous sub-panel area for future expansion.

2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.

3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.

2.2 HEATING, VENTILATING AND COOLING

A. Provide forced air ventilation for panels where indicated on the drawings. Forced air ventilation shall also be provided if the cabinet's heat load calculations indicate that the interior temperature of the cabinet will exceed 115 degrees-F, under worst case conditions.

B. When not specified or shown elsewhere, ventilation for panel racks shall be venturi fans provided on 5-1/2-inch high-notched panel. Ventilation for consoles shall be similar to that for panel racks except EIA RS-310 mounting is not required. Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (CFM). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.

C. Provide outdoor panels with thermostatically controlled space heaters. Space heater surface temperature that exceeds 120 degrees F requires an expanded metal guard. Thermostats: Honeywell T631B1013, Penn Controls A28AA-4, or approved equal.

D. Panel air conditioning cooling requirements a cooling system that does not exchange cabinet interior air with ambient air. The cooling system either a closed glycol loop heat exchange system or a CFC-free refrigeration system as required for the specified equipment and instrument complement and ambient temperature conditions.

E. Panel air conditioner NEMA rated based on the installed area environment and the coils shall be Heresite, or approved equal coated and protected from corrosion.

2.3 PROTECTION COATING AND FINISH

A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

2.4 NAMEPLATES

A. Identify external door-mounted components and the panel description with nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

B. The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the panel title, panel tag number and power source(s) in 3/32-inch minimum size lettering.

C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

D. Attach nameplates to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.

E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.5 PANEL FEATURES

A. CONNECTION WIRING:

1. Panel control wiring: Single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.

2. Panel instrument wiring: Twisted No. 18 AWG shielded pair or tri conductors.

3. Panel power wiring: Conductors specified in Division 26 and meet the NFPA No. 70 NEC requirements for power including phase, grounded, and grounding conductors.

4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.

5. Comply with UL 94, Type V for Wiring channels.

6. Wiring channel fill not to exceed 40 percent per NFPA 70.

B. CONDUCTOR IDENTIFICATION:

1. Wiring colors per Section 26 05 19.

2. Wire tag numbers to indicate to/from termination points and the associated equipment.

3. Wire tag numbers to be machine printed on white sleeves with text 1/8 inches high minimum in permanent black ink.

C. CONDUCTOR INSTALLATION AND PROTECTION:

1. FEATURES:

a. Terminal blocks shall be screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high. DIN rail mounted.

b. Wire connectors ferrule, locking fork tongue or ring tongue insulated crimp type.

c. Power and control wiring carried in covered channels separate from low voltage signal circuits.

d. No more than two connections made to one terminal.

2. MANUFACTURERS:

a. Phoenix Contact, or approved equal.

D. FIELD WIRING: Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel.

E. FUSE AND FUSE HOLDERS:

1. FEATURES:

a. Fuses for 120 Vac Circuits: Minimum of 12,000-amperes interrupting capacity and blown fuse indicators.

b. Fuses for 24 Vdc Loop Circuits: Fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.

c. Fuses for 24 Vdc Power Supply Circuits: 1/2 amp for the power supply to individual instruments.

d. Fuse holders shall be tip-out or draw-out type.

2. MANUFACTURERS: Allen-Bradley, Phoenix Contact or approved equal.

F. CIRCUIT BREAKERS:

1. FEATURES: Provide circuit breaker for branch circuit protection. Circuit breaker UL rated, DIN rail mounted, and trip current rating to be determined based on the circuit load by System Integrator.

2. MANUFACTURERS: Altech, or approved equal.

G. CONTROL POWER:

1. Provide control power transformers, as required for the load.
2. Provide direct current power supplies, as required for the load.
3. Provide UPS for PLC, RIO and derived loop power as defined above, as required for the load.

H. PANEL POWER:

1. Provide a 120 Vac circuit for the panel light, receptacle, heating, fan, heat exchanger, or air conditioner]cooling load as required.

2. Provide a 240 Vac circuit for air conditioning load as required.

I. ACCESSORIES:

1. Provide 120 V AC utility light fixtures with 40-watt (W) lamp and protective plastic shield. Lights to cover the whole width of panel for good illumination inside panel.

2. Provide 120 V AC, 20A, door switches, to turn on the utility light fixtures unless, or as specified on the drawings.

3. Provide one 120 V AC, 20A duplex, ground fault interrupting type receptacle for every 36 inches of panel width.

4. Do not power receptacles and utility light by the UPS, where included.

5. Provide print pocket.

2.6 PANEL GROUNDING

A. Provide each control panel with two copper ground bars.

1. Bond one bar (NEC required) to the panel or panel frame or back-plate and to the facility grounding system.

2. Mount on insulated stand-offs second (signal) ground bar and bond to the panel ground bar only at one point.

    a. Bond signal circuits, signal cable shields, and low-voltage DC power supply commons to the signal ground bar.

    b. Ground field analog wiring shields at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

B. Bond surge protectors and separately derived AC power supplies to the frame ground bar.

C. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.

2.7 PANEL DRAWING PROTECTION

A. Provide wiring diagrams in accordance with Section 01 33 00. Provide a panel- wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.8 DIRECT-CURRENT POWER SUPPLIES

A. FEATURES:

1. Convection-cooled linear type or switching type.

2. Line regulation: 0.4 percent for line variations from 105 to 132 volts.

3. Load regulation: 0.4 percent for load variations from 0 to full load.

4. Ripple and noise: Not exceed 100 mV peak-to-peak.

5. Hold-up time at maximum load: Not less than 16 milliseconds.

6. Continuous duty from 0 to 50 degrees C at rated load.

7. Output electronically current limited.

8. Over-voltage crowbar shutdown.

9. Output voltage:

    a. Rated 24 - 28 Vdc.
    b. Adjustable plus or minus 5 percent.
    c. Set to provide 24.0 volts.

B. MANUFACTURERS: As shown on the drawings, or approved equal.

2.9 120VAC UNINTERRUPTIBLE POWER SYSTEM (UPS)

A. FEATURES:

1. Provide on-line, computer-grade UPS with electrical isolation including output neutral.

   a. Nominal input voltage: 120Vac.
   b. Nominal output voltage: 120Vac.

2. Provide UPS with integral sealed no maintenance batteries, sized to provide full capacity backup power for 10 minute minimum at connected load with integral battery charger.

3. Calculate the required kVA rating at 150 percent of connected load. Submit load calculations, schematic diagrams, and wiring connection diagrams. Provide battery cabling and other required cabling for a complete system.

4. Mount UPS within the panel on a pedestal or tray with stainless-steel legs to provide space for wire entry and passage.

5. Provide contacts for remote monitoring of POWER FAIL and LOW BATTERY as specified on Drawings.

B. MANUFACTURERS: As shown on the drawings, or approved equal.

2.10 24 VDC UNINTERRUPTIBLE POWER SYSTEM (UPS)

A. FEATURES:

1. Provide industrial-grade UPS with electrical isolation. UPS shall consist of direct current power supply, charge controller, and sealed backup battery pack.

   a. Nominal input voltage: 120Vac.
   b. Nominal output voltage: 24Vdc.

2. Provide battery pack with sealed no maintenance batteries, sized to provide 20 AH or better backup power for a current range of 0 to 20A at connected load with battery charger.

3. Calculate dead battery recharge time, recharge after drain cycle, runtime for connected load as specified. Ensure to include inrush current associated with the connected load in calculations. Submit calculations (ensure power cabling has less than 3% voltage drop at the connected load), schematic diagrams, and wiring connection diagrams. Coordinate with battery cabling requirements for wire size required to terminate. Power cabling to be less than 3% voltage drop at the connected load.

4. House UPS assembly in a NEMA 12 enclosure. DIN rail mount UPS within enclosure with circuit breakers for 24 V dc load distribution. Provide a 120 Vac power disconnect on face of panel. Provide power protection/conditioning as required for UL 508A fabrication.

5. Provide dry contacts rated for 120Vac @ at least 0.5 amps for remote monitoring of DC OK, BATTERY FAIL and BATTERY DISCHARGE as specified on Drawings. The use of interposing relays if dry contacts are rated for another voltage can be provided.

B. MANUFACTURERS: As shown on the drawings, or approved equal.

2.11 CONTROL DEVICES

A. Selector switches, push buttons, potentiometers, hand stations (control stations) and indicating lights specified in Section 26 09 16.

B. Signal Isolator: Accepts an active current input 0 to 20 mA or 4 to 20 mA (4 wire) and provides a passive 4 to 20 mA current output. DIN rail mounted with no external power required. As shown on the drawings, or approved equal.

C. Universal Converter: Provide UL recognized, DIN rail mountable universal signal conditioning module with electrically isolated input and output powered from 24 Vdc. Input and output signal range and type easily configurable via DIP switch settings. Module with field calibration functionality for custom scaling of input and output signals. Linear input to output conversion with accuracy of + 0.2% of selected span and resolution of + 0.01% of full scale. Red Lion Model IAMA, or approved equal.

2.12 SPARE PARTS

A. Provide each control panel with the following spare parts:

1. Ten each of each type of light bulb used in the panels.
2. Five each of each type and rating of fuse used in the panels.

PART 3 EXECUTION

3.1 EXECUTION

A. Mount and shim to precise alignment floor mounted control panels so doors operate without binding. Provide sealant for conduit entering the panels.

B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete.

C. Spray terminals and terminal blocks after all terminations have been completed with a silicone resin similar to Dow Corning R-4-3117 conformal coating. Spray coating only required for control panels in corrosive or classified installation environments.

D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind Plexiglas holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.

E. Vacuum clean control panels and cabinets.

3.2 FACTORY TESTING

A. The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment.

B. The initial testing of the control system shall include configuration of the PLC and its communications equipment, energizing each digital input and output and simulating each analog input and output using a loop simulator and calibrator. Circuits not energized shall be tested for continuity. Energized circuits shall be tested through all components from the terminal blocks in the control panel to the hardware I/O memory locations in the PLC. Initial testing of the control system shall be considered completed only after the control system has operated continuously, 24 hours per day, for at least one week.

C. Provide all hardware and software necessary to perform the software test. This includes test cables, Volt-Ohm meters, communications cables, and sufficient space are available in the Hardware Integrators shop to perform the software test.

D. Provide an I/O checklist for all points in the control panel. The list shall include for each point, the tag name of the points, a description of the point, comments, date and time of the test, and a signature line for the person performing the test. Show that each Digital point was set and reset. Show verification of all Analog points at 0%, 25%, 50%, and 100% of range.

E. The Owner shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner at least two weeks in advance prior of the scheduled functional shop test.

3.3 FIELD TESTING

A. Panels shall be tested in accordance with Section 26 08 00.

END OF SECTION

SECTION 40 70 00 - INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies general requirements which are applicable to providing instrumentation and controls for process systems.

B. The requirements of this section are applicable to all work specified in sub-sections of Division.

C. Electrical requirements applicable to this work are specified in Division 26.

D. Instrumentation schedules, control sequences, and commissioning applicable to this work are specified elsewhere in Division 40.

E. Section includes:

1. Scope.
2. Definitions.
3. Quality Assurance.
4. Submittals.
5. Performance Requirements.
6. Functional Requirements.
7. Products.
8. Installation.
9. Testing and Inspections.

1.2 SCOPE

A. INSTRUMENTATION AND CONTROL SYSTEM: The work consists of a qualified System Integrator to provide requirements specified in herein:

1. New primary process measurement devices, instrumentation and new process auxiliary devices.

2. New control system hardware including digital process controllers (PLC based), IO modules, power supply modules and communication modules.

3. New custom control panels

4. Process control system networking

5. Submittal documentation for process systems instrumentation and control including schedules, drawings, product manuals.

6. Maintaining construction RECORD/AS BUILT of submittal documentation and incorporating interconnection detail from other sections submittals to show accurately process systems instrumentation and control wiring as complete from circuits start and end connections.

7. Configuration set up, calibration, testing process systems instrumentation and controls.

8. Training.

9. Collaboration with System Programmer to provide a fully integrated PLC based control system. System Programmer is to be hired by the Owner and is providing OIT and PLC application programming.

1.3 DEFINITIONS

A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

B. TWO-WIRE TRANSMITTER: An instrument which derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit from a 24 volt direct current driving potential and a maximum circuit resistance of 600 ohms. A two-wire transmitter is also referred to as looped power.

C. FOUR-WIRE TRANSMITTER: An instrument which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120Vac or 24Vdc input power supply.

D. GALVANIC ISOLATION: Electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs which are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

E. PANEL: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems including consoles, cabinets and racks. Panels provide mechanical protection, electrical isolation, and protection from dust, dirt, moisture, and chemical contaminants which may be pre- sent in the atmosphere.

F. DATA SHEETS: Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.

G. SIGNAL TYPES:

1. LOW-LEVEL ANALOG: Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.

2. HIGH-LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.

3. DIGITAL CODE: Coded information from the output of an analog to digital converter or digital transmission terminal.

4. PULSE FREQUENCY: Counting pulses emitted from speed or flow transmitters.

5. DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits typically rated for 120 volts AC, 12 or 24 volts DC.

6. LOW VOLTAGE DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.

H. VENDOR PACKAGE PROCESS CONTROL SYSTEM: A system of equipment and hardware provided by a vendor used for control, monitoring process conditions, control feedback and process performance for an associated vendor package equipment system which interfaces to the control system.

I. SYSTEMS INTEGRATOR: A firm engaged in the business of detailed control system design and engineering, custom panel fabrication, instrumentation component purchase, instrumentation tuning, system and panel assembly, and testing the specified process control and industrial automation systems.

1. For this Project, the SYSTEMS INTEGRATOR may be the packaged pump station supplier or a qualified local integrator located within xxx miles of the project site.

J. SYSTEMS PROGRAMMER: The Owner's programmer will provide the PLC, SCADA and OIT application programming.

K. OIT: Acronym for Operator Interface Terminal.

L. SCADA: Acronym for Supervisory Control And Data Acquisition

M. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project.

1.4 QUALITY ASSURANCE:

A. REFERENCES

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

a. The control system components shall, as far as practical, be of one manufacturer.

b. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.

c. The specified system performance shall be demonstrated to and accepted by the Owner, the Systems Programmer and the Engineer.

B. PROCESS EQUIPMENT COORDINATION

1. Systems Integrator shall provide wiring interconnect diagrams for the plant process control system to interface with submitted vendor equipment panels and devices. The wiring diagrams shall be a complete representation of the process control requirements for specific equipment. Systems Integrator coordinates to collect equipment wiring information from other Sections to show a totally wired integrated control system.

2. Integrate, furnish, and install equipment in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.

3. Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.

5. Systems Integrator shall provide installation supervision for the duration of the project.

6. Systems Integrator shall provide installation supervision for the duration of the project. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Owner for resolution before proceeding.

1.5 SUBMITTALS

A. Submittals requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

C. Manufacturer's installation instructions, including mounting requirements.

D. Operation and maintenance information.

E. Warranty information.

1.6 FUNCTIONAL REQUIREMENTS

A. GENERAL:

1. The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Divisions 26 and 40. The Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

2. All equipment with power; control and/or signal electrical interconnections require drawings to be submitted as either elementary if motorized or loop if instrument. All equipment must have a unique drawing reflecting only that equipment's power; control and/or signal electrical interconnections (no typical are permissible).

3. All process control panels and instrument power distribution panels require drawings to be submitted for arrangement, layout and connections. All process control panels and instrument power distribution panels must have a unique drawing with its own Bill of Material reflecting only that panel components and wiring (no typical are permissible).

4. Each communication system requires a network diagram to be submitted.

B. SUBMITTAL DRAWINGS:

1. GENERAL

a. Prepare drawings in AutoCAD version 2018 or later with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Include the date and description of all revisions when submitting drawings. Print drawings as 11" x 17" with a minimum lettering size of 1/8". Generate drawings using Owner furnished drawing borders and title blocks, and in adherence to Owner's drawing standards. All drawings submitted to be bound; no x-references. Provide the AutoCAD files in addition to the PDF file required in Sections 01 33 00.

b. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel wiring Section 40 67 00.

c. The drawing numbers and file names are to be based on equipment tag numbers as specified on the drawings.

d. Provide five types of submittal drawings: Connection Diagrams, Elementary or Schematic Diagrams, Arrangement and Layout Drawings, Loop Diagrams and Network Block Diagram.

2. CONNECTION DIAGRAMS: Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices include IO module layout connections. Show terminal blocks used for internal wiring or field wiring, identified as such. Indicate insulation color code, signal polarities, and wire numbers and terminal block numbers. For Contractor's Drawing Number and Drawing Title use associated "E" or "I" drawing number and suffix with A, B, C, D, etc. to represent the as fabricated connections.

Maintain electronic red- lines of the unique drawing during construction for as-built drawings.

3. ELEMENTARY OR SCHEMATIC DIAGRAM: Contract document drawings are typical illustrations of an elementary or schematic and may represent more than one piece of equipment with similar interconnection requirements. Provide the unique elementary diagram per equipment using the Contractor's Drawing Number and Drawing Title specified. Start the unique elementary drawings using the "typical drawing's electronic CAD file as a baseline which has the Owner CAD layers and the Owner drawing border. Add to the baseline drawing the details as specified. Maintain electronic redlines of the unique drawing during construction for as-built drawings.

4. ARRANGEMENT AND LAYOUT DRAWINGS: Contract document's drawings are typical illustrations of panel hardware/component arrangement and layouts representing one or more than one panel with similar interconnection requirements. Provide the unique panel arrangement, layout and outline drawings per panel using the Contractor's Drawing Number and Drawing Title specified. Show arrangement and layout to scale. Add components and wiring to the unique panel drawings as required to complete a fully integrated operation. Include on the drawings a Bill of Material that identifies all components in the arrangement and layout. Maintain electronic redlines of the unique drawing during construction for as-built drawings.

5. LOOP DIAGRAMS: Contract document's drawings are functionally typical illustrations of a loop and may represent more than one piece of equipment with similar interconnection requirements. Provide the unique loop diagram per equipment using the Contractor's Drawing Number and Drawing Title specified. Start the unique loop diagram using the typical drawing's electronic CAD file as a baseline which has the Owner CAD layers and the Owner drawing border. Add to the baseline drawing the de- tails as specified. Maintain electronic redlines of the unique drawing during construction for as-built drawings.

6. NETWORK BLOCK DIAGRAM: A network block diagram is a diagram of the control system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols]. Contract document's drawings are net- work block diagrams. Provide a unique network diagram based on the communication protocol. Start the drawing using the typical drawing's electronic CAD file as a baseline which has the Owner CAD layers and the Owner drawing border. Add to the baseline drawing the details as required. Maintain electronic redlines of the drawings during construction for RECORD drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. MATERIALS AND QUALITY:

1. Provide equipment material new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work to be manufactured by one firm, where possible.

2. Provide electronic equipment solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.

B. ENCLOSURES: Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application.

Table A

Location	Enclosure Material and NEMA Rating
Indoor Dry	NEMA 12: mild steel
Indoor Wet	NEMA 12: mild steel when specified with mounting pad or legs for minor splash resistance) or NEMA 4X: 316 Stainless Steel
Outdoor	NEMA 4X: 316 Stainless Steel
Process Corrosive	NEMA 4X: 316 Stainless Steel
Chemical Corrosive	NEMA 4X: 316 Stainless Steel
Hazardous Area:	NEMA 7: Galvanized Malleable Iron or Aluminum or NEMA 4X and UL listed or FM Approved for the Hazardous Area.
Hazardous and Corrosive Area	NEMA 4X/7: Iron or Aluminum with factory applied corrosion resistant coating or NEMA 4X and UL listed or FM Approved for the Hazardous Area.

2.2 NAMEPLATES

A. Provide nameplates for all field mounted instrument, analyzer, or equipment specified in Divisions 40, 41, 43, and 46. Include the equipment title, the equipment tag number, and power source(s) in the nameplate inscription. Provide machine engraved laminated black phenolic nameplates with white lettering for equipment identification with 1/8-inch high lettering, as minimum, unless otherwise specified or shown. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

B. Nameplates shall be attached to support hardware with a minimum of two self-tapping type 316 stainless steel screws in a readily visible location, so the nameplate will remain to identify the service when the device is removed.

PART 3 EXECUTION

3.1 INSTALLATION

A. GENERAL:

1. Install equipment in locations that are accessible for operation and maintenance services. Equipment not accessible shall be reinstalled at no cost to the Owner.

2. Installation, calibration, settings, and testing procedures are specified in Division 26.

B. FIELD EQUIPMENT:

1. Provide equipment with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 50 inches and 60 inches above the floor or permanent work platform. Mount equipment to avoid shock or vibration that may impair operation. Mount equipment for unobstructed access and walkways. Equipment support systems not to be attached to hand- rails, process piping or mechanical equipment.

2. Space instruments and cabinets supported by concrete walls by 5/8 inch using framing channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid dam- age to the wall. Equipment supports shall be hot-dip galvanized after fabrication or shall be 316L stainless steel, as shown or specified.

3. Design support systems for panels to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

4. In wet or outdoor areas, conduit penetrations into instrument housing shall be made through the bottom (preferred) or side of enclosures to minimize water entry from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.

5. Nameplates shall be provided for all field mounted equipment. Nameplates shall be attached to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location, such that if the field device is changed out, the nameplate will remain to identify the service.

C. ELECTRICAL POWER CONNECTIONS:

1. Equipment electric power wiring shall comply with Division 26. Power disconnect switches shall be provided within sight of equipment and labeled to indicate the specific equipment served and the power source location (including circuit

breaker number). "Within sight of" is defined as having an unobstructed view from the equipment served and within 50 feet of the equipment served.

2. Equipment power disconnect switches (Section 26 09 16) shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location requirements cannot be met by a single disconnect switch, provide two disconnect switches: one at the equipment and one at the work platform.

D. CONTROL AND SIGNAL CONNECTIONS:

1. Equipment electric signal connections shall be made on terminal blocks or by locking plug and receptacle assemblies. Flexible cable, receptacle and plug assemblies shall be used where shown or specified.

2. Jacketed flexible conduit shall be used between equipment and rigid race- way systems (Section 26 05 33). Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 3 feet except where sufficient length is required to allow withdrawal of instruments for maintenance or calibration without disconnection of conduit or cord assemblies.

3.2 TESTING AND INSPECTIONS

A. DELIVERY INSPECTION: Notify the Owner upon arrival of any material or equipment to be incorporated into the work. Remove protective covers or other- wise provide access in order that the Owner may inspect such items.

B. INSPECTION AND TESTING: Section 40 80 00

END OF SECTION

SECTION 40 72 23 - RADAR LEVEL METERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance.
4. Submittals.
5. Performance Requirements
6. Product Requirements.
7. Installation.
8. Testing.
9. Manufacturer's Services.

1.2 SCOPE

A. This Section specifies requirements for supply and installation of the Radar Level Monitoring system. This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor requires for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

A. UL – Underwriters Laboratory approved
B. ASTM – American Society for Testing and Materials
C. NEMA – National Electrical Manufacturer's Association
D. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 70 00 Instrumentation for Process Systems.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. Submittals requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

C. Manufacturer's installation instructions, including mounting requirements.

D. Operation and maintenance information.

E. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 70 00.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Radar Level Meter candidate manufactures and models:

1. Endress+Hauser Micropilot FMR20 and RIA15 Remote Display/Transmitter with explosion protection field housing (Option R5)

2.2 GENERAL

A. Radar Level Measurement provided as a system consisting of a radar level sensor and a remotely mounted display unless otherwise noted.

B. Radar Level Sensor and Remote Display/Transmitter specified is to comply with Section 40 70 00 transmitter requirements.

C. Radar Level Measurement system shall be a pulse time of flight based system intended primarily for solids applications. The unit shall operate at ~26 GHz.

D. The Radar Level Meter shall not be affected by changing media, changing temperatures, gas blankets or vapors. The transmitter shall measure almost completely independent from product properties.

2.3 FEATURES

A. Radar Level Sensor and Electronics:

1. Process Connection: Flange, UNI DN80….DN150 (3"…6")B

2. Commissioning, operation and maintenance via free iOS / Android app. SmartBlueSignal curves can be shown via app.B

3. Hermetically sealed wiring and fully potted electronics

4. Unit shall employ multi echo tracking algorithms for reliable level measurement.

5. Specifications:

a. Ingress protection: IP66/68 / NEMA 4X/6P
b. Measuring range: up to 20 m (66 ft)
c. Process temperature: –40 to 80 °C (–40 to 176 °F)
d. Process pressure: –1 to 3 bar (–14 to 43 psi)
e. Accuracy: up to ± 2 mm (0.08 in)
f. International explosion protection certificates

6. Materials: Full PVDF body

B. Remote Display / Transmitter

1. Loop Powered 4-20mA

2. Display: 5-digit with 7-segment bargraph

a. Plain text display for unit/TAG
b. Activatable backlight
c. Pushbutton configuration

2.4 ELECTRICAL REQUIREMENTS

A. Signal Output: 4 – 20 mA Analog (Loop Powered)

B. Contain electronics associated with the radar level meter system. Enclosure rating NEMA-4X.

C. Cable: Signal cable between the sensor and remote display/transmitter provided by the system manufacturer with sufficient length of cable for continuous installation between the sensor and remote display/transmitter.

PART 3 EXECUTION

3.2 INSTALLATION

A. REQUIREMENTS: Section 40 70 00.

B. Install all components of in accordance with manufacturer's specifications and instructions for the specified functional requirements.

C. Ensure proper installation of the Radar Level Measurement system so as to not result in false reading due to ambient conditions or equipment at the installation site.

D. Comply with mounting details provided on the drawings and in the manufacturer's specifications.

3.3 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 80 00 and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 40 72 76 - LEVEL SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance.
4. Submittals.
5. Product Requirements.
6. Installation.
7. Testing.

1.2 SCOPE

A. This Section specifies requirements for supply and installation of process level sensing devices.

1.3 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials
B. NEMA – National Electrical Manufacturer's Association
C. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 70 00 Instrumentation for Process Systems.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. Submittals requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

C. Manufacturer's installation instructions.

D. Operation and Maintenance Manual if applicable.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 70 00.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Level Switches candidate manufactures and models:

1. Flygt ENM-10
2. Warrick Controls Inc. Series M.
3. Pulsar Inc., Model 800-70 Signal Master
4. STI Corp. Series KA
5. Approved equal

2.2 GENERAL

A. Float switches shall be provided where indicated, specified, or required to meet the functional requirements of the System, as specified.

B. Unit shall be suspended type, and provided with length of cable required to reach panel or junction box without splicing. Contractor to verify length of cable required for each float switch before ordering.

C. Float switches shall be provided with necessary brackets and clamps to suspend the unit where required. The suspended type shall include an integral or attached weight assembly for stabilization and positive operation of the unit. All mounting clamps shall be PVC or Neoprene.

2.3 FEATURES

A. Direct-acting float type consisting of a mechanically activated (non-mercury) SPDT switch enclosed in a float and connected to a multi-conductor combination support and signal cable. The entire assembly shall form a completely watertight and impact-resistant unit.

B. Chemical-resistant polypropylene or other corrosion-resistant float material suitable for use in water and wastewater applications.

C. Cable shall be rugged and flexible with heavy neoprene or PVC jacket.

D. The suspended type shall include an integral or attached weight assembly for stabilization and positive operation of the unit.

E. Actuation/deactivation differential shall be 1 inch minimum.

2.4 ELECTRICAL REQUIREMENTS

A. Switch shall be SPDT, form C, rated at 5 amps (minimum) at 120 VAC.
B. The conductors shall be a minimum size of 18 AWG.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.

B. Install all components of chlorine monitoring system in accordance with manufactures specifications and instructions.

C. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 01 75 16 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day got the installation of the instruments and for certification of proper installation.

D. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.

E. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

F. Verify size and type of mounting hardware required for each float switch to be installed.

3.2 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 80 00 and in accordance with the manufacturer's recommendations.

B. Verify float switch is using the correct contact – normally open or normally closed – required for the specific application.

END OF SECTION

SECTION 40 73 46

MULTI-LOAD CELL DRY CHEMICAL SCALE

PART 1 GENERAL

1.1 SCOPE

A. CONTRACTOR shall furnish and install a multi-load cell scale for monitoring the contents of an existing dry chemical feed hopper.

B. Work includes testing, documenting, and starting up the scale.

C. CONTRACTOR shall provide all components, piping, wiring, anchors, accessories and labor required for a complete, workable and integrated system. All metal mounting hardware shall be stainless steel.

1.2 REFERENCE STANDARDS

A. UL – Underwriters Laboratory approved
B. ASTM – American Society for Testing and Materials
C. NEMA – National Electrical Manufacturer's Association
D. NEC – National Electrical Code
E. NTEP – National Type Evaluation Program

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions.

B. The manufacturer shall provide a full five year factory warranty.

1.4 SUBMITTALS

A. Submittals requirements specified in: Section 01 33 00.

B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

    a. Mark data sheets to clearly show exact product model and options being provided.

C. Provide Manufacturer's installation instructions, including mounting requirements.

D. Provide Manufacturer's operation and maintenance information.

E. Warranty information.

1.5 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 70 00.
B. OPERATING CONDITIONS: Interior location.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Dry chemical scale candidate manufactures and models:

1. Force Flow electronic volumetric feeder scale, model 27-DR10VFHA3 with a Solo G2 single channel digital indicator and transmitter, model SRG2-1, for remote display and transmission of a signal to SCADA.

2. Or approved equal.

2.2 GENERAL

A. Scale shall be of the three-load cell design.

B. All load cells shall be shear beam strain gauge type and shall be NTEP approved.

C. Full scale accuracy shall be 0.25% or better.

D. A manufacturer supplied flexible cable shall connect the summing box of the scale to the remote display and transmitter.

E. The display shall provide a six-digit read out for monitoring the chemical weight at the display. Weight shall be capable of being displayed in pounds or kilograms and a bar scale graph shall display 0 to 100 percent for the net contents.

F. The Radar Level Meter shall not be affected by changing media, changing temperatures, gas blankets or vapors. The transmitter shall measure almost completely independent from product properties.

2.3 FEATURES

A. Scale:

1. Scale shall be a heavy-duty, low profile platform, designed for installation between the base of the existing dry chemical hopper and the concrete pedestal on which the dry chemical feeder is mounted.

2. Steel platform shall be protected from chemicals by an industrial, corrosion resistant coating with a minimum 80 mil thickness.

B. Remote Display/Transmitter

1. Remote mounted LCD indicator shall be housed in a NEMA 4X, UL approved enclosure.

2. Display shall be keypad operated & menu driven to avoid compromising the NEMA 4X seal.

3. The 6-digit LCD readout shall have backlighting for readability in low light conditions. Power requirement shall be 120 VAC.

4. A dual mode TARE key shall allow user to enter the tare weight of the vessel or enter the net weight of the chemical.

5. A diagnostics menu shall allow recalibration without the need to apply field test weights.

6. A user adjustable filter function shall stabilize display in the event of vibration from mechanical equipment in the vicinity of the scale.

7. Transmitter shall output net weight via a 4-20mA signal. Full-scale output shall be user adjustable via the keypad. Indicator shall have four adjustable set points to display low- or high-level conditions on the display.

2.4 ELECTRICAL REQUIREMENTS

A. Signal Output: 4 – 20 mA Analog.

B. Contain electronics associated with the load-cell weight measurement system. Enclosure rating NEMA-4X.

C. Cable: Signal cable between the sensor and remote display/transmitter shall be provided by the system manufacturer with sufficient length of cable for continuous installation between the sensor and remote display/transmitter.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 70 00.

B. Install all components of the system in accordance with manufacturer’s specifications and instructions for the specified functional requirements.

C. Field verify the anchor bolt pattern on the existing hopper base to ensure that factory installed mounting holes are correctly located.

D. Field locate the remote display and transmitter at the direction of the OWNER.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Instruments shall be calibrated and tested on site in accordance with the manufacturer's recommendations.

C. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

END OF SECTION

SECTION 40 80 00 - COMMISSIONING OF INTEGRATED AUTOMATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Quality Assurance.
3. Submittals.
4. Product
5. Execution – General
6. Preoperational Test Phase
7. Component Test Phase
8. Operation Test Phase

1.2 SCOPE

A. This section specifies Contractor requirements for testing and documenting the process instrumentation and control system (PICS) for automation integration with SCADA in conjunction with the Owner's Systems Programmer.

B. The term instrumentation covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

C. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all test procedures with the requirements of Section 01 75 16. Include the following action items:

1. Develop test plan.
2. Develop record keeping system.
3. Coordinate testing with Vendor package equipment.
4. Coordinate testing with the Owner's Systems Programmer.

D. Testing to include:

1. Pre-Operational - Factory Acceptance Testing (FAT)

2. Component Testing Sequence:

a. Wiring Testing
b. Network and Bus Cable System Inspection and Testing
c. Piping Testing
d. Installation Inspection

e. Instrumentation Calibration
f. Loop Testing
g. Network Testing

3. System (Functional) Testing Sequence:

a. Process Control Strategy/Sequence Testing
b. Control System Closed Loop
c. Functional Checkout

4. Operational Testing:

a. System Acceptance Testing (SAT)

1.3 QUALITY ASSURANCE

A. PICS TESTING MANAGER:

1. The Contractor shall appoint a qualified specialist as PICS Testing Manager to manage, coordinate, and supervise the testing work.

2. The PICS Testing Manager requires at least 5 years of total experience, or experience on at least five separate projects, in managing the testing and startup of electrical and instrumentation control systems of equal or greater scope and complexity. PICS Testing Manager to provide a quality assurance program which includes:

a. Definition of process areas and systems, with testing executed on an area by area basis.

b. Sequential list of the test phases required for each process area and system.

c. Completion status tracking form by process area, system, and test phase.

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. ACTION SUBMITTAL ITEMS: Organize the items as packages for review.

1. Package 1:

a. QUALIFICATION SUBMITTAL:

1) PICS Testing Manager Qualifications and resume as specified in this Section.

b. NETWORK TESTING QUALIFICATION SUBMITTAL: Qualifications of independent industrial network testing firm and staff performing the inspection and testing.

2. Package 2:

    a. DEFINITION SUBMITTAL: Provide the following submittal after review of the Qualification Submittal, Package 1. Separate submittals may be provided for each process area:

        1) Control descriptions in accordance with the requirements of Part 2 of this specification section.

        2) I/O Interface Summary in accordance with the requirements of Part 2 of this specification section.

        3) Testing status spreadsheet in accordance with the requirements Part 2 of this specification section.

        4) Test procedures in accordance with the requirements of Part 3 of this specification section.

        5) Proposed test forms per Part 3 of this specification section, detailed for each test for this project.

        6) Certified Factory Calibration Reports.

3. Package 3: FAT schedule and location.

4. Package 4:

    a. Completed test forms per PART 3. Separate submittals may be provided for each process area.

    b. List of factory calibrated items and calibration certificates.

    c. Documentation of network data communication nodes for networked controllers, remote I/O and related devices.

    d. Final Test Report assembled in a three-ring binder and submitted at the completion of the inspection and testing activities for a facility.

        1) Label the binder cover and spine to identify the project name and facility. Test report includes the applicable test procedures for the facility and the completed inspection and test report forms associated with the equipment and systems of that area.

        2) Organize test results by equipment item or system with individual, labeled tab dividers to identify each. System deficiencies and non-compliant test

results identified in the final test report acknowledged by the responsible testing entity as corrected.

PART 2 PRODUCTS

2.1 GENERAL

A. The PICS Testing Manager shall provide test forms, documentation, and records as specified in the following paragraphs.

2.2 TESTING DOCUMENTATION

A. DOCUMENTATION RECORDS: The PICS Testing Manager shall develop a records keeping system to document progress and completion for each task in each process area or system. Keep the following current and available for inspection on- site at all times in a location designated by the Owner:

1. PICS Testing Manager's qualifications, project startup and testing history, including resume as specified in this Section.

2. List of names of Contractor’s personnel associated with final construction and testing, and normal and emergency contact telephone numbers

3. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.

4. Test Report Volumes.

B. TEST REPORT VOLUMES: The Contractor develops and maintains testing documentation for each facility in separate volumes. Keep each volume current and available for inspection on-site at all times in a location designated by the Owner. Each volume includes the following as a minimum:

1. Three-ring binder with front cover and spine labeled: “Testing Documentation For Process Area / Process System” including Owner’s name, facility name, project name, and project number.

2. Table of Contents with same labeling as the volume cover with tabs for each section:

a. Section 1 – Control Description for control sequences as shown on the P&IDs

b. Section 2 – I/O Interface Summary

c. Section 3 – Schedules for Integrated Automation Instrumentation and Terminal Devices

d. Section 4 – Test Forms

e. Section 5 – Certified Factory Calibration Reports

f. Section 6 – Final Test Report

C. I/O INTERFACE SUMMARY: Provide I/O spreadsheets which include the following for each I/O point:

1. Signal number/tag

2. Annotation description that may be logically abbreviated and that is subject to approval.

3. Complete physical I/O channel designation and addressing or communication I/O register designation.

4. True/False status designations for digital I/O.

5. Process range; engineering units and any multipliers; and raw signal range count for analog I/O.

6. Test result- pass or fail and date of test.

7. Maintain in Excel with electronic updates to Owner issued within 2 days after each test after any updates or changes by Contractor.

PART 3 EXECUTION

3.1 GENERAL

A. GENERAL REQUIREMENTS:

1. Prior to testing, provide notice to the Owner. Provide notice between 60 and 70 days before starting any testing activity, and include a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.

B. TECHNICIAN QUALIFICATIONS:

1. Calibrate and set up field instruments and analyzers using a certified instrument technician qualified to calibrate the instrumentation.

2. Technicians are to be qualified by completion and certification from training courses offered by the Instrumentation, Systems, and Automation Society (ISA), the

instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

C. TEST EQUIPMENT AND MATERIALS:

1. Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.

2. Ensure test instruments have a current calibration sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Include certified calibration reports traceable to the National Institute of Standards and Technology with the final test report.

3. Provide a documenting calibration system to conduct process instrumentation calibration activities that consist of a documenting process calibrator and an instrumentation data management software system that captures the calibration results and electronically documents instrument data, date of calibration, calibration procedures, and as-found and as-left instrument calibration data.

4. Provide an instrument calibration system such as Fluke 743B with Fluke DPC/Track Instrumentation Management software or similar system. Submit calibration files with the final test report in hard copy and electronic formats that do not require specialized equipment or software to read and print the files.

5. Provide buffer solutions and reference fluids for tests of analytical equipment.

6. Vendor software tools may document the systems where a licensed copy of the identical software including connectors, cables, keys, interface cards and devices required for operation is submitted with the final documentation files.

D. FIELD TEST PROCEDURE DOCUMENTATION:

1. Organize and assemble in separate volumes for each process area test procedures for each analog and discrete loop in the process control system. Submit final test records in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.

2. Include test procedure documentation with detailed step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.

3. Include test report forms for each loop covering wiring, piping, and individual component tests. Record the actual test results on these forms and assemble a final test report as specified in this Section.

4. Preprint and complete test report forms to the extent possible prior to commencing testing. Include for test report forms that document the field test procedures the following information:

    a. Project name

    b. Process area associated with the equipment under test.

    c. Instrument loop description.

    d. Instrument loop identification number.

    e. Instrument nameplate data.

    f. Instrument setup and configuration parameters.

    g. Time and date of test.

    h. Inspection checklist and results.

    i. Reference to applicable test procedure.

    j. Expected and actual test results for each test point in the loop including programmable controller data table or register values.

    k. Test equipment used.

    l. Space for remarks regarding test procedure or results, unusual or noteworthy observations, etc.

    m. Name, date, and signature of testing personnel.

    n. Test witness' name and signature.

E. INSTALLED TESTS

1. Provide test forms in conformance with the referenced forms. Develop additional or detailed forms as necessary to suit complex instrumentation. Usage of terms used on test forms shall comply with ISA S51.1.

F. WITNESSING

1. The Owner reserves the right to observe factory and field instrumentation testing and calibration procedures. Notify Owner and Owner's System Programmer prior to testing, as specified herein.

3.2 PREOPERATIONAL TEST PHASE

A. FACTORY ACCEPTANCE TEST (FAT):

1. GENERAL: Factory Acceptance Test control system equipment witnessed by the Owner. The Owner's System Programmer loads control system panel programmable logic controllers (PLCs) with testing software to allow the PLCs to view the process control hardware integrated in specified panels at Contractor's factory prior to the FAT. Contractor sets up a temporary network with power to the equipment and collaborates the testing with the Owner's System Programmer to be able to check out the process control hardware. Provide written notice to the Owner and the Owner's System Programmer thirty working days before the commencement of the FAT activity which includes:

   a. Schedule for the FAT.
   b. Location of the FAT.
   c. Testing equipment used.
   d. Detailed test procedure with forms for the recording of test results.
   e. Sign-off spaces for the individuals performing and witnessing the tests.

2. FACTORY ACCEPTANCE TEST PROCEDURES: Interlock or network panels as applicable, operated, and checked-out by the equipment supplier prior to the FAT. Submit certification indicating that the panels are ready for the FAT. Include in the FAT the following:

   a. Visual inspection of equipment, instruments, control panels, and graphic displays.

   b. Validate each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs with the Owner's System Programmer.

   c. Validate with the Owner's System Programmer the following:

      1) Monitoring state changes on operator interface screens based on the inputs state change.

      2) Observation of online PLC programming application software with the associated PLC outputs state change.

3) Outputs triggered by operator interface software devices (pushbuttons, sliders, manually-entered values, etc.)

4) Calibration and operation of instruments on or in the control panels.

d. Repair of loops which do not pass validation.

e. Retest of the FAT at no additional cost.

f. Panels that pass the FAT may be shipped to the site upon shipping schedule and storage accommodation approval by the Owner.

3.3 COMPONENT TEST PHASE

A. GENERAL REQUIREMENTS: In general, perform tests in the following order

1. WIRING TESTING: Provide electrical power and signal cable ring-out and resistance testing. Conduct test in accordance with Sections 26 05 00 and 26 08 00. Do not conduct wiring tests until cables have been tagged and inspected.

a. Power and Control: In accordance with the requirements of Section 26 08 00.
b. Test shield to ground in panels and cabinets to verify terminal connections.
c. Sample test forms are included at the end of this section.

2. NETWORK AND BUS CABLE INSPECTION AND TESTING

a. Inspect and test by independent industrial network testing firms.

b. Test proprietary bus systems by the manufacturers' qualified field services technician. Manufacturer's sales personnel are not considered to be qualified technicians unless qualifications are documented and certified by the manufacturer.

c. Test standardized networks and buses by a qualified independent network testing service. Test the following types of cabling and networks, and certify by the independent industrial network testing firm:

1) Ethernet system cabling

2) Other networks provided as a part of a vendor packaged monitoring or interfacing to the process control system.

d. Test and verify control and instrumentation bus cabling using the standards that apply to the specific cable and bus type as follows:

1) Ethernet Category 6: in accordance with the requirements of TIA/EIA-568B standards

2) PRE-ACTIVE TESTING: Prior to energizing, inspect and test cabling to verify the following:

   a) Media type and specifications.

   b) Physical routing and project specific cable identification tagging.

   c) Correct termination installation and connection of conductors to pins at terminations.

   d) Record cable run length and compare to the manufacturer or industry standards to verify lengths are within specifications.

   e) Locations and values of network termination resistance.

   f) Integrity and grounding of cable shields.

   g) Values of transient protection (surge) elements.

   h) Firmware revision level of network devices available prior to energization.

   i) Settings of dip switches and configuration parameters.

3) ACTIVE SYSTEM TESTING: After the cable or network system has been activated for testing, provide diagnostic monitoring and signal analysis for the bus network system to evaluate network and bus integrity and data transfer quality. Measure, verify and record the following parameters:

   a) Node addressing.

   b) Signal attenuation before and after any repeater device and at the farthest point in the network.

   c) Total network trunk voltage and current loading as applicable.

   d) Baud rate, message traffic rate, percent bandwidth used, error rate, lost packet count.

   e) Firmware revision level of the network devices.

   f) Pre-active and active testing shall fall within the specified range of values established by the referenced standards.

   g) Correct the functionality of networks and devices connected to the network.

3. INSTRUMENT AND COMPONENT INSPECTION: Inspect PICS components include the following:

    a. Compare and validate instrument type and nameplate data with the drawings, specifications, and data sheet.

    b. Validate instrument identification tag.

    c. Confirm instrument installation conforms to drawings, specifications, and manufacturer's instructions.

    d. Verify proper conductor termination and tagging.

    e. Visual check for physical damage, dirt accumulation, and corrosion.

    f. Verify all components and instruments including isolation amplifiers, surge protection, and safety barriers are properly installed.

    g. Report deficiencies identified within 24 hours of discovery. No instrument or system component shall be tested until all deficiencies are addressed.

4. INSTRUMENTATION CALIBRATION:

    a. Field calibrate instruments and final elements in accordance with the manufacturer's recommended procedures and test in accordance with the Contractor's submitted test procedure.

    b. Do not commence individual component calibration and testing until Instruments and Component Inspections are completed and documented to the satisfaction of the Owner and the Engineer.

    c. Calibrate analog instruments at 0, 10, 50, 90, and 100 percent of the specified full scale range in both ascending and descending order. Adjust each signal sensing trip and process sensing switch to the required setting. Record calibration data on test forms as specified herein.

    d. Test and adjust final element alignment to verify that each final element operates smoothly over the full range in response to the specified process control signals.

    e. Enter test data on the applicable test forms at the time of testing: Set alarm trips, control trips, and switch dead bands to initial values. Check final elements for range, dead- band, and speed of response.

f. Repair or replace by the manufacturer any component that fails to meet the required tolerances. Repeat the specified tests until the component is within tolerance.

g. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.

h. Use test form at the end of this section

i. CERTIFIED TEST REPORTS: Field test and inspection activities include verification of instrument parameter setup, verification of instrument zero, and performance at five operating points within the instrument range. Return for re-calibration or replace as agreed depending on the impact to the project as determined by the Owner and Engineer, any instrument which fails to demonstrate proper performance.

5. LOOP TESTING: Contractor to collaborate the loop testing with the Owner's System Programmer. The Contactor is to be in the field with the Owner's System Programmer to assist in the testing by verifying wiring and equipment is functioning properly and recording testing results. The Owner's System Programmer verifies the application programming.

   a. Do not commence Loop Testing until the Individual Component Calibration and Testing has been completed and documented to the satisfaction of the Owner and Engineer.

   b. Test each instrument loop as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Inject test signals at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

   c. Testing of loops with an interface to a programmable logic controller and SCADA graphical user interface are to include verification of the programmable logic controller input/output assignment and verification of operation of the input/output system, processor and SCADA. Test loop from field through programmable logic controller and SCADA with the Owner's System Programmer.

   d. Correct the loop circuitry or device if the output control or monitoring device fails to indicate properly. Repeat the test until devices and instruments operate as required.

   e. See test form at the end of this section

3.4 SYSTEM TEST PHASE

A. GENERAL: Contractor to collaborate the system test phase with the Owner's System Programmer. The Contractor to be in the field with the Owner's System Programmer to assist in the testing by verifying wiring and equipment is functioning properly, tuned as required, and recording testing results. The Owner's System Programmer verifies the application programming.

B. PROCESS CONTROL STRATEGY/FUNCTIONAL TESTING:

1. Do not commence Control Strategy Testing until the Loop Testing has been completed and documented to the satisfaction of the Owner and Engineer.

2. Control Strategy Testing consists of installing and debugging the PLC control logic program, verifying the interface points between the PLCs and field devices and equipment, and exercising the control strategies. Perform Control Strategy Testing on one PLC at a time.

3. Provide qualified personnel to immediately correct any deficiencies in the Work that may be encountered during Control Strategy Testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete Control Strategy Testing.

C. CONTROL SYSTEM CLOSED LOOP TESTING:

1. Do not commence Closed-Loop tests until the Control Strategy Testing has been successfully completed and documented to the satisfaction of the Owner and Engineer.

2. Demonstrate closed-loop tests, performed as part of the system tests, provide stable operation of each loop under operating conditions. Adjust loop tuning parameters as required during the testing.

3. Tuning parameters for PID control: Tune the gain (or proportional band), integral time constant, and derivative time constant for each control loop. Adjust to provide 1/4-amplitude damping, unless otherwise specified.

4. Adjust control loops with "batch" features to provide optimum response following start-up from an integral action saturation condition.

5. Provide graph recordings to show the PID response (include set point, control output, measured feedback) at initial start-up, during sequencing, during a step disturbance additional and show 1/4 amplitude damping. Label to show loop number and title, and settings of parameters and set point.

6. Where a loop is controlled under the direction of a programmable logic controller, the Owner's System Programmer will perform the necessary adjustment of loop tuning parameters and set points; Contractor records the loop response, adjusts final elements, and assures total integrated loop performance as specified.

D. FUNCTIONAL CHECKOUT:

1. Conduct to verify the operation of discrete and hardwired control devices, refer to Section 01 75 16.

2. Exercise the operable devices and energizing the control circuit.

3. Operate control element, alarm device, and interlocks to verify the specified action occurs.

3.5 OPERATIONAL TEST PHASE

A. Perform System Acceptance Test (SAT) after component and subsystem tests have been completed. Perform the test of the completed system in full operation and demonstrate that all functional requirements of this specification have been met. Contractor to collaborate SAT with the Owner's System Programmer. The Contractor to be in the field with the Owner's System Programmer to assist in the testing by verifying wiring and equipment is functioning properly, tuned as required, and recording testing results. The Owner's System Programmer verifies the application programming. Demonstrate during SAT the following:

1. Each component of the system operates correctly with all other components of the system.

2. Analog control loops operate in a stable manner.

3. Hardwired and software equipment interlocks perform correctly.

4. Process control sequences perform correctly.

5. PLC application program performs monitoring and control functions correctly.

6. Operator interface graphics represent the monitoring and control functions correctly.

SAMPLE LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM:

Loop No.:_____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	Panel Tie	Field TB	Continuity Resistance[a]		Insulation Resistance[b]			
			Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

NOTES:

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of an ohmmeter to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the resistance and record each reading.

CERTIFIED_____ Date_____

Contractor's Representative

WITNESSED_____ Date_____

Owner's Representative

SAMPLE NEUTRAL GROUNDING RESISTOR TEST

Equipment No.:_____

Location:_____

1. The pickup and time delay setting on the ground fault relay shall be set in accordance with Section 26 05 73.

2. The transformer neutral insulation resistance shall be measured with and without the grounding resistor connected to insure no parallel ground paths exist.

3. The protective relay pickup current shall be determined by injectingtest current into the current sensor. The pickup current should be within 10 percent of the dial setting. Record the dial setting and actual pickuptie.

4. The relay timing shall be tested by injecting 150 and 300 percent of pickup current into the current sensor. The relay timing shall be in accordance with the manufacturer's published time-current characteristic curves. Record the relay timing at 150 and 300 percent of pickup current.

5. The circuit interrupting device shall be operated by operating the relay.

The results shall be recorded and signed by the Contractor and Construction Manager. A copy shall be given to the Construction Manager.

SAMPLE CONTROLLER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

Connect output to PV for following tests:

Set Point (SP) Indicator Accuracy			Output Meter Accuracy			Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Reading	Expected Reading	Actual % Dev.	Output	Output	% Dev.
(0%)								
(50%)								
(100%)								
% Deviation Allowed:			% Deviation Allowed:			% Deviation Allowed:		

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

SAMPLE PANEL INDICATOR CALIBRATION TEST DATA FORM:

Tag No. and Description:_____

Make & Model No.:_____ Serial No.:_____

Input:_____

Scale:_____ Range:_____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED_____ Date_____

Contractor's Representative

WITNESSED_____ Date_____

SAMPLE TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description:_____

Make & Model No.:_____ Serial No.:_____

Input:_____

Output:_____

Range:_____ Scale:_____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED_____ Date_____

Contractor's Representative

WITNESSED_____ Date_____

Owner's Representative

SAMPLE LOOP PERFORMANCE TEST SHEET

Project Name:	Project No.:
Demonstration Test(s): For each functional requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff.	

Forms/Sheets Verified	By	Date	Loop Witnessed By CITY
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Acceptance Test	By	Date	
Performed			
Witnessed			Loop No.:

CERTIFIED_____ Date_____

Contractor's Representative

WITNESSED_____ Date_____

Owner's Representative

SAMPLE INDIVIDUAL LOOP TEST DATA FORM

Loop No.:

Description:

(Give complete description of loop's function using tag numbers where appropriate.)

A. Wiring tested:
   (Attach test form)

B. Instrumentation tubing/piping tested:
   (Attach test form)

C. Instruments calibrated:
   (Attach test forms)

D. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Owner's Representative's approval.

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
Owner's Representative

SAMPLE MOTOR DATA FORM:

Equipment Name_____Equipment No(s)_____

Project Site Location_____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	ºC
Time rating:				Design Letter:			
	(NEMA MG1-10.35)				(NEMA MG-1.16)		
KVA Code Letter:				Insulation Class:			

The following information is required for explosion-proof motors only:

A. Approved by UL for installation in Class__, Div___, Group _____

B. UL frame temperature code_____ (NEC Tables 500-8B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:	ºC (NEMA MG1-12.41,42)				
Space Heater included?	☐ Yes	☐ No	If Yes:	Watts	Volts
Type of motor winding over-temperature protection, if					

Provide information on other motor features specified:

SAMPLE INSTRUMENT CALIBRATION SHEET

COMPONENT	MANUFACTURER	PROJECT
Code:	Name:	Number:
Name:	Model:	Name:
	Serial #:	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N
Indicate? Y / N Record? Y / N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:				SWITCH? Y / N Unit Range:
Transmit/ Convert? Y / N	Input:				Differential: fixed/adjustable Reset? automatic / manual
	Output:				

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					Note No.
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
							1.					
							2.					
							3.					
							4.					
							5.					
							6.					
CONTROL MODE SETTINGS:			P:	I:	D:		1.					

#	NOTES:	Component Calibrated and Ready for Startup
		CONTRACTOR'S REPRESENTATIVE:
		Date:
		Tag No.:

END OF SECTION

SECTION 43 33 20 - LIQUID CHEMICAL PUMPING APPURTENENCES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes furnishing and installing new chemical feed pump accessories required for a complete and functioning chemical feed pumping system using existing positive displacement, diaphragm metering pumps.

B. CONTRACTOR shall use OWNER-furnished diaphragm metering pumps, relocated from their current location to a new location as shown on the Drawings, as part of the complete chemical feed system.

C. Chemical feed pump appurtenances shall be mounted on a back panel and the back panel shall be anchored to a concrete wall, as shown on the Drawings.

1.2 REFERENCES

A. NSF International (NSF):

1. 61 - Drinking Water System Components - Health Effects.

1.3 SYSTEM DESCRIPTION

A. General: Provide accessories, and other items required for a complete and operational chemical feed system. The chemical metering pump system shall include, but not be limited to, the following items, which shall be supplied by the CONTRACTOR.

1. Calibration columns.
2. Pulsation dampeners.
3. External pressure relief valves.
4. Diaphragm back pressure valves.
5. Pipe and isolation valves.
6. High density polyethylene (HDPE) back panel for mounting the appurtenances.

B. Fluid characteristics:

1. Aluminum Chlorohydrate:

a. Dry chemical formula: $Al_2ClH_7O_6$
b. Solution concentration: up to 50 percent by weight
c. Solution pH: 3.4 to 5.0
d. Solution specific gravity: 1.35

1.4 SUBMITTALS

A. Submit as specified in Section 01 33 00 - Submittal Procedures.

B. Product data:

1. Design data, test reports, certificates, manufacturer's instructions, manufacturer's field reports:

C. Shop drawings:

1. Dimensions, including anchor bolt layout, materials of construction, size, weight, and performance data.

2. Drawings: Provide electrical and instrumentation drawings showing coordination with electrical control devices operating in conjunction with the associated feed system.

3. Dimensioned inlet and outlet connections.

4. Current NSF 61 Certification for components to be in contact with associated chemical or potable water.

5. Provide data showing chemical compatibility of the materials of construction for the appurtenances, and history of service with the associated chemical.

D. Vendor operation and maintenance manuals: As specified in Section 01 33 00 - Submittal Procedures.

1. Provide information on each piece of equipment.

2. Provide all safety considerations relating to operations and handling of the associated chemical.

3. Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated, and adjusted so that it functions economically throughout its full design life.

1.5 WARRANTY

A. Provide warranty as specified in the Contract Documents.

PART 2 PRODUCTS

2.1 GENERAL

A. A single pump manufacturer shall furnish and coordinate all drives and pump components specified in this Section, including motors, couplings, supports, and other specified accessories and appurtenances to ensure compatibility and integrity of the individual components.

B. The manufacturer of the pumps shall have sole-source responsibility for furnishing the complete assemblies and meeting the specified performance requirements.

2.2 ACCESSORIES

A. Provide the following materials, or other material as approved by the Engineer:

1. Sodium Hypochlorite:

a. Piping: PVC or CPVC.
b. Tubing: PFA.
c. Valve and Ancillary Equipment: PVC, CPVC.
d. Seals: Viton or Teflon (PTFE).

2. Aluminum Chlorohydrate:

a. Piping: PVC or CPVC.
b. Tubing: PFA.
c. Valve and Ancillary Equipment: PVC, CPVC.
d. Seals: Viton or Teflon (PTFE).

B. Pulsation dampeners:

1. Manufacturers: One of the following or equal:

a. Kemlon Products.
b. Blacoh Fluid Controls, Inc.
c. Pulsafeeder.
d. Primary Fluid Systems, Inc.
e. Grifco.

2. Pulsation dampeners shall be furnished and installed on each chemical metering pump's discharge lines as indicated on the Drawings and scheduled in this Section.

3. Materials:

    a. Pulsation dampeners materials shall be compatible with the pumped liquid at the specified concentration, and suitable for outdoor use and exposure (if located outdoors).

4. Characteristics:

    a. Pulsation dampeners shall be gas or air charged, single diaphragm type complete with valved gas/air charge valve connection and pressure gage graduated from 0 to 200 pounds per square inch.

    b. Pulsation dampeners shall allow no more than 6 percent discharge pressure fluctuation.

5. Dampeners shall be provided with a true-union ball valve for shutoff.

C. Calibration columns:

1. Materials:

    a. Materials shall be compatible with the pumped liquid and concentration specified in this Section, and suitable for outdoor use and exposure (if located outdoors).

2. Characteristics:

    a. Furnish and install calibration columns, 1 for each skid, on each chemical pump's inlet line as indicated on the Drawings and specified in this Section.

        1) Columns shall be translucent.

    b. Provide top cap threaded connection with vent piped to common vent piping to prevent entry of foreign materials and to direct spillage or overflow.

    c. End connections shall be flanged.

    d. Capacities and graduations shall be as recommended by column manufacturer and large enough to accommodate the autocalibration feature of the pump.

D. Diaphragm backpressure and pressure relief valves:

1. Manufacturers: One of the following or equal:

    a. Pulsafeeder.
    b. Griffco.
    c. Milton Roy Co.

d. Primary Fluid Systems, Inc.

2. Materials:

a. Valves shall be of suitable materials for the pumped liquid.

3. Characteristics:

a. Ported to serve as either a backpressure valve or a pressure relief valve.

b. Relief valve shall be plumbed to the nearest chemical drain, or back to the pump suction on the non-pump side of the pump suction isolation valve, to avoid spillage, as indicated on the Drawings.

c. Valves shall be furnished and installed on each chemical metering pump's discharge lines as indicated on the Drawings and scheduled in this Section.

d. Valves shall have an adjustable spring range of 15-100 pounds per square inch. Valves shall be factory adjusted for the backpressure recommended by the pump manufacturer.

e. Valves shall produce a back pressure no greater than 10 pounds per square inch above valve set pressure when metering pumps are operating at full capacity, pulsating flow.

E. Diaphragm seals:

1. One of the following or equal:

a. Primary Fluids Systems

2. Materials:

a. Body: See section 2.05.A.
b. Diaphragm: PTFE
c. Pressure: Rated to 200 psi

F. Pressure gauges:

1. One of the following or equal:

a. Primary Fluids Systems

2. Materials:

a. Premium Series, 2.5" diameter, liquid filled.
b. Connection Size: ¼".

c. Housing: Stainless steel.
d. Internals: 316 stainless steel.
e. Accuracy: +/- 1.6% or less.
f. Pressure Range: See drawings.

G. Additional accessories:

1. Additional accessories required for the system but not required to be supplied by the pump manufacturer include:

a. Pump appurtenance back panel.

1) Back panel shall house the equipment shown on the Drawings. Pipe and appurtenances shall be mounted to the skid using click-in type non-metallic pipe supports

2) Back panel shall be constructed of polyethylene or polypropylene.

b. Isolation valves as specified in Section 40 05 60 - Miscellaneous Valves for suction and discharge piping as indicated on the Drawings.

c. Check valves as specified in Section 40 05 60 – Miscellaneous Valves on the discharge piping of each pump, as indicated on the Drawings.

d. Piping as specified in Section 40 05 31 – Thermoplastic Pipe and Tubing.

2.3 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: Furnish the following spare parts packed and labeled for storage:

1. Complete set of inlet and outlet ball check valves (balls, seats and gaskets).
2. 1 spare parts kit for each size and type of backpressure and pressure relief valve.

PART 3 EXECUTION

3.1 COMMISSIONING

A. Conduct functional testing to confirm proper operation of the assembled and installed appurtenance back panel.

END OF SECTION

SECTION 43 41 43 - POLYETHYLENE TANKS

PART 1 GENERAL

1.1 REQUIREMENTS

A. The CONTRACTOR shall furnish all labor necessary to install OWNER-furnished polyethylene tanks and accessories.

B. The CONTRACTOR shall furnish all materials and accessories not furnished by OWNER that are necessary for the installation, in accordance with the Contract Documents. CONTRACTOR shall provide a complete and functional system, whether or not any specific component is shown on the Drawings or specified.

1.2 REFERENCES, CODES AND STANDARDS

A. American Society of Testing Materials (ASTM).

1. D638 Tensile Properties of Plastics
2. D883 Standard Definitions of Terms Relating to Plastics
3. D1505 Density of Plastics by the Density-Gradient Technique
4. D1525 Test Method for Vicat Softening Temperature of Plastics
5. D1693 ESCR Specification Thickness 0.125" F50-10% Igepal
6. F412 Standard Terminology Relating to Plastic Piping Systems

B. ANSI Standards: B-16.5, Pipe Flanges and Flanged Fittings

C. Building Code: International Building Code, IBC, 2018

D. ARM: Low Temperature Impact Resistance (Falling Dart Test Procedure)

E. NSF/ANSI Standard 61, AWWA – Drinking Water System Components

F. ASTM D-1998, Standard Specification for Polyethylene Upright Storage Tanks

1.3 SUBMITTALS

A. OWNER shall provide to CONTRACTOR Shop Drawings obtained from the tank Manufacturer.

1. Dimensioned Tank Drawings.
2. Location and orientation of openings, fittings, accessories, restraints and supports.
3. Details of manways, flexible connections, and vents.
4. Details of the tank restraint system designed by Manufacturer.
5. Manufacturer's unloading procedure.
6. Manufacturer's installation instructions.

1.4 DELIVERY, STORAGE AND HANDLING

1. Delivery of the tanks and accessories shall be made by Manufacturer to OWENR'S facility.

2. If delivery occurs after award of contract, CONTRACTOR and OWNER shall jointly inspect the equipment upon receipt to assess the condition of the equipment and confirm receipt of all materials in Manufacturer's bill of materials.

3. If delivery occurs prior to award of contract, CONTRACTOR and OWNER shall jointly inspect the equipment upon CONTRACTOR mobilization to assess the condition of the equipment and confirm the presence of all materials in Manufacturer's bill of materials.

4. CONTRACTOR shall handle and store the equipment in strict accordance with the written instructions from the Manufacturer.

5. CONTRACTOR and OWNER shall inspect the equipment upon receipt to assess the condition of the equipment. at the time that CONTRACTOR receives, and assumes responsibility for, the equipment.

PART 2 PRODUCTS

2.1 GENERAL

A. OWNER shall furnish the following:

1. Two double wall, high density, cross-linked polyethylene tanks (SAFE-Tank by Poly Processing) with nominal capacity of 1,015 gallons for storage of Sodium Hypochlorite.

2. One double wall, high density, cross-linked polyethylene tank (SAFE-Tank by Poly Processing) with nominal capacity of 1,015 gallons for storage of Aluminum Chlorohydrate.

3. Restraint system, including base clips and anchor bolts.

4. Fittings for each tank:

   a. 2-inch fill connection with interior drop pipe

   b. 4-inch connection for vent pipe

   c. 2-inch bolted, one-piece sidewall fitting on the interior tank wall with siphon leg inside the main

d. 2-inch bulkhead fitting on a vertical face for overflow pipe

e. 2-inch universal ball dome bulkhead fitting for vertical installation of a non-contacting level sensor

f. Reverse level gage

g. 1-inch bulkhead fitting penetrating only the exterior tank wall for installation of leak monitoring.

B. CONTACTOR shall furnish all other accessories and appurtenances required for a complete and functional system.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. The tank shall be shipped upright or lying down on their sides with blocks and slings to keep them from moving.

B. When receiving the tanks and when moving the tanks into storage and from storage to the installation site, sharp objects on trailers, forklifts and other equipment used to move the tanks into place shall be avoided.

C. All fittings shall have been installed at the factory to confirm proper installation. Manufacturer may remove some fittings for shipping separately.

3.2 INSTALLATION

A. Manufacturer shall provide detailed instructions for tank installation. CONTRACTOR shall install the tanks in strict accordance with Manufacturer's written installation instructions.

B. CONTRACTOR shall reinstall all fittings that the manufacturer removes for shipping separately. CONTRACTOR shall follow Manufacturer's written instructions for reinstallation of removed fittings.

C. Anchoring: CONTRACTOR Shall install OWNER-Furnished equipment for anchoring the tanks in accordance with the printed instructions of the equipment manufacturer, including anchoring methods and leveling criteria.

D. After CONTRACTOR has installed the tanks, manufacturer shall inspect the installed tanks to verify proper installation of flexible outlet and drain connections, venting pipe connections, fill pipe connections, overflow, reverse level gage and other fittings.

E. OWNER and CONTRACTOR shall jointly review the Manufacturer's check list for installed tanks to confirm that all requirements have been met prior to requesting Tank Manufacturer review of the installed tank systems. CONTRACTOR shall coordinate construction schedule with OWNER so that OWNER can request and schedule Manufacturer's review at least two weeks prior to the review.

F. Manufacturer shall provide a training session to instruct Owner's operators on servicing and maintaining the tank system. CONTRACTOR shall coordinate the schedule for testing and startup with OWNER so that OWNER can request and schedule Manufacturer's training at least two weeks prior to the training.

G. Manufacturer's trained technician shall conduct an onsite inspection of the completed installation. Inspection will verify chemical application, plumbing connections, venting, and applicable ancillary equipment such as restraints. Manufacturer will not supply Owner with a certificate verifying proper installation until equipment has passed the installation checklist. CONTRACTOR shall make any repairs and modifications noted by Manufacturer's technician and required by Manufacturer as a condition of issuing the certificate of proper installation.

3.3 FIELD TESTING

A. All tanks shall be hydrostatically tested for 24 hours prior to commissioning.

END OF SECTION