ADDENDUM

PUBLIC WORKS DEPARTMENT
Engineering Division -CITY OF WOODBURN
190 Garfield Street
Woodburn, OR 97071
FAX: 503.982.5242

Addendum No.:	1
Project Name:	New Production Well for the Parr Road Treatment Plant
Project No.	2018-011-28
Date:	May 17, 2022
To:	All Bidders

NOTE: This Addendum forms part of the Contract Documents and modifies specifications under Bid No. 2022-09, as noted below. Bidders submitting an offer must sign this form, acknowledging receipt of addendum, and supply it with their proposal. Failure to do so will subject the Bidder to disqualification.

REVISIONS TO BID DOCUMENTS:

Insert into the bid book the attached "Technical Specifications" between the "Front End Specifications" and "Drawings", as indicated in the Section 00 01 10 - Table of Contents.

I have received, read and incorporated changes, per this addendum, in my proposed bid:

Signature *Date*

SPECIFICATIONS

NEW PRODUCTION WELL FOR THE PARR ROAD TREATMENT PLANT

FOR

City of Woodburn

Volume 1 of 2

MARCH 2022

City of Woodburn
Engineering Department
190 Garfield St
Woodburn, Oregon 97071

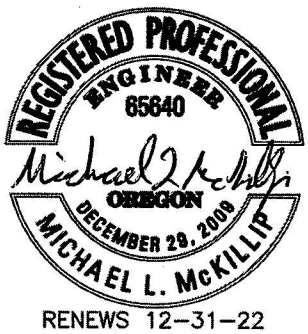
CITY OF WOODBURN, OREGON

TECHNICAL SPECIFICATIONS

FOR

NEW PRODUCTION WELL FOR THE PARR ROAD TREATMENT PLANT PROJECT

PROFESSIONAL OF RECORD CERTIFICATION(s):

Michael McKillip - Murraysmith  RENEWS 12-31-22	I declare the Technical Specification(s) listed below are applicable to the design for the subject project for the City of Woodburn. Technical Specifications were prepared by me or under my supervision. Section(s): 011000, 012220, 013300, 014500, 015639, 017516, 023000, 0721000, 074113, 076000, 079200, 081113, 086200, 087100, 089119, 099000, 104416, 110500, 221116. 22119, 230593, 230913, 233400, 238300, 310513, 310516, 311000, 312213, 312316, 312317, 312323, 321123, 321216, 321613.16, 323113, 328000, 329000, 329121 330130.13, 330513, 330517, 331110, 331213, 331216, 331219, 331300, 332150, 334110, 335613, 400507, 400513, 400523, 400523.15, 400523.18, 400523.24, 400523.72, 432100, 432152, 432314
Date Signed: 3/11/2022	

CITY OF WOODBURN, OREGON

TECHNICAL SPECIFICATIONS

FOR

NEW PRODUCTION WELL FOR THE PARR ROAD TREATMENT PLANT PROJECT

PROFESSIONAL OF RECORD CERTIFICATION(s):

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

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

Section(s): 260500, 260519, 260526, 260529, 260533, 260543, 260553, 260800, 262213, 262416, 262419, 262716, 262726, 262816.13, 262913.13, 263213, 264313, 265000, 400670, 407113, 407243, 407276, 407326</td>
</tr>
<tr>
<td>Date Signed: 3/9/2022</td>
</tr>
</table>

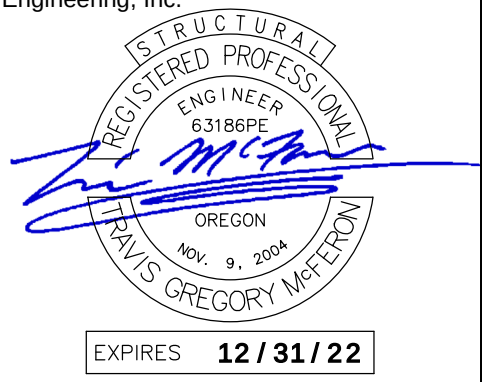
CITY OF WOODBURN, OREGON

TECHNICAL SPECIFICATIONS

FOR

NEW PRODUCTION WELL FOR THE PARR ROAD TREATMENT PLANT PROJECT

PROFESSIONAL OF RECORD CERTIFICATION(s):

Travis McFeron – Peterson Structural Engineering, Inc.  EXPIRES **12/31/22**	I declare the Technical Specification(s) listed below are applicable to the design for the subject project for the City of Woodburn. Technical Specifications were prepared by me or under my supervision. Section(s): 032100, 033000, 036000, 040517, 042200, 060523, 061000, 061753
Date Signed: 03/09/2022	

TECHNICAL SPECIFICATIONS
FOR
NEW PRODUCTION WELL FOR THE PARR ROAD TREATMENT PLANT PROJECT
FOR
CITY OF WOODBURN, OREGON

TABLE OF CONTENTS

SECTION 01 10 00 - SUMMARY OF WORK

PART 1 GENERAL

This Summary of Work supplements and amplifies certain sections of the General Conditions and Supplementary General Conditions. The General Conditions and Supplementary General Conditions shall apply except as modified herein. These Special Provisions and additional technical specifications may contain occasional requirements not pertinent to the project. However, these specifications shall apply in all particulars insofar as they are applicable to this project.

1.1 APPLICABLE STANDARD SPECIFICATIONS AND PLANS

Oregon Standard Specifications for Construction and the City of Woodburn Standard Drawings and Specifications (including all revisions at date of bid opening), apply except as may be modified herein. In the case of discrepancy, unless noted otherwise herein, the more restrictive provisions shall apply.

1.2 SCOPE OF WORK

The work to be performed under these specifications and drawings consists of construction of a new CMU well house, furnishing and installing a 125 HP well pump, site improvements, installation of a storm pond pumping and force main system, installation of 1,814 LF or 10-inch diameter ductile iron raw water line, 864 LF of 12-inch diameter ductile iron distribution main, landscaping and I&C improvements.

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.

1.3 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:

A. Permits for outside agencies required by law
B. OWNER-CONTRACTOR Agreement
C. Addenda to Contract Documents
D. CONTRACTOR's Proposal
E. Special Provisions
F. Contract Drawings
G. Technical Specifications
H. Supplementary General Conditions
I. General Conditions of the Contract
J. City of Woodburn Standard Specifications
K. City of Woodburn Standard Drawings

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. 19-2697. and the general title:

New Production Well for the Parr Road Treatment Plant

The specific titles of each sheet are contained on the Drawing Sheet Index, G-1.

1.4 CODE REQUIREMENTS

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

A. International Building 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. Marion County, Plumbing and Electrical Standards
H. City of Woodburn, Public Works Standards

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

1.5 TIME OF COMPLETION/LIQUIDATED DAMAGES

Refer to the Special Provisions.

1.6 COORDINATION WITH OTHER CONTRACTORS AND WITH OWNER

Certain work within this contract may require connection to and coordination with the work of other contractors 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.

1.7 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.

1.8 PERMITS AND LICENSES

Unless provided for otherwise in these contract documents, all permits, licenses and fees shall be obtained by the CONTRACTOR and all costs shall be borne by the CONTRACTOR. CONTRACTOR shall pay all plan check fees and other fees necessary to obtain permits and shall accommodate special inspections required thereof. CONTRACTOR shall be responsible for compliance with all permit provisions and shall accommodate all special inspections required thereof, all at no additional expense to the OWNER beyond prices as bid.

1.9 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.

1.10 TEMPORARY UTILITIES FOR CONSTRUCTION PURPOSES

The CONTRACTOR shall make all arrangements necessary to provide all temporary utilities for construction purposes and shall pay all costs associated those temporary utilities. 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.

1.11 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.

1.12 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.

1.13 CONSTRUCTION WITHIN PRIVATE EASEMENTS

When portions of the work contemplated are within easements held by the OWNER on private property, the CONTRACTOR shall ascertain for itself to what extent the width, status, and special conditions attached to easements may have on its operations and all costs resulting therefrom shall be included and absorbed in the unit prices of the CONTRACTOR's bid. CONTRACTOR shall coordinate with private property owners and businesses if required. Landscaping, surface restoration and fence restoration shall be completed within 24 hours following piping and conduit installation and other construction work. Temporary fencing shall be provided continuously until such private fencing is properly restored.

Certain portions of this project require working near existing structures and property within private easements. It is the CONTRACTOR'S responsibility to conduct its operations and limit the size of equipment used in such a manner to prevent damage to existing property from excessive vibration or from other direct or indirect CONTRACTOR operations. The cost associated with repairing or replacing property that is damaged by the CONTRACTOR's operations shall be the responsibility of the CONTRACTOR, in accordance with the General Conditions.

1.14 RAILROAD CROSSINGS

Whenever a utility passes under a railroad or is on a railroad right-of-way, the work to be done shall be subject to the approval of proper officials of the railroad involved. Drawings and specifications will be filed by the OWNER with the railroad concerned prior to the time of bidding, but it is the responsibility of the CONTRACTOR to determine the requirements of the railroad with respect to maintaining traffic, amounts of insurance, and allowable construction procedures. All costs due to the existence of railroad track and other related facilities and the requirements of the railroads shall be covered by the price bid in the CONTRACTOR's proposal

1.15 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.

1.16 TRAFFIC CONTROL AND PROTECTION

The CONTRACTOR shall maintain traffic control and protection in the work areas 24 hours per day. Traffic control shall conform to the standards set forth in the "Oregon Manual on

Uniform Traffic Control Devices" issued by the Oregon Department of Transportation.

The CONTRACTOR shall conduct its operations to keep one lane of traffic open for public and private access at all times on City, County and Public streets, roads and highways. If required by the State, the CONTRACTOR shall conduct its operations to keep both directions of traffic open on State Highways. Permits obtained for the project may have more stringent requirements than noted in this section.

Prior to beginning construction, the CONTRACTOR shall submit a detailed street closure and traffic control plan to the ENGINEER for approval. As construction proceeds, the CONTRACTOR shall notify the ENGINEER as to the status of street closures and detours.

On streets where traffic is heavy, the ENGINEER may require the construction of two-way bridges of adequate design. These bridges shall be provided with guard rails and shall be well lighted at all times. Detours as required by the ENGINEER shall be surfaced with gravel or crushed rock and maintained in good condition. Detours for pedestrians shall not exceed one block in length, and foot bridges over the trenches shall be provided with adequate handrails.

All work shall be carried on with due regard for safety to the public. Open trenches shall be provided with barricades of a type that can be seen at a reasonable distance, and at night they shall be distinctly indicated by adequately placed lights.

1.17 MATERIALS AND COMPACTION TESTING

The CONTRACTOR shall provide the services of a licensed, independent agency to perform materials and compaction testing for this project. The agency must be approved by the ENGINEER. Materials and compaction tests will be required to show that specified densities of compacted backfill and asphaltic concrete surfacing are being achieved by the CONTRACTOR’s compaction methods. The CONTRACTOR shall provide the ENGINEER with copies of recent Proctor tests for the backfill and paving material in addition to copies of compaction tests performed in the field.

After the ENGINEER is satisfied that the CONTRACTOR’s method of compaction consistently meets specified compaction requirements, the testing frequency may be reduced. The ENGINEER may direct testing at a higher frequency upon failure to obtain specified densities or if the CONTRACTOR changes compaction equipment or methods of compaction. All test locations shall be determined by the ENGINEER.

1.18 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.

1.19 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.

1.20 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.

1.21 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.

1.22 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.

1.23 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.

1.24 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.

1.25 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.

1.26 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
- Accident Reporting
- Signs and Barricades
- Fire Prevention and Protection
- Welding, Cutting, and Burning
- Painting and Surface Treatment
- Electricity
- Hazardous Materials
- Hazardous Communications Program
- Job Hazard Analysis
- First Aid/Medical Facilities
- Personal Protective Equipment
- Confined Space Entry Plan
- Shoring Plan
- Fall Protection Plan
- Emergency Action Plan

- Machinery and Mechanized Equipment
- Excavations
- Sanitation
- Chlorine Safety
- 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.

1.27 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.

1.28 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.

Utilities which may be impacted include the following:

Northwest Natural Gas	Natural Gas
Portland General Electric	Power
City of Woodburn	Water, Sanitary Sewer, Storm Drain

1.29 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.

1.30 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.

1.31 VEHICLE PARKING

The vehicles of the CONTRACTOR's and subcontractors' employees shall be parked in accordance with local parking ordinances.

1.32 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.

1.33 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.

1.34 "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.

1.35 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.

1.36 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. No weekend work will be allowed. Requests for variations in work hours shall be made in writing for consideration by the ENGINEER. No work shall be conducted outside

of the above-described days and hours without prior approval of the ENGINEER.

1.37 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.

1.38 EROSION AND SEDIMENTATION CONTROL

Erosion control measures shall be maintained throughout the project site until approved permanent cover such as a healthy stand of grass, other permanent vegetation, or other ground covering is established. When approved permanent ground cover is established, all temporary erosion control measures shall be removed from the construction site. Erosion control measures shall be installed as approved, per the erosion control drawing(s) in the above referenced document. Erosion control measures including stabilized construction entrances and sediment barriers must be established in conjunction with site clearing and grading.

During construction, and until permanent vegetation or other ground covering is established, the erosion control facilities shall be upgraded as needed for unexpected storm events or site conditions and with the purpose of retaining sediment and sediment-laden water on the construction site.

1.39 INTERFERENCES, OBSTRUCTIONS, AND SEWER CROSSINGS

At certain places, power, light and telephone poles may interfere with excavation and the operation of the CONTRACTOR's equipment. Necessary arrangements shall be made with utility companies for moving or maintaining such poles. The utility company affected by any such interferences shall be notified thereof so that the necessary moving or proper care of poles and appurtenances may have appropriate attention.

All costs resulting from any other interferences and obstructions, or the replacement of such, whether or not herein specifically mentioned, shall be included and absorbed in the unit prices of the CONTRACTOR's bid.

1.40 NOISE LIMITATIONS

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

1.41 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 except as allowed in 1.41 C. :

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.

C. The secure public works facilities paved area at the Parr Road Treatment Plant can be used for equipment storage in coordination with City staff. Contractor shall be responsible for all additional are needed for equipment or material storage.

1.42 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.

1.43 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.

1.44 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.

1.45 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.

1.46 USE OF EXPLOSIVES

The use of explosives shall not be allowed on this project. Alternative methods of excavation shall be utilized.

1.47 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.

1.48 EQUIPMENT QUALIFICATION PRIOR TO BIDDING

(not used)

1.49 SEQUENCE OF CONSTRUCTION REQUIREMENTS

A. Complete construction of new yard piping and stormwater facilities to facilitate new well house and well pump testing.

B. New raw water piping and well water must pass microbial testing prior to start-up testing of the well pump. Pump discharge for pump and motor testing will be discharged to the Parr Road WTP site.

1.50 FACILITY OPERATIONS REQUIREMENTS

The work included in these plans and specifications is to be performed that will effect a water treatment facility that must continue in operation during construction. The CONTRACTOR shall always cooperate fully with the OWNER and the ENGINEER to ensure that the production capability of the plant will continue and that any interruption to plant operations are minimized.

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.

1.51 CONSTRUCTION WITHIN STATE WATERS

(not used)

1.52 CONDITIONAL USE PERMIT

The OWNER has obtained Conditional Use Permits for the construction of the project. All terms of the Conditional Use Permits related to construction shall apply and by reference shall be included as part of this contract. The project is located in residential areas. The CONTRACTOR is obligated to become familiar with the terms of the Conditional Use Permit prior to bidding and to assess any implications with respect to construction cost/pricing/bidding. CONTRACTOR failure to become familiar with the Conditional Use Permit provisions will not relieve the CONTRACTOR from permit obligations and will not constitute justification for added compensation for any requirements thereof which may not have been included in the CONTRACTOR's bid. A copy of the Conditional Use Permit is bound herewith as Supplementary Information. Included copy is provided for bidder information only and may not include all various attachments and exhibits.

The CONTRACTOR shall furnish and install project information signs in accordance with the following requirements:

A. For a project located on a confined site such as a reservoir, pumping station, well house, treatment plant, or similar facility, one project information sign shall be required. For a project located on a public right of way such as a pipeline project, a project information sign shall be installed facing each direction of traffic at each location where traffic is entering the work area. A minimum of two signs will be required.

B. A submittal for the project information sign(s) shall be prepared for the ENGINEER'S approval prior to fabrication.

C. The CONTRACTOR shall install the project information sign(s) at location(s) as directed by the ENGINEER.

D. No construction work shall commence on the project site until the project information signs are installed.

E. The CONTRACTOR shall maintain the signs through the duration of the project.

The project information sign(s) shall be constructed of 3/4-inch thick plywood with a finish grade of veneer on the sign face. The sign(s) shall be 48 inches high by 60 inches wide. The sign(s) shall be securely attached to two 4-inch square treated wood posts. The sign(s) shall be installed such that the top of the sign is approximately 10 feet above grade or as necessary

to permit proper public viewing. The wood posts shall be buried at least 3 feet below grade. Provide adequate supports for the sign(s) as site conditions dictate. The sign(s) shall have black letters on a white background, and they shall be the product of a commercial sign manufacturer or supplier. Logos shall be color. The letters shall be at least 4 inches in height.

The sign(s) will contain basic project information including: Project name, estimated project duration, project construction cost, project OWNER's name and OWNER's contact and phone number, ENGINEER's name, CONTRACTOR's name, OWNER's and ENGINEER's company logos, the CONTRACTOR's logo if the CONTRACTOR so desires, any funding agency logo(s) along with any required wording from those agencies. The logos shall be sized such that they are visible from a distance approved by the ENGINEER. The OWNER, ENGINEER and funding agencies will provide electronic images of their logos for the CONTRACTOR's use in developing the signs.

END OF SECTION

SECTION 01 22 20

UNIT PRICE MEASUREMENT AND PAYMENT

PART 1 GENERAL

Measurement and payment will be on a unit price basis in accordance with the prices set forth in the proposal for individual work items. Where work is required but does not appear as a separate item in the proposal, the cost for that work shall be included and absorbed in the unit prices named in the proposal. CONTRACTOR shall make a careful assessment when preparing the bid.

1. Mobilization, bonds, permitting, insurance and demobilization: Payment for mobilization, bonds, permitting, insurance and demobilization will be on a lump sum basis. The amounts paid for mobilization in the contract progress payment will be based on the percent of the original contract amount that is earned from other contract items, as follows:

   A. When 5 percent of the original contract amount is earned, 2/3 of the amount for the bid item will be paid.

   B. When 95 percent of the original contract amount is earned, 1/3 of the amount for the bid item will be paid.

   This schedule of mobilization progress payments will not limit or preclude progress payments otherwise provided by the contract.

2. Erosion and sediment control plan and maintenance: Payment for installation of approved erosion control devices (silt fencing, straw bales, and other items), as required, including all labor, materials, and equipment, as required, will be on a lump sum basis.

3. Construction survey and staking: Payment for construction survey and staking, including all coordination, materials, labor and equipment, as required, will be on a lump sum basis, complete.

4. All work required to construct wellhouse building complete, complete: Lump sum payment under this item shall cover all particular elements of the project, whether or not specifically or specially identified, as specified herein, in the contract documents and as shown on the plans, except for work included separately under separate bid items. Payment will be made on a lump sum basis for the completion of all work to the wellhouse. The wellhouse work shall be defined as all work not identified under separate bid items. Payment shall be full and complete compensation for all work shown in the drawings and other work required to provide complete and usable facilities including materials, equipment, and labor for construction. Payment shall also include the furnishing of all required record drawings, operation and maintenance manuals, and other documents, certifications and reporting specified herein. The Contractor shall provide a breakdown of contract price as required by Section 01 33 00, Submittal Procedures.

5. All work required for civil site improvements, complete: Measurement and payment for all project work required for civil site improvements, complete, other than as provided for under separate unit prices, will be made on a single lump sum basis. For purposes of evaluating monthly partial payments, this lump sum is broken down as follows:

    a. Clearing and grubbing, tree protection, site restoration;
    b. Site preparation, excavation, backfill, and grading;
    c. Furnish and install site fencing and gates;
    d. Gravel access road, complete;
    e. Relocate pedestrian walkway;
    f. Parking spots;
    g. Furnish and install bollards;
    h. Landscaping.

6. Asphalt Concrete (AC) Paving: Payment for AC paving shall include all labor, materials, and equipment needed to place AC paving per Drawings. Payment for the individual components shall be as follows:

    a. HMAC Pavement, 4-inch depth: Payment shall be made on a per Ton basis.
    b. Aggregate base, ¾-inch minus 0 , 9-inch depth: Payment shall be made on aper cubic yard basis.

7. Saw-cutting existing AC pavement and concrete surfacing: Measurement and payment for saw cutting shall include the total sawed length of the roadway, as shown on the drawings. Payment for saw cutting existing surfacing, which includes AC and concrete surfaces, for cuts up to 6-inches in depth will be on a linear foot basis. Payment for each 1-inch depth beyond 6-inch thickness will be on a per linear foot basis.

8. Asphalt Concrete (AC) Pavement Repair: Measurement and payment for permanent AC pavement restoration shall be on a per square yard basis and shall include furnishing and installing of the crushed rock bedding material, permanent asphaltic concrete, compaction, process control, acceptance testing, and other incidental work required to provide permanent AC pavement, in place, as required by the Contract Documents. Temporary paving is considered incidental and no separate measurement and payment item will be included.

9. Concrete Curb: Payment for this item shall be on a per linear foot basis and include all labor, materials, and equipment required to construct standard concrete curb per the Drawings.

10. Concrete Sidewalk: Payment for this item shall be made on a square-foot basis and include all materials, labor, and equipment required to install concrete walks to the limits shown on Drawings.

11. Furnish and install Class 52 restrained DI pipe with Class B (imported granular material) trench backfill: Payment for furnishing and installing Class 52 restrained DI pipe with Class B trench backfill, including all work and materials; excavations to depths shown in the Drawings; all required joint restraint systems for pipe, fittings, valves, and appurtenances; standard concrete thrust blocks (including concrete, excavation, and thrust plates) where shown in the Drawings; dewatering; double-wrapping of the piping in 8 mil polyethylene film; Class B pipe bedding and pipe zone backfill; and Class B trench backfill will be on a per linear foot basis for the pipe diameters shown. Measurement will be based on total length of piping constructed with restrained joints as indicated on the Drawings without deduction for fittings and valves. Pipe bedding, pipe zone and trench backfill material is understood to be imported granular material, compacted in place as shown on the Drawings. Class B fill material shall be as specified within Section 31 23 17, Trenching.

    The pay quantities for pipe, trench excavation and backfill will be on the basis of the horizontal length of pipe laid without deductions for valves or fittings which may be included in the end-to-end measurement of a continuous section of pipe. Where pipe is laid on a continuous slope greater than 10 percent for a distance greater than 100 feet, payment will be made upon the average slope distance between 100-foot stations. When water mains intersect, the measurement of each main shall be to the intersection of the center lines of the connecting fittings.

    The unit price shall include any incidental excavation, backfill and additional work required to cutting existing piping, installation of branch-line fittings and/or connection to existing pipelines. Unit price shall also include as incidental the removal of existing fittings and piping as shown on the plans.

12. Furnish and install zinc coated ductile iron fittings: Payment for furnishing and installing cast or ductile iron fittings will be made on a per pound basis. The weight of fittings used for payment will be the nominal weights listed in AWWA Standard C110 for the actual Class and type of fitting specified and shown on the plans. Fitting installation will be considered a separate pay item from work performed under other pay items. Fitting accessories including glands, bolts, and gaskets shall be considered incidental in the fitting weights for payment.

13. Furnish and install 10" flexible expansion joint: Payment for furnishing and installing double-ball flexible expansion joints shall be on a per each basis for the size and type shown on the Drawings, and shall include all trench excavation, pipe zone, bedding and backfill material, and polyethylene material required for installation.

14. Connection to Exist 14" water at STA A19+14: Payment for connecting to existing water system piping, including exploratory excavation as may be required to confirm piping locations and type, any additional excavation and backfill, cutting existing piping, and all other miscellaneous tie-in related work not included in other pay items will be on a lump sum basis for the sizes and types as shown in the Drawings.

15. Furnish and install 60" Precast Manhole: Payment for furnishing and installing 60-inch diameter manhole shall be made at the unit price. The unit price shall be full compensation for the manhole in-place including excavation and backfill, hatch, piping connections, restrained flap valves, and any other work shown on the Drawings, complete.

16. Hot tap connection: Payment for furnishing and installing hot tap assemblies shall be on a per each basis for the size and type shown on the Drawings and shall include all costs for tapping sleeve assembly, driving, and tagging of existing water main. Hot tap isolation valve will be paid for at the unit contract price under the appropriate bid item.

17. Furnish and Install Fire Hydrant Assembly: Payment for furnishing and installing fire hydrant assemblies will be on a per each basis. The unit price for hydrants shall include all costs for shackles, tie rods, pier blocks, gravel, painting, and all other items for the complete installation of the hydrant including the pipe connecting the hydrant to the main. Hydrant isolation valves and tees will be paid for at the unit contract price each under the appropriate bid items.

18. Furnish and Install Services: The lump sum price for installing the new service line shall be full compensation for all service line work including excavation, installation, backfill, copper tubing, fittings, couplings, service saddles, corporation stops, unions, adapters, angle meter stops, meter box, and expansion joint filler material (where required). The Owner will provide and install the meter.

19. Furnish and install PVC drain piping with Class B (imported granular material) trench backfill: Payment for furnishing and installing PVC drain piping with Class B trench backfill, including all work and materials; excavations to depths shown in the Drawings; dewatering; Class B pipe bedding, pipe zone and trench backfill materials will be on a per linear foot basis for the pipe diameters shown. Measurement will be based on total length of piping constructed as indicated on the Drawings without deduction for manholes or other structures. Pipe bedding, pipe zone, and trench backfill material is understood to be imported granular material, compacted in place as shown on the Drawings. Class B fill material shall be as specified within Section 31 23 17, Trenching.
    The pay quantities for pipe, trench excavation and backfill will be on the same basis and shall include the same work as specified in Pay Item 11.

20. All work required for stormwater improvements, complete: Measurement and payment for all project work required for stormwater improvements, complete, other than as provided for under separate unit prices, will be made on a single lump sum basis. For purposes of evaluating monthly partial payments, this lump sum is broken down as follows:

    1. Stormwater detention pond;
    2. Furnish and install curb inlet;
    3. Outlet control structures and pumps;
    4. Start-up and testing.

21. All work required for infiltration trench, complete: Payment for infiltration trench, complete will be on a lump sum basis. The lump sum price shall include all coordination, materials, labor and equipment required for the construction of the infiltration trench.

22. All work required for System integration, complete: Payment for system integration, complete will be on a lump sum basis. The lump sum price shall include all coordination, materials, labor and equipment required for the system integration.

23. Water supply well disinfection: Payment for disinfection and bacteriological testing of the existing water supply well will be on a lump sum basis.

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. Schedule of Submittals.
2. Submittal requirements.
3. Submittal procedures.
4. Engineer review.
5. Resubmittal procedures.
6. Product data.
7. Shop Drawings.
8. Samples.
9. Design data.
10. Test reports.
11. Certificates.
12. Manufacturer's instructions.
13. Manufacturer's field reports.
14. Erection Drawings.
15. Construction progress schedules.
16. Breakdown of contract price.
17. Construction photographs.
18. 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 SCHEDULE OF SUBMITTALS

A. Within 10 days after the Effective Date of the Contract, Contractor shall submit to Engineer a preliminary Schedule of Submittals, including proposed list of major products proposed for use, with specification section reference, name of manufacturer, supplier, trade name, subcontractor and model number of each

product. Provide a schedule of specific target dates for the submission and return of submittals and shop drawings required by the Contract Documents.

B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

C. The list and schedule shall be updated and resubmitted when requested by the Engineer.

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

1.4 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 separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review of each such variation.

1.5 SUBMITTAL PROCEDURES

A. Contractor shall submit Shop Drawings and Samples to Engineer for review in accordance with the accepted Schedule of Submittals.

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.

1.6 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 will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. 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.

1.7 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 PROGRESS SCHEDULES

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.

Detailed subnetworks will include all necessary activities and logic connectors to describe the work and all restrictions to it. In the restraints, include those activities from the project schedule which initiated the subnetwork as well as those restrained by it.

Include a tabulation of each activity in the computer mathematical analysis of the network diagram. Furnish the following information as a minimum for each activity:

- Event (node) number(s) for each activity
- Activity description
- Original duration of activities (in normal workdays)
- Estimated remaining duration of activities (in normal workdays)
- Earliest start date or actual start date (by calendar date)
- Earliest finish date or actual finish date (by calendar date)
- Latest start date (by calendar date)
- Latest finish date (by calendar date)
- Slack or float time (in workdays)

Computer printouts shall consist of at least a node sort and an "early start/total-float" sort.

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.

D. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

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.

E. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

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.

H. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

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 PROJECT HEALTH AND SAFETY PROGRAM

A. Develop, publish, and implement an overall Project Health and Safety Program for the Project. This Program shall conform to all applicable codes. The written Safety Program

shall be provided 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 at a minimum the following items when they apply:

1. Employee orientation
2. Safety inspections
3. Instruction and training
4. Accident reporting
5. Signs and barricades
6. Fire prevention and protection
7. Welding, cutting, and burning
8. Painting and surface treatment
9. Electricity
10. Machinery and mechanized equipment
11. Excavations
12. Sanitation
13. Chlorine safety
14. Hazardous materials
15. Hazardous communications program
16. Job hazard analysis
17. First aid/medical facilities
18. Personal protective equipment
19. Confined space entry plan
20. Shoring plan
21. Fall protection plan
22. Emergency Action Plan
23. Housekeeping
24. Safety training requirements and certification
25. Pedestrian access around work site during construction and after hours
26. Neighboring residences/community access and safety

B. If the project requires other health and safety issues to be addressed, they too shall be included in the Project Health and Safety Program. The Program shall subsequently be distributed to and implemented by the Contractor's personnel, as well as its Subcontractors and Suppliers, the Owner and Engineer. 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 and Engineer when safety meetings will be held so that Owner's and Engineer's personnel may attend. A copy of the Health and Safety Program must be maintained on-site at all times during the life of the Project.

2.13 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 copies 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. 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.

2.14 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.
3. Traffic Control and Protection Plan.

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 45 00 - QUALITY CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers quality control requirements supplementary to those of the General Conditions and Technical Specifications.

1.2 PROVISIONS

A. Contractor's Responsibility for Testing

The CONTRACTOR shall be responsible for the cost of all testing as specified in this section. Additional information has been provided regarding the payment responsibility for the OWNER with regards to the Project.

B. OWNER's Right to Perform Additional Tests

The OWNER or ENGINEER reserves the right to complete additional testing. In such cases, the CONTRACTOR shall provide safe access for the OWNER or ENGINEER and their inspectors to adequately inspect the quality of work and the conformance with project specifications.

1.3 QUALITY ASSURANCE

A. Testing Requirements

An independently owned and operated laboratory approved by the ENGINEER shall perform all testing as specified herein.

B. Testing

1. General

a. All required testing of work and/or materials shall be conducted in the presence of the ENGINEER. The CONTRACTOR shall provide 48-hour notification to the OWNER and OWNER's REPRESENTATIVE prior to conducting any and all quality assurance testing. Where applicable, work and materials shall only be buried with the consent of the ENGINEER.

b. Where such inspection and testing are to be conducted by an independent laboratory or agency, the sample or samples of material to be tested shall be selected by such laboratory or agency or by the ENGINEER. The CONTRACTOR shall furnish such samples of all materials without charge to OWNER.

c. The results from any and all tests are made for the information of the OWNER. Regardless of any test results, the CONTRACTOR is solely responsible for the quality of workmanship and materials and for compliance with the requirements of the Drawings and Specifications.

2. Costs of Testing

a. The CONTRACTOR shall be responsible for and shall pay for all tests as specified in Part 3 of this Section. Additional information has been provided regarding the payment responsibility for the OWNER with regards to the Project.

b. With regards to all materials to be tested, where test results demonstrate that the material or workmanship does not meet the minimum requirements of the Contract Documents, additional testing shall be completed and shall be paid for by the CONTRACTOR with no reimbursement by the OWNER.

1.4 SPECIAL INSPECTIONS

Special inspections and testing as required by Chapter 17 of the IBC shall be conducted by OWNER-retained Special Inspectors and Testing Agencies 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 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, 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 pre-construction 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.

1.5 SUBMITTALS

A. Laboratory Test or Inspection Reports

Each report shall be signed and certified by the independently owned and operated testing laboratory. Unless otherwise specified, submit three copies of each report to the OWNER or OWNER's REPRESENTATIVE.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 FIELD TESTING SCHEDULE

A. The CONTRACTOR shall complete field testing in accordance with the following schedule. Additional source material testing shall be completed as necessary to establish the basis of field tests. The frequency of testing listed in this schedule lists the minimum number of tests per quantity of work completed by the CONTRACTOR. Testing locations to be determined by the ENGINEER.

Material to be Tested	Payment Responsibility for Initial Testing	Minimum Testing Frequency
Structural Backfill	OWNER	In-place compaction testing (w/ nuclear compaction gage) performed at 2-foot elevation increments, one test per 2,500 sf of material placed. See Article 3.5, Field Quality Control of Section 31 23 23, Fill, for further details on testing requirements.
Trench Backfill	OWNER	In-place compaction testing (w/ nuclear compaction gage) performed at 2-foot elevation increments, one test per 200 lineal feet of pipeline trench as measured along pipe centerline. ENGINEER may reduce frequency to one test per lift for every 1,500 lineal feet of pipeline trench when satisfied with CONTRACTOR's method of compaction. See Article 3.16, Field Quality Control of Section 31 23 17, Trenching.
Asphalt Concrete	CONTRACTOR	As required when placed. See detailed requirements in Article 1.6, Field Quality Control of Section 32 12 16, Asphalt Paving.
Concrete	OWNER	As required when placed. See detailed requirements in Article 3.14, Concrete Tests of Section 03 30 00, Cast-In-Place Concrete.
Grout	OWNER	Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the ENGINEER to insure continued compliance with Specifications. See detailed requirements in Article 3.2, Field Quality Control of Section 03 60 00, Grouting.
Masonry Mortar and Grout	OWNER	As required when placed. See detailed requirements in Section 04 05 17-1.3.
Waterline – Hydrostatic testing and disinfection	CONTRACTOR	As required. See Section 33 13 00, Testing & Disinfection of Water Utility Piping.
Well Disinfection	CONTRACTOR	As required. See Section 33 20 20, Disinfection of Water Supply Wells
Structural Observations	Owner	Per Oregon Structural Specialty Code

END OF SECTION

SECTION 01 56 39 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes provisions for temporary protection of trees and other plant life in preparation for site or building excavation Work.

B. Related Sections:

1. Section 31 10 00 - Site Clearing
2. Section 31 22 13 - Rough Grading
3. Section 31 23 16 - Excavation
4. Section 31 23 17 - Trenching

C. This specification shall be applied concurrently and in conjunction with other plant material protection measures herein described and specified.

PART 2 MATERIALS - Not Used

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect all trees specified on the Drawings for protection prior to construction.

1. Document with written memorandum and photographs any unusual conditions.

2. Submit copies of documentation to ENGINEER prior to beginning work.

B. Verify all conditions on the Drawings with actual conditions at Site regarding tree protection prior to any site disturbance.

C. The ENGINEER must be present during demolition of existing conditions occurring within the drip line of trees designated to remain.

D. Notify ENGINEER 24 hours prior to inspections and/or tagging of protected trees.

3.2 PROTECTION

A. Install barricades specified in the Drawings at drip lines of trees designated to remain prior to the commencement of construction.

B. Clearly designate protected trees and clear of any material storage, personnel, or vehicular movement.

C. Provide temporary fencing, barricades, and guards as necessary or required to protect trees designated on the Drawings to remain, from damage above and below grade.

D. Protect root systems of trees and plant life to remain.

1. Protect from damage due to noxious materials in solution caused by runoff or spillage during mixing and placement of construction materials.

2. Protect from flooding, erosion, or excessive wetting resulting from dewatering operations and compaction.

3. Protect against unauthorized cutting, breaking, skinning roots and branches, or bruising bark.

4. Protect from smothering and compaction.

a. Do not store construction materials or permit vehicles to drive or park within the drip line area of any tree to remain.

5. Protect from dumping of refuse in close proximity.

E. Where cutting is necessary, review conditions with the ENGINEER before proceeding, and comply with directives of ENGINEER.

3.3 EXCAVATION AROUND TREES

A. Excavate within drip lines of trees only where indicated on the Drawings or as directed by ENGINEER.

B. Where trenching for utilities is required within drip lines, tunnel under or around roots by hand excavating.

1. Where possible trench toward trunk of tree and tunnel under central root mass to avoid severing all lateral roots on side of trench.

2. Do not cut main lateral roots or tap roots over 1-inch in diameter.

3. Temporarily support and protect trees from damage until permanently covered with approved backfill.

C. Do not allow exposed roots to dry out before backfill is placed.

1. Provide temporary earth or burlap cover.

2. Water roots daily when exposed and maintain in a moist condition.

D. Backfill roots only upon inspection approval from the ENGINEER.

1. Backfill around root excavations only with clean imported topsoil free from materials deleterious to root growth.

2. Backfill to eliminate voids and compact only by means of manual tamping at root areas.

3. Water sufficiently to settle topsoil and eliminate voids or air pockets around roots.

4. Allow for natural settlement of soil surface and furnish and apply topsoil sufficient to bring to original finish grade after backfill settlement.

E. If during excavation, any condition arises that threatens the survivability of the protected tree, or an unknown condition arises that affects the stability or integrity of the root system, notify the ENGINEER immediately.

3.4 REPAIR AND REPLACEMENT OF DAMAGED TREES

A. In the event of damage to existing trees:

1. Immediately prune limbs smaller than 3-inch caliper or roots smaller than 2-inch caliper to repair trees damaged by construction operations.

2. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.

3. Any such pruning and/or repairs shall be approved in advance and at completion by ENGINEER.

4. The ENGINEER shall reserve the right, at cost to the CONTRACTOR, to obtain the services of a Certified Consulting Arborist with current membership in the American Society of Consulting Arborists to determine the severity of damage.

5. The CONTRACTOR is responsible for the cost of repairs caused by their actions or by the actions of subcontractors engaged by the CONTRACTOR.

B. Remove and replace dead or damaged trees which are determined by the ENGINEER to be incapable of restoration to normal growth patterns at no additional cost to OWNER.

1. Provide new trees of the same species as those removed or damaged, with size and/or quantity to be determined by ENGINEER.

2. Furnish replacement trees and plant life to the Site and plant, maintain, and warranty as directed by the ENGINEER.

3. If trees are not replaceable with the same species, and size, compensate the OWNER for the replacement cost of the trees based on the evaluation of a Certified Consulting Arborist.

4. The CONTRACTOR is responsible for additional costs of removing damaged trees and labor for planting new specimens.

3.5 DESIGNATED TREE REMOVAL PROCEDURES

A. If designated tree removal is specified by ENGINEER, furnish labor, material, and equipment necessary for removing and/or salvaging existing trees, if necessary, as designated on the Drawings for removal.

1. Verify location and species with ENGINEER prior to removal.

B. Salable logs or timber may be sold to CONTRACTOR's benefit upon notification and prior approval of OWNER. Upon approval, remove salable logs or timber promptly from site.

3.6 DESIGNATED TREE TRANSPLANTING PROCEDURES

A. If designated tree transplanting is specified by ENGINEER, verify and identify existing trees to be transplanted.

B. All work shall be in accordance with the standards and practices outlined in the following: Tree and Shrub Transplanting Manual, E.B. Himelick, 1981 Ed., International Society of Arboriculture.

C. Prior to commencement of Work, submit a coordination schedule, method of transplanting, traffic control, routing, etc., to ENGINEER, for review and approval.

D. Warranty for transplanted trees shall be determined and directed on a case by case basis by the ENGINEER, upon contracting of specified transplanting work.

E. Review and verify location of utilities in area of operation. Obtain location and jurisdictional approval from utilities prior to transplanting activities. Protect utilities and the public at all times.

F. Prior to transplanting, spray trees with an anti-desiccant emulsion-type film forming agent, "Dowax" by Dow Chemical Company, "Wilt-Pruf" by Nursery Specialty Products Inc., "D-Wax", by Plant Products Inc., or approved equal, prior to digging with two separate applications allowing 48 hours apart. Use a power sprayer to provide an

adequate film over trunks, branches, stems, twigs, and foliage. Anti-desiccant must be dry prior to relocation.

G. Dig, ball and burlap, and move designated trees for relocation to the new planting location shown on the Drawings. In the event the new planting area is not prepared, place tree in a storage area approved by the ENGINEER solely designated for healing-in of plant materials until final planting may occur. Brace in a vertical position, provide shade, wind protection, and irrigation at plant storage area. Utilize all horticulturally proper methods for plant storage. Plants shall be maintained by CONTRACTOR while in storage.

3.7 GRADING AND FILLING AROUND TREES

A. Maintain existing grade within drip line of trees unless otherwise indicated on the Drawings or directed by the ENGINEER.

3.8 MAINTENANCE OF PROTECTIVE MEASURES

A. Maintain protective measures throughout the construction process. Immediately repair any alteration to protection measures throughout construction process. Repair or reinstall protective measures immediately upon alteration. Monitor protective measures daily.

B. Remove and clear area of debris and fencing, barricades, etc., upon final written approval of ENGINEER.

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 MINIMUM SERVICE SCHEDULE

Minimum services as specified shall be provided in accordance with the following schedule:

Specification Section	Equipment	Minimum On-Site Time Requirements		
		1) Equipment Installation	2) Equipment Testing	3) Operator Training
40 21 52	Deep Well Vertical Turbine Pumps	0.5 CWD	0.5 CWD	0.5 CWD
43 23 14	Non-Clog Submersible Pumps	0.5 CWD	0.5 CWD	0.25 CWD
40 71 13	Electromagnetic Flow Meters	0.5 CWD	0.5 CWD	0.25 CWD

NOTE: CWD is defined as a consecutive working day consisting of 8 hours each from 8:00 a.m. to 5:00 p.m.

1.9 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.

1.10 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 30 00 - SUBSURFACE INVESTIGATION

PART 1 GENERAL

1.1 SUMMARY

A. Subsurface investigations and reporting have been performed for the purpose of obtaining data for the planning and design of this project. Copies of such reporting are attached to the Contract Documents as Supplementary Information.

1.2 LIMITATIONS

A. The subsurface investigations and reporting are being made available solely for the convenience of the Bidder and shall not relieve the Bidder or the Contractor of any risk, duty to make examinations and investigations as required by Section 00120 of the Standard Specifications, or any other responsibility under the Contract Documents.

B. It is mutually agreed to by all parties:

1. Written reports are reference documents and are not part of the Contract Documents.

2. Subsurface investigations are for the purpose of obtaining data for planning and design of the project.

3. Data concerning borings and test pits is intended to represent with reasonable accuracy conditions and material found in specific borings and test pits at the time the borings and test pits were made.

C. It is expressly understood and agreed the Owner and Engineer assume no responsibility whatsoever in respect to the sufficiency or accuracy of the investigation thus made, the records thereof, or of the interpretations set forth therein, or made by the Owner in his use thereof; and there is no warranty or guarantee, either expressed or implied, that the conditions indicated by such investigations, or records thereof, are representative of those existing throughout such areas, or any part, or that unforeseen developments may not occur.

D. The Owner’s subsurface investigations and reporting are made available to Bidder or Contractor only on the basis of the understandings and agreement herein stated.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 03 21 00

REINFORCING STEEL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all the work necessary to furnish all labor, materials, equipment, and services necessary to furnish reinforcing steel, accessories, welding, equipment and services, and place concrete reinforcement.

B. Section includes:

1. Reinforcing steel.

1.2 RELATED SECTIONS

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

B. Section 04 22 00 – Concrete Masonry Units.

1.3 SUBMITTALS

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

B. Shop Drawings: Submit shop drawings of detailed placing and bending lists for the ENGINEER's approval before the reinforcement is fabricated.

C. Mill Certificates: Mill test certificates shall be submitted to the ENGINEER to certify that the reinforcing steel meets the specified requirements. Mill test certificates shall be furnished and paid for by the CONTRACTOR.

D. In addition, the ENGINEER may require that test samples be taken and test certificates be furnished by a reputable material testing laboratory at the OWNER's expense.

1.4 QUALITY CONTROL

A. The ENGINEER may require that test samples be taken and test certificates be furnished by a reputable material testing laboratory at the OWNER's expense.

PART 2 PRODUCTS

2.1 DEFORMED REINFORCING BARS

A. Unless otherwise specified, reinforcing steel shall be Grade 60 billet steel conforming to ASTM Specification A615 or ASTM 706.

1. All such reinforcing shall be deformed steel bars with *deformations* conforming to the requirements set forth in ASTM Specification A615 or ASTM 706

2. Stirrups and Ties shall be Grade 60 but Grade 40 may be used for #3 and smaller.

B. Spiral reinforcement and steel wire shall be cold-drawn steel wire conforming to the requirements of ASTM Specification A82 unless shown otherwise on the Drawings.

C. Welded Wire Fabric (WWF) shall conform to ASTM Specification A185.

D. Bar and rod mats for concrete reinforcement conforming to ASTM A184

E. Tie wire, 16 gauge or heavier black annealed wire.

F. Varying grades shall not be used interchangeably in structures.

G. Steel bending processes shall conform to the requirements of ACI 318.

H. Bending or straightening shall be accomplished so that the steel will not be damaged.

I. Kinked bars shall not be used.

2.2 PLAIN REINFORCING BARS

Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A82 unless shown otherwise on the Drawings.

Plain smooth dowels and ¼-inch diameter smooth bars conforming to ASTM A615 Grade 60.

2.3 SUPPORTS

A. Bar supports shall conform to ACI 315 and CRSI Manual of Standard Practice, Chapter 3, Bar Supports

B. Bar supports shall consist of approved high density "adobes", stainless steel chairs, plastic spacers or plastic shim plates.

1. Brick, broken concrete masonry units, spalls, rocks or similar materials shall not be used for support of reinforcing steel.

2. Steel chairs shall be furnished with plastic tips when incorporated into concrete exposed to view, such as in the roof slab.

3. Plastic spacers shall be PRECO BARSPAN WHEELS, as manufactured by the PRECO CORPORATION or equal.

4. Plastic shim plates may be used to support the plastic spacers and shall be used to support the vertical reinforcing in the corewall, unless shown otherwise on the Drawings.

C. Hot-dipped Galvanized Reinforcing Bars

When reinforcing bars are indicated on the Drawings to be hot-dipped galvanized, they shall be galvanized in accordance with ASTM A767 and ASTM A143. The grade of reinforcing bars shall be as specified under Section 2.1. The bars shall be galvanized in conformance with a Class 1 coating and shall be galvanized after fabrication and shearing.

D. Steel Tie Wire: Annealed steel tie wire shall be used to fasten the reinforcing steel in place.

PART 3 EXECUTION

3.1 REINFORCING BARS

Comply with the specified codes and standards and Concrete Reinforcing Steel Institutes recommended practice for "placing reinforcing bars," for details and methods of reinforcement placement and supports, and as herein specified.

A. General

1. Mild steel reinforcing bars shall be furnished, cut, bent and placed as indicated on the Drawings.

2. At the time of placing concrete, all reinforcement shall be free from loose mill scale, rust, grease, oil, or other coating which might destroy or reduce its bond with concrete.

a. Reinforcing bars with rust, mill scale or a combination of both will not be acceptable without cleaning or brushing provided that upon wire brushing a sample, the dimensions including height of deformations and weights shall not be less than the applicable ASTM requirements. Steel reinforcement which is to be placed in the work shall be stored under cover to prevent rusting and shall be placed on blocking such that no steel touches any ground surface.

3. All reinforcing steel placed in the work shall be tied together and supported in such a manner that displacement during placing of concrete and shotcrete will not occur.

4. When there is a delay in depositing concrete, reinforcement shall be re-inspected and cleaned when necessary.

B. Cutting and Bending

1. Steel reinforcement shall be cut and bent in accordance with ACI 318 and with approved practices and machine methods, either at the shop or in the field.

2. Reinforcement shall be accurately formed to the dimensions indicated on the Drawings and on the bending schedule.

3. Bends for hooks on bars shall be made around a pin having a diameter not less than six times the minimum thickness of the bar.

4. All bars shall be bent cold.

C. Minimum Bar Spacing

The clear distance between parallel bars shall not be less than one and one-half times the diameter of the bars and, unless specifically authorized, shall in no case be less than 1-inch, nor less than the maximum size of coarse aggregate specified.

D. Concrete Cover (Minimum)

1. On all formed surfaces which will be exposed to water, ground or the elements, there shall be a nominal cover over the steel of 2.0-inches for bars number 6 through number 18 and 1-1/2 inches for bars number 5 and smaller, with an installation tolerance of + 1/4 inch. When crossing bars of different diameter are encountered in one face, one shall consider the bar size and location that will provide the largest cover over the nearest steel to the outside surface.

2. Unless otherwise specified in these specifications or shown on the Drawings, all reinforcing steel facing subgrades for concrete construction of the foundation or below-grade elements shall be given a nominal protective cover of 3.0-inch minimum. The largest cover shall be used when different size bars are encountered in one face.

3. The minimum cover over reinforcing steel for concrete construction of other facilities shall be as shown on the Drawings.

4. No "bury" or "carrier" bars will be allowed unless specifically approved by the ENGINEER.

E. Splicing

1. Except as shown or specified on the Drawings, reinforcing steel shall not be spliced at any location without specific approval by the ENGINEER. Splices in adjacent bars shall be staggered.

2. Where permitted or required, splices in reinforcing steel shall have sufficient lap to transfer full strength of the bar by bond and shear. Unless specified or shown otherwise on the Drawings, the bars at a lap splice shall be in contact with each other. In no event shall the lap be less than 40 diameters of the spliced bars.

3. Unless specified or shown otherwise on the Drawings, bars shall be lap spliced in accordance with ACI 318 and shall be fastened together with steel tie wire.

4. Unless shown otherwise on the Drawings, where bars are to be lapped spliced at joints in the concrete, all bars shall project from the concrete first placed, a minimum length equal to the lap splice length indicated on the Drawings. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sandblasting before the bars are embedded in a subsequent concrete placement.

F. Supports

1. All reinforcement shall be retained in place, true to indicated lines and grades, by the use of approved bar supports. The CONTRACTOR shall submit for ENGINEER's approval, samples of all bar supports he proposes to use along with a written description of where each bar support will be used.

2. The supports shall be of sufficient quantity, strength and stability to maintain the reinforcement in place throughout the concreting operations. Bar supports shall be placed no further than 4 feet apart in each direction. Supports must be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete. The CONTRACTOR shall be held responsible for providing the appropriate quantity and type of bar supports.

3. Do not place reinforcing bars more than two inches beyond the last leg on continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

G. Bar Tying

1. Bars shall be tied sufficiently often to prevent shifting. There shall be at least three ties in each bar length (this shall not apply to dowel laps or to bars shorter than 4 feet, unless necessary for rigidity).

2. Slab bars shall be tied at every intersection around the periphery of the slab. Wall bars and slab bar intersections shall be tied at not less than every fourth intersection, but at not greater than the following maximum spacings:

	Slab Bars (in)	Wall Bars (in)
Bars No. 5 and smaller	60	48
Bars No. 6 through No. 9	96	60
Bars No. 10 through No. 11	120	96

H. Reinforcement Around Openings -- Where reinforcing steel has to be cut to permit passage of pipe or to create openings, and should no detail be shown for extra reinforcing in such areas, the area of steel removed by the creation of the opening must be replaced by placing at least double the area of steel removed by the opening equally around the openings. The steel shall be placed such that it extends 5 feet beyond the opening on each side to provide for sufficient bond.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE 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 RELATED SECTIONS:

A. Section 03 21 00 - Reinforcing Steel.

1.3 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 anytime 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.

1.4 SUBMITTALS

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

B. For information only, submit an 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.

1.5 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.

1.6 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.

1.7 SAMPLE

Upon request by the OWNER or ENGINEER the CONTRACTOR shall pour and finish one 2-foot square exposed aggregate concrete sample for ENGINEER's approval prior to construction if exposed aggregate is included on job.

1.8 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 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.

2.2 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.

2.3 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. 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.

D. 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.

2.4 REINFORCING MATERIALS

A. See Section 03 21 00 – Reinforcing Steel for additional information

B. 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

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

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

E. 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.

F. Fiber Reinforcement – Collated polypropylene fiber, ¾"-inch, manufactured from 100% virgin homopolymer polypropylene, hydrophobic, in compliance with ASTM C116.

2.5 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 1-1/2-inch or 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.

2.6 RELATED MATERIALS

A. Bituminous and Fiber Joint Filler

Provide resilient and non-extruding type premolded bituminous impregnated fiberboard units complying with ASTM D1751, FS HH-F-341, Type 1 and AASHTO M 213. Provide one of the following products:

1. Elastite; Philip Carey/Celotex

2. Flexcell; Celotex Corp.

3. Crane Fiber 1390; W.R. Grace & Co.

4. Fibre; W.R. Meadows, Inc.

5. Tex-Lite; J & P Petroleum Prod. Inc.

6. Sonoflex; Sonneborn/Contech, Inc.

B. Joint Sealing Compound: See Section 07 92 00, Sealants and Caulking.

C. Moisture Barrier

Provide moisture barrier cover over all prepared base material. Use only materials that are resistant to decay when tested in accordance with ASTM E154. The moisture barrier consists of heavy Kraft papers laminated together with glass fiber reinforcement and overcoated with black polyethylene on each side. Provide Moistop, St. Regis, or equal.

D. 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.

E. 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.

F. 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.

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

H. Non-slip Aggregate Finish

Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.

I. Non-shrink Grout: See Section 03 60 00, Grouting.

2.7 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 0.40. 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 six (6) 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).

G. Fiber reinforcement admixture shall be included in the ready-mix concrete design used for filling and channeling the wet well chambers. Fibers shall be used in strict accordance with the manufacturer’s directions.

2.8 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.

2. Joint sealant material shall be as specified above.

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.

C. Cast in Place Reglets - Place in straight and continuous lines as detailed to enable flashing to be applied continuously without deviation at reglet joints more than 1/8-inch. Miter corners for continuous reglet joint where outside corners occur. At inside corners extend one section 1-inch past corner. Adequately anchor or secure reglets per manufacturer's instructions prior to pouring and during construction to insure dimensional tolerances and alignment. Vibrate concrete to insure concrete cover adjacent to and around reglet. Visually inspect after pour and patch as required.

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

Also see Section 09 90 00, Painting and Coating for protective coating requirements.

Surface Description		Type	Finish Requirement
A.	Interior Horizontal Slabs	Slab	Trowel Finish
B.	Exterior Horizontal Slabs	Slab	Broom Finish (Non-Slip)
D.	Interior Vertical Surfaces (including Wet Well)	Formed	Smooth Form
E.	Exterior Vertical Surfaces Exposed to View	Formed	Smooth Form

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 of door frames in CMU wall
3. Grouting for support of plumbing, fir sprinklers, and HVAC equipment
4. Grout for support of mechanical, electrical, and communications equipment
5. Removal of loose and spalling grout and concrete.
6. Anchoring cement for metal fabrications

1.2 RELATED SECTIONS

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

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. Steel Reservoir Grouted Bearing Surface:

1. Support wall plates above cleaned bearing surfaces with wedges or shims.

2. Fill space below bearing plates supporting structural members and stationary equipment with non metallic non shrink grout to depth and thickness as shown on the drawings.

3. Slope the face of grout to ensure water flows away from grouted edge.

B. 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.

C. 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.

D. 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 04 05 17

MASONRY MORTAR AND GROUT

PART 1 GENERAL

1.1 SCOPE

A. This Section includes all labor, materials and equipment required to complete masonry mortar and grout work required by the Contract Documents including, but not limited to, these major items:

1. Installation
2. Grouting.
3. Placement of vertical and horizontal reinforcing.
4. Cleaning of masonry.

B. Section Includes:

1. Masonry Grout.
2. Mortar.
3. Admixtures.
4. Masonry cleaners.

C. Related Sections:

1. Section 03 30 00 – Cast-in-Place Concrete Work
2. Section 03 21 00 – Reinforcing Steel
3. Section 04 22 00 – Concrete Masonry Units

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
2. ASTM C204 - Standard Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus.

3. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.

4. ASTM C270 - Standard Specification for Mortar for Unit Masonry.

5. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.

6. ASTM C476 - Standard Specification for Grout for Masonry.

1.3 SUBMITTALS

A. Masonry Grout design: Indicating type and proportions of the ingredients according to the proportion requirements herein and ASTM C 476.

1. In lieu of Masonry Grout design, submit the mix designs and grout strength test performed in accordance with ASTM C 476.

B. Mortar design: Indicating type and proportions of ingredients in compliance with the proportion specification herein and ASTM C 270.

1. In lieu of mortar design, submit the mix design and mortar tests performed in accordance with the property specification of ASTM C 270.

C. Color samples for OWNER selection of mortar color.

D. Material certificates certifying each material is in compliance for all Mortar and Grout materials and admixtures.

E. Construction procedures for Cold Weather Construction and/or Hot Weather Construction.

1. Adhere to the procedures and general practices provided for cast-in-place concrete in Section 03 30 00 Cast-in-Place Concrete Work

F. Masonry Cleaner: Product information

1.4 QUALITY ASSURANCE

A. Testing Service -- The OWNER will engage an independent testing laboratory to perform material evaluation tests and to perform required Special Inspections.

B. 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. All initial testing required by the Contract Documents shall be done at the OWNER's expense. Testing expenses for the retesting of rejected materials and installed work will be charged back to the CONTRACTOR.

C. Minimum Testing Frequency:

1. An independent testing agency or laboratory shall make test specimens of masonry grout and mortar on job site.

2. One mortar test and one grout test shall be taken for each 5,000 square feet of wall area but at least one set of tests shall be taken.

3. The use of testing and inspection does not relieve the CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.

D. Inspection Criteria:

1. Masonry construction shall be inspected and evaluated in accordance with the requirements of Chapter 17 of the Oregon Structural Specialty Code, per TMS 402/ACI 530/ASCE 5 Table 1.19.3 – Level C Quality Assurance and TMS 602/ACI 530.1/ASCE 6, Table 5 – Level C Quality Assurance requirements (ACI 530 Table 1.19.1, Table 1.19.2, & Table 1.19.3), unless otherwise indicated.

2. The Contract Documents shall dictate the required level of inspection per above reference or provide a project specific special inspection program.

3. If the Contract Drawings do not specify the level of required inspection, provide Level C Quality Assurance, or obtain written direction from the ENGINEER to the required level of inspection.

E. Environmental:

1. The cold weather construction provisions of ACI 530.1/ASCE6/TMS 602, Article 1.8 C shall be implemented when the ambient temperature falls below 40 degrees F or the temperature of the masonry units is below 40 degrees F.

2. The hot weather construction provisions of ACI 530.1/ASCE 6/TMS 602, Article 1.8 D shall be implemented when the ambient temperature exceeds 100 degrees F or when the temperature exceeds 90 degrees F and the wind velocity is greater than 8 mph.

3. No salt, anti-freeze chemicals or related materials permitted. Store masonry units and bagged materials off ground and protect from rain.

4. Do not build on work having film of water or frost on surfaces.

5. Protect work by covering in rainy weather; protect green masonry from freezing.

6. Before stopping work for day, cover tops of walls at new work with non-staining waterproof covering extended 2 feet minimum down both sides of wall and secured.

F. Delivery, Storage and Handling – Deliver and store packaged materials in original, unopened containers and store in dry weathertight enclosures. Stockpile and handle aggregates to prevent segregation and contamination. Maintain sand for volume proportioning of mortar and grout in a damp loose condition.

PART 2 PRODUCTS

2.1 MORTAR AND GROUT MATERIALS

A. Cement: Type I Portland cement conforming to ASTM C150.

B. Fine and coarse aggregate: ASTM C404 for grout.

C. Sand:

1. Clean, sharp, well graded, and free from salt, loam, clay, and other foreign matter.

2. Sand shall conform to ASTM C144 for mortar.

3. Sand shall be graded as follows:

Sieve Size	Percent Passing
4	100
8	95 – 100
16	70 -100
30	40 – 75
50	15 – 35
100	2 – 15
200	0

D. Lime: Hydrated type conforming to ASTM C207, Type S.

E. Water: Clean, fit for drinking (potable), and free from strong acids, alkalis, oils, or organic material.

F. Waterproofing admixture: Powder.

1. Type: Grace Hydratite Plus, CemMaster Hydrolox 400, BASF Rheomix, BASF Rheopel or approved equal.

G. Accelerator or retardant

1. May be added when required by weather conditions.

2. Type: Anti-Hydro, Grace Dehydratine 80 or Dehydratine 80M, BASF Pozzolith, Sika Plastiment, Sonneborn Sonotard, Trimex, or approved equal.

H. Intrusion (water-reducing) admixture for masonry grout.

1. Type: BASF Pozzolith, IntrusionAid or approved equal.

I. Water-reducing admixture for mortar.

1. Type: BASF Rheomix or approved equal.

J. Mortar Color.

1. Pure natural finely milled inert water insoluble non-bleeding and free of deleterious fillers or extenders.

2. Color shall be as shown on the Drawings.

3. Color shall be selected by OWNER from manufacturer's standard range of colors.

2.2 PROPORTION OF MIXES

A. Mortar

1. Conform to ASTM C270 and be of the type and color specified.

2. Type S with minimum 28-day compressive strength of 2,000 psi minimum.

3. Mixed by volume in ratio of 1-part Portland cement (6 sacks per cubic yard minimum), 1/4 to 1/2-part lime, 2-1/4 to three (3) parts (to cement-lime combined volume) sand.

4. Pointing mortar shall be one part cement, 1/4 lime, three (3) parts sand by volume. Add one (1) pound of water-reducing admix for mortar per bag of cement and one pound per cubic foot of lime.

5. Add waterproofing in amounts recommended by manufacturer, 0.2 pounds of waterproofing per 100 pounds of cement minimum.

6. Do not use admixtures containing more than 0.2 percent chloride ions.

7. Limit the maximum percentage of mineral oxide or carbon black job site pigments by weight of cement as follows: For pigmented Portland cement-lime mortar; 10

percent maximum mineral oxide pigment or 2 percent maximum carbon black pigment.

B. Masonry grout

1. Conform to ASTM C476.

2. Minimum 28 days compressive strength greater than or equal to 2,500 psi, seven (7) sacks of cement minimum per cubic yard.

3. Waterproofing admix and intrusion admix in amounts recommended by manufacturer, 0.2 lb. of waterproofing per 100 pounds of cement minimum.

C. Masonry grout for pouring:

1. Fluid consistency, seven (7) to eight (8) inches slump.

2. Accurately mix by volume 1-part Portland cement: two (2) parts minimum to three (3) parts maximum of damp loose sand: two (2) parts maximum of 3/8-inch minus aggregate.

3. For masonry grout spaces less than three (3) inches in any dimension, omit 3/8-inch minus aggregate.

D. Masonry grout for pumping:

1. Without segregation of the constituent parts.

2. Mixed to a consistency that has a slump between eight (8) to eleven (11) inches.

E. Empty bags for waterproofing and intrusion admixes shall be retained for verification prior to their disposal. Use accelerator or retardant in strict accordance with manufacturer's printed instructions.

2.3 MASONRY CLEANER

A. Sure Kleen #101 Lime Solvent or approved equal.

PART 3 EXECUTION

3.1 MIXING

A. Masonry grout shall be plant batched.

B. Mortar:

1. All tools and equipment used in mixing of mortar shall be clean and free of contaminants.

2. Measure materials by volume or equivalent weight, not by shovel.

3. Supply only as much water as necessary to obtain desired workability; required compressive strength must be met.

4. Mix by placing 1/2 of the water and sand in the operating mixer. Then add the cement, lime and the remainder of the sand and water.

5. After all ingredients are in the batch mixer, they shall be mechanically mixed for not less than three (3) minutes.

6. Hand mixing shall not be employed.

7. Heat aggregates when air temperature is below 32 degrees F to maintain mortar at 70 to 120 degrees F until used.

8. Maintain workability of mortar by retempering.

    a. Retemper by adding only as much water as required to maintain high plasticity.

    b. Retempering shall only be done by adding water within a basin formed from mortar on a mortar board and working mortar into water.

    c. Discard all mortar which has begun to stiffen, or which is unused after 2-1/2 hours from the initial mixing.

3.2 INSTALLATION

A. See Section 04 22 00, Concrete Masonry Units.

B. All masonry shall be laid true straight level, plumb and neatly in accordance with the drawings; lay out in advance so that no concrete unit less than eight (8) inches in length occur except where necessary as in reveals, etc.

C. All units shall be saw cut accurately to fit all openings, and for electrical and plumbing work.

1. No plumbing or electrical boxes or conduit shall be placed in any cell or course that contains reinforcing.

2. All cutting shall be done with masonry saw and produce neat and true surface.

D. All units shall be sound, dry, clean, and free from cracks and chips.

E. No construction supports shall be attached to the wall except where specifically permitted by the ENGINEER.

F. Units shall be “air” dry at time of laying.

3.3 REINFORCEMENT

A. Refer to Section 03 21 00, Reinforcing Steel.

B. The following minimum requirements shall be met unless shown otherwise:

1. Provide #5 verticals at thirty-two (32) inches maximum on center.

2. Locate two #5 at each jamb of door, window, louver, and other openings and end of walls; run full height of wall. Reinforcement adjacent to openings need not be provided for openings smaller than 16-inches in either the horizontal or vertical direction, unless the spacing of distributed reinforcing is interrupted by such openings.

3. Position two #5 verticals at each wall corner and each wall intersection; run full height of wall.

4. Dowel verticals to foundation with one #5 dowel four (4) feet long minimum per vertical; embed dowel fifteen (15) inches in foundation unless otherwise shown on drawings.

5. Horizontal reinforcement, unless shown otherwise, shall be two #4 rebars in the bond beams which are located at thirty-two (32) inches maximum on center and at all floor and roof levels. Bend rebar at corners and intersections, or supply two (2) feet by two (2) feet rebar of same size and number as horizontal reinforcement. Horizontal reinforcement shall be anchored around vertical reinforcing bars with a standard hook at all wall ends, corners, and intersections that are not continuous around the corner or through the intersection. For openings, minimum lintel size and reinforcement shall be two (2) #4 rebars in bottom of 8-inch lintel for less than four (4) feet span, and two (2) #5 rebars in bottom of 24 inches lintel for four (4) feet to 10 feet span. Lintel reinforcement to extend two (2) feet beyond each side of jamb.

6. Before placing reinforcement remove mud, oil, mills scale, loose rust, ice, and any other coatings from it. Position reinforcement accurately; center in cells unless noted otherwise. Secure against displacement, holding vertical reinforcement firmly in place by means of frames, rebar spacers, or other suitable devices, and place horizontal reinforcement as laying progresses. Vertical bars shall be held in position at the top and bottom and at intervals not exceeding 192 diameters of the reinforcement.

7. Minimum clear distance between longitudinal bars shall be nominal diameter of bar or 1-inch, whichever is larger. Minimum thickness of mortar or grout between masonry and reinforcement shall be 1/4-inch for fine grout and 1/2-inch for coarse grout. Unless noted otherwise, reinforcing bars and dowels shall be lapped 40 bar diameters or 2-foot six (6) inches minimum, where spliced end shall be separated by 1 bar diameter or wired together.

8. Splice reinforcement only at points shown on Drawings or reviewed shop drawings; any other locations must be specifically reviewed by ENGINEER.

    a. Splices in adjacent bars shall be staggered; in horizontal reinforcement of walls separate at least 10 feet longitudinally for bars of same tier.

    b. Splices in reinforcement shall be made only at such points and in such a manner that the structural strength of the member will not be reduced.

    c. Lapped splices shall provide sufficient lap to transfer the working stress of the reinforcement by bond and shear.

    d. Minimum lap shall be 40 bar diameters, where spliced end shall be separated by 1 bar diameter or wired together.

    e. Welded or mechanical connections shall develop the full yield strength of the reinforcement.

    f. Bond beams shall be continuous around corners.

9. When a foundation dowel does not line up with a vertical core, it shall not be sloped more than one horizontal in six vertical. Dowel shall be grouted into a core in vertical alignment, even though it may be in cell adjacent to cell holding vertical wall reinforcing.

10. Bond beam reinforcement shall be laid continuously on webs of bond beam units. Intersecting masonry walls shall be tied to one another by horizontal reinforcement, unless noted otherwise; where masonry walls intersect with concrete walls, connect with 1/2-inch diameter by 15-inch mechanical bolts in flush shells at bond beams.

11. To allow bonding masonry, clean laitance from top of concrete foundation before proceeding. The stating joint on foundations or slabs shall be laid with full mortar coverage except at the area where grout occurs, which shall be kept free of mortar so that grout is in contact with the foundation slabs.

12. Lay units in regular running bond except where soldier or other coursing is shown on drawings; maintain even module. Corners shall have same masonry bond by

overlapping units. Joints shall be uniform throughout all work having same type of masonry units.

13. At running bond, thread vertical reinforcing through alternately overlapping cells. Lay units according to “face and shell” method; provide full mortar coverage on all face shells, and on faces and webs surrounding vertical and horizontal cells to be filled with grout.

14. Do not furrow bed joints. Shove tightly each new unit against existing unit so that mortar bonds well to both.

15. Rock closures into place. Do not pound corners and jambs to fit stretcher units after they are set in position. Remove all excess grout and mortar spilled on masonry units during construction.

16. Dry brush all masonry surfaces at end of each day’s work. Stop off horizontal run of masonry by racking back one-half length of unit in each course at end of day’s work. Toothing is not permitted. Where fresh masonry joins partially set masonry, remove loose units and mortar clean and then lightly wet exposed surface of set masonry before starting new work.

17. Joints of walls to be covered or furred may be left flush, without tooling. Joints of all walls which are to be exposed shall be tooled when “thumb right” hard mortar is partially set but still sufficiently plastic to bond) with round jointer or bar to produce a dense, slightly concave surface, well bonded at edges. All tooling shall be done with a tool which compacts the excess mortar out of joint rather than dragging it out. Joints which are not tight at the time of tooling shall be raked out, pointed, then tooled. If it is necessary to move to a unit after it has been once set in place, the unit shall be removed from wall, cleaned, and set in fresh mortar. Remove any mortar fins from joint junctions.

18. Unless shown otherwise on drawings, provide 8-inch lintel for concrete masonry openings four (4) feet wide or less and 16-inch lintel for openings greater than four (4) feet wide. Forms and shores for lintels shall be substantial. Brace or tie forms to maintain position and shape. Forms shall be tight with no leakage of mortar or grout. Do no remove forms and shores until masonry has hardened sufficiently to carry its own weight and other temporary loads that may be placed on it during construction, 10 days minimum.

3.4 MASONRY GROUTING

A. Masonry grouting shall be by low lift method.

1. The repetitive construction procedure of erecting a masonry wall to a height not greater than five (5) feet, grouting the wall as required and then repeating this cycle

until the top of the wall is reached shall be classified as low-lift grouting. Grout shall be placed while mortar joints are still soft and plastic or the grout spaces shall be cleaned of mortar dropping and protruding mortar joints shall be removed.

B. Cells containing reinforcement or embedded items shall be solidly filled with grout. Before grouting starts, reinforcing steel shall be secured in a place and observed by ENGINEER and inspected by Building Inspector from governmental unit having authority.

C. Vertical cells to be filled shall have vertical alignment to maintain continuous unobstructed cell area. To confine grout to horizontal masonry beams, the tops of unfilled cell cavities or cores in masonry units under beams shall be covered with metal lath, or special bond beam or lintel units shall be used, or another method may be employed if approved by ENGINEER, building paper shall not be permitted.

D. All bolts, anchors, etc., inserted in walls shall be fully and solidly grouted in place. Embedment shall not be less than 3/4 of the wall thickness, unless otherwise noted.

E. Masonry shall cure at least 24 hours before grouting. Keep clean of mortar and drippings those cavities and cores which are to be grouted. Mortar projections and droppings shall be washed out of spaces and off reinforcing with a jet stream of water.

F. Masonry grout shall be poured in lifts not exceeding five (5) feet. All masonry shall be laid using the Low-Lift grouting method with maximum grout pour heights not to exceed five (5) feet unless otherwise allowed in writing by the ENGINEER. In addition, grout pour heights shall not exceed the maximum grout pour height limits of Table 7 of TMS 602/ACI 530.1/ASCE 6, based upon the minimum grout space dimensions for grouting of cells of hollow units. Lay masonry until location of a bond beam or horizontal lintel beam is reached, but not to exceed the limits of Table 7 of TMS 602/ACI 530.1/ASCE 6, and then grout full the vertical cells required to be grouted and fill the beam or lintel without pause.

G. To ensure complete filling of grout space, consolidate grout at time of pouring by puddling and then reconsolidate by later puddling before the plasticity is lost. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.

H. Solid grout hollow metal door and window frames; for all wall openings over two (2) feet wide, solid grout from lintel to floor or roof above in one continuous operation.

I. Place grout within 1 1/2 hour from introducing water in the mixture and prior to initial set.

3.5 MASONRY CLEANING

A. All mortar and grout must be thoroughly set and cured before cleaning. Remove excess mortar or mortar stains or efflorescence; scraping devices shall be nonferrous. Protect all adjacent surfaces, including sash and other corrodible metalwork, from damage by cleaning solvent.

B. Saturate all exposed masonry with water immediately before cleaning, apply solution of cleaner as per manufacturer's instructions and rinse thoroughly with fresh, clean water immediately after cleaning. Do small sections at a time, working from top to bottom. Repeat as necessary.

C. Tuckpoint any loose or defective mortar joints. At conclusion of masonry work, remove scaffolding and equipment used in work and remove debris, refuse and surplus masonry material.

END OF SECTION

SECTION 04 22 00

CONCRETE MASONRY UNITS

PART 1 GENERAL

1.1 SCOPE

A. Work included under this section shall include all materials and perform labor required to execute this work as indicated on the drawings, as specified and as necessary to complete the work, including, but not limited to, these major items:

1. Concrete masonry units.

2. Vertical and horizontal reinforcing and dowels projecting into subsequently placed concrete.

3. Setting of flashing and other work to be embedded in masonry.

B. Related Sections:

1. Section 03 21 00, Reinforcing Steel.

2. Section 04 05 17, Masonry Mortar and Grout.

1.2 SUBMITTALS

A. Samples -- Before any concrete unit masonry materials are delivered to the job site, submit one sample of each proposed concrete masonry unit.

B. Submit color samples for OWNER selection of concrete masonry unit colors.

C. Material Certificates -- Prior to delivery of concrete masonry materials, anchors, ties, fasteners, and metal accessories to the job site, deliver a letter from the manufacturer of the proposed masonry units, anchors, ties, fasteners, and metal accessories certifying that all such units to be delivered to the job site are in strict conformance with the provisions of this Section.

D. Construction procedures for Cold Weather Construction and/or Hot Weather Construction for review and approval by OWNER in compliance with the requirements herein prior to use on the project.

E. A letter of certification from the Supplier of the materials prior to delivery of the materials to the site to verify f'm according to the Chapter 17 of the International Building Code (IBC).

1.3 QUALITY ASSURANCE

A. Qualifications of Workers

1. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

2. Provide one skilled journeyman mason who shall be present at all times during execution of this portion of the work and who shall personally direct all work performed under this Section.

B. Standards, Specifications and Codes

Comply with the applicable provision of the following codes, specifications and standards to the extent indicated by reference thereto:

1. American Concrete Institute (ACI)
2. American Society of Testing and Materials (ASTM)
3. National Concrete Masonry Association (NCMA)
4. Structural Clay Products Institute (SCPI)
5. American Society of Civil Engineers (ASCE)
6. The Masonry Society (TMS)
7. The International Building Code (IBC)

Comply with building code requirements which are more stringent than the above and all O.S.H.A. requirements.

C. Testing Service -- The OWNER will engage an independent testing laboratory to perform material evaluation tests and to perform required Special Inspections.

D. 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. All testing required by the contract documents shall be done at the OWNER's expense. Testing expenses for the retesting of rejected materials and installed work will be charged back to the CONTRACTOR.

E. Inspection Criteria:

1. Masonry construction shall be inspected and evaluated in accordance with the requirements of Chapter 17 of the Oregon Structural Specialty Code, per TMS 402/ACI 530/ASCE 5 Table 1.19.3 – Level C Quality Assurance and TMS 602/ACI 530.1/ASCE 6, Table 5 – Level C Quality Assurance requirements (ACI 530 Table 1.19.1, Table 1.19.2, & Table 1.19.3), unless otherwise indicated.

2. The Contract Documents shall dictate the required level of inspection per above reference or provide a project specific special inspection program.

3. If the Contract Drawings do not specify the level of required inspection the CONTRACTOR shall provide Level C inspection or obtain written direction from the ENGINEER to the required level of inspection.

F. Minimum Testing Frequency:

1. An independent testing agency or laboratory shall verify the compressive strength (f'm) of the proposed construction prior to construction and at regular intervals during construction as indicated in the Contract Documents, but at least one test for every 5,000 square feet during construction.

2. The compressive strength (f'm) shall be determined for each wythe of multiwythe walls.

3. Unless specifically directed within the Contract Documents, use the unit strength method specified by TMS 602/ACI 530.1/ASCE 6.

4. The use of testing and inspection does not relieve the CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the

1.4 PRODUCT HANDLING

A. Store materials under cover in a dry place and in a manner to prevent damage or intrusion of foreign matter. During freezing weather protect all masonry units with tarpaulins or other suitable material. Store masonry units under covers that will permit circulation of air and prevent excessive moisture absorption. Protect concrete masonry units from wetting.

B. Handle unit on pallets or flatbed barrows.

C. Replacements -- In the event of damage, immediately make all repairs and replacements necessary to the approval of the OWNER and at no additional cost to the OWNER.

D. Reinforcing, metal ties, and anchors shall be protected from contact with soil and water and before being placed shall be free of loose rust and other coatings that will reduce or destroy bond.

E. Environmental Conditions - Implement the following special construction procedures based on the environmental conditions encountered during masonry construction. Failure to maintain the conditions specified below during the construction of masonry work will be just and sufficient cause for such work to be rejected.

1. Cold Weather - The cold weather construction provisions of TMS 602/ACI 530.1/ASCE 6, Article 1.8 C shall be implemented when the ambient temperature falls below 40 degrees F or the temperature of the masonry units is below 40 degrees F. All masonry units and all work on which new masonry is constructed shall be free of frost, ice, snow, and surface moisture and their temperature shall not be lower than 40 degrees F. Protect green masonry from freezing. No salt, anti-freeze chemicals or related materials are permitted.

2. Hot Weather - The hot weather construction provisions of TMS 602/ACI 530.1/ASCE 6, Article 1.8 D shall be implemented when the ambient temperature exceeds 100 degrees F or when the temperature exceeds 90 degrees F and the wind velocity is greater than 8 mph.

3. Wet Weather - Store masonry units and bagged materials off ground and protected from rain. Do not build on work having a film of water on any surfaces. Protect work by covering in rainy weather. Before stopping work for the day, cover the tops of walls at new work with non-staining, waterproof covering extended 2 feet minimum down both sides of wall and secured in place.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. One-sided, exterior facing, split face concrete block, unless noted otherwise.

B. Unit shall be in modular sizes. Exposed-to-view units in anyone building shall be of the same appearance. The texture of units shall match the approved samples for the types of construction and locations designated on the plans. Units shall not contain iron spots or other substances that will stain plaster or paint.

C. Hollow load-bearing units shall conform to ASTM C90 type 1, Grade N.

D. The composition shall be 50 percent lightweight (pumice) and 50 percent sand. The lightweight aggregate shall conform to ASTM C331 and the sand shall conform to ASTM C33.

E. Minimum compressive strength of all blocks shall be 2,000 psi based on the net area.

F. Maximum water absorption permitted for units at the time of delivery to the job site shall be 15 pounds per cubic foot (15 pcf) of concrete as an average of five units for normal weight aggregate per ASTM C140.

G. Maximum moisture content permitted for standard weight aggregate units at time of delivery shall be 30 percent of total absorption. The tests for moisture content shall be determined from an average of five units per ASTM C140.

H. Maximum linear shrinkage shall not exceed 0.035-inch/unit. Concrete masonry units shall include lintel, and bond beam units, and special shapes and sizes required to complete the work indicated.

I. Certification required above shall show results of tests made not more than 12 months prior to delivery of concrete masonry units to the job site, shall show compliance with the specified values, and shall certify that the mix design, yield per batch, and curing procedures for the units delivered to the job site will be equal to those submitted for the test.

J. Unit Colors. Pure natural finely milled inert water insoluble non-bleeding and free of deleterious fillers or extenders. Colors shall be as shown on the plans. Colors shall be selected by OWNER from manufacturer's standard range of colors.

2.2 MORTAR AND GROUT

Provide mortar and grout as indicated on the drawings in conformance with the requirements of Section 04 05 17, Masonry Mortar and Grout, of these specifications.

2.3 REINFORCEMENT STEEL

Provide reinforcement steel as indicated on the drawings and in conformance with the requirements of Division 3 of these specifications and of Section 04 05 17, Masonry Mortar and Grout.

2.4 OTHER MATERIALS

All other materials, not specifically described but required of a complete and proper installation of the work of this Section, shall be as selected by the CONTRACTOR subject to the approval of the OWNER.

PART 3 EXECUTION

3.1 INSPECTION

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

Carefully coordinate with all other trades to ensure proper and adequate interface of the work of other trades with the work of this Section.

3.3 INSTALLATION

A. Masonry shall be plumb, true to line, with level courses accurately spaced, and built to thickness and bond pattern indicated. Where no pattern is indicated, masonry shall be laid in running bond pattern. Concrete masonry units shall be dry when laid. Each unit shall be adjusted to final position in the wall while mortar is still soft and plastic. Any unit disturbed after mortar has stiffened shall be removed and re-laid with fresh mortar. Chases shall be built in and not cut in. Chases shall be plumb and shall be minimum one unit length from jambs of openings. Chases and raked-out joints shall be kept from mortar or debris. Spaces around metal door frames and other built-in items shall be solidly filled with mortar as each course is laid. Anchors, wall plugs, accessories, flashings, and other items to be built in shall be installed as the masonry work progresses. All cutting and fitting of masonry, including that required to accommodate the work of other sections shall be done by masonry saws.

B. Where fresh masonry joins masonry that is partially set or totally set, clean the exposed surface of the set masonry, and remove all loose mortar. If it is necessary to “stop off” a horizontal run of masonry, this shall be done by raking back one-half brick or block length in each course. Toothing will not be permitted.

C. Before closing up any pipe, duct or similar inaccessible spaces or shafts with masonry, remove all rubbish and sweep out the area to be enclosed.

D. Provide level and solid bearing in masonry walls under all bearing structural floor and roof elements. Solid bearing shall be bond beams unless otherwise indicated.

E. All masonry walls shall extend to underside of floor beams or roof metal decking unless otherwise indicated.

F. If blowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt at no additional cost to the OWNER.

G. Mortar Beds and Joints

1. Hollow units shall be laid with full mortar coverage on horizontal and vertical face shells, except that webs shall be also be bedded in all courses of the starting course on footings and solid foundation walls, and where adjacent to cells or cavities to be reinforced and/or filled with grout or concrete.

2. Horizontal and vertical face joints shall be 3/8-inch thick unless otherwise indicated. Vertical joints shall be shoved tight. Mortar joints in exposed or painted surfaces shall be tooled when thumbprint hard to a flush joint. Joints in unparged masonry below grade shall be pointed tight with a trowel. Mortar joints in surfaces to be plastered, stuccoed, or covered with other masonry shall be cut flush. Mortar

protrusions extending into cells or cavities to be reinforced and filled shall be removed.

H. Placing Reinforcement

1. Place reinforcing as covered in Section 04 05 17 – 3.3, Masonry Mortar and Grout, of these specifications.

    a. Vertical reinforcement shall be rigidly secured at the top and bottom of CMU wall and at intervals necessary to hold the reinforcing in proper position.

    b. Reinforcement shall be placed at the wall centerline unless indicated otherwise.

I. Low-Lift Grouting

1. Place reinforcing as covered in Section 04 05 17 – 3.4, Masonry Mortar and Grout, of these specifications.

    a. Set steel lintels in beds of mortar. Fill spaces around jambs and head of metal door buck and frames solidly with mortar.

J. Pointing and Cleaning

1. At the completion of the work, all holes in joints of masonry surfaces to be exposed or pointed except weep holes shall be filled with mortar and suitably tooled, masonry walls shall be dry brushed at the end of each day's work and also final pointing, and shall be left clean and free from mortar spots and droppings. Any cracks in masonry shall be repaired. Defective joints shall be cut out and repointed.

2. Remove efflorescence, mortar spots and other areas that appear unclean with cleaning agent to a sample wall area as directed by the OWNER. The OWNER retains the right to change proposed cleaning methods and shall be notified before any additional cleaning agent is used. The cleaning methods agent shall be applied to a small section of the wall at a time and work shall proceed from the top to the bottom. Protect all metal sashes, lintel, louvers, and other corrodible parts when masonry is cleaned.

END OF SECTION

SECTION 06 05 23

WOOD, PLASTIC, AND COMPOSITE FASTENINGS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for fasteners and adhesives used in the construction of the wood, plastic, and composite elements of the project.

B. Section includes:

1. Rough carpentry hardware.
2. Nails.
3. Bolts and screws.
4. Framing anchors.
5. Joist, rafter, and beam hangers.
6. Adhesives.

1.2 RELATED SECTIONS

A. Section 06 10 00 - Rough Carpentry.

B. Section 06 17 53 - Shop-Fabricated Wood Trusses.

1.3 SUBMITTALS

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

B. Product Data: Submit manufacturer’s data on all materials.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer’s handling, delivery, storage, and installation requirements.

PART 2 PRODUCTS

2.1 ROUGH CARPENTRY HARDWARE

Rough carpentry hardware used in CMU Wellhouse shall conform to the latest provisions of the Oregon State Structural Specialty Code, the International Building Code (IBC), and to any local codes and ordinances.

2.2 NAILS

A. Steel Common Nails: For framing, appropriately sized for the materials being joined.

B. Hot-Dipped Galvanized Nails: Wherever exposed.

C. Stainless Steel Nails: At locations where stainless-steel hardware is specified. Do not mix dissimilar materials without approval of the ENGINEER.

D. Treated Wood: Hot-dipped galvanized or stainless-steel nails are required at all locations where they are in contact with treated wood.

E. The number and size of nails connecting wood members shall be per the Contract Documents but shall not be less than that set forth in Table 2304.9.1 of the IBC for any members.

2.3 BOLTS AND SCREWS

A. Conforming to ASTM A307, Grade A, appropriately sized for the materials being joined.

B. Use galvanized bolts and screws where exposed or in contact with treated wood or embedded into concrete.

2.4 FRAMING ANCHORS & JOIST, RAFTER AND BEAM HANGERS

A. Use galvanized, minimum 18-gauge steel of the size and type required for the materials connected.

B. Post hot-dip galvanize all connection hardware in contact with pressure treated wood, or use stainless steel connectors.

C. Manufacturers:

1. Simpson “Strong-Tie”.
2. Teco “MiTek”.
3. Approved equal.

2.5 ADHESIVES

Use gun grade adhesive suitable for bonding various metals and non-metallic materials such as wood, plastic, and glass without primer.

PART 3 EXECUTION

3.1 GENERAL

A. Use only skilled workers and the highest standards of the craft.

B. Lay out, cut, fit, and install all rough carpentry items.

C. Anchor sufficiently to ensure rigidity and permanence as noted on the Drawings.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish materials, labor, equipment, and services necessary to provide rough framing as shown on the Drawings and as specified herein.

B. Section includes:

1. Lumber.
2. Plywood.
3. Building paper.

1.2 RELATED SECTIONS

A. Section 06 05 23 - Wood, Plastic, and Composite Fastenings.

B. Section 06 17 53 - Shop-Fabricated Wood Trusses.

1.3 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Submit a complete list of products, product information, type, and grade for prior to beginning building construction.

1.4 QUALITY ASSURANCE

A. All work specified herein shall conform to the latest provisions of the International Building Code (IBC), the Plastic Lumber National Evaluation Service, NER-508, and the local Codes and Ordinances of all Governmental agencies having jurisdiction over the Project.

B. Where special inspection of wood structural elements is required in the Contract Documents, an independent testing agency or laboratory shall perform special inspection of the elements indicated in the Contract Documents. The OWNER or an agent of the OWNER will engage a testing laboratory acceptable to the ENGINEER to perform the required Special Inspections and/or Material Tests.

C. Materials and installed work may require testing and retesting, as directed by the ENGINEER, at any time during the progress of the work.

1. Allow free access to material stockpiles and facilities at all times.

2. All testing required by the contract documents shall be done at the OWNER'S expense.

3. Testing expenses for the retesting of rejected materials and installed work will be charged back to the CONTRACTOR.

1.5 DELIVERY, HANDLING AND STORAGE

A. Immediately upon delivery to Site, place materials in an area protected from weather.

B. Store materials a minimum of six (6) inches above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.

C. Do not store seasoned materials in wet or damp portions of building.

D. Protect sheet materials from breaking corners and damaging surfaces while unloading.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber grading rules and wood species shall be in conformance with the latest edition of U.S. Department of Commerce, National Institute of Standards and Technology, Product Standard DOC PS 20 and the National Forest Products Association.

B. Wood members shall conform to the requirements above and provide design values equal to those published in the "Design Values for Wood Construction," a supplement to the 2018 edition of the National Design Specification for Wood Construction, published by the National Forests Products Association.

C. Plywood grading rules shall be in conformance with the latest edition of U.S. Product Standards PS 1 and PS 2, and be Engineered Wood Association (APA) rated Exposure 1.

2.2 GRADE MARKS

A. Each piece of lumber shall be stamped or branded with the grade as determined by an approved grading association indicating conformance with the latest edition of U.S. Product Standard DOC PS 20.

B. Each panel of plywood shall be identified with the appropriate grade trademark of the American Plywood Association.

C. Moisture content shall not exceed 19 percent, unless otherwise specified.

2.3 LUMBER

A. Dimensions given are nominal. Surface four sides (S4S), unless specified otherwise.

B. Unless otherwise noted, lumber shall be as follows:

Use	Minimum Grade
General framing, studs, plates, blocking, furring, braces and nailers	Douglas Fir-Larch No. 2
Structural light framing, two (2) inches to four (4) inches thick, two (2) inches to six (6) inches wide	Douglas Fir-Larch No. 2
Structural joists, rafters, and planks, two (2) inches to four (4) inches thick, five (5) inches and wider and headers	Douglas Fir-Larch No. 2
Beams, stringers, posts, timber	Douglas Fir-Larch No. 2
Fascia Board	Fiber cement board manufactured by James Hardie or approved equal
Sills and Plates	Douglas Fir-Larch No. 2, Treated in accordance with IBC 2303.1.9

2.4 PLYWOOD

A. Roof Sheathing:

1. Conform to APA-rated sheathing and shall be identified with the appropriate trademark.

2. Minimum sheathing shall be Exposure 1, 1/2-inch or greater, grade CDX. Span rated 32/16 per APA.

B. MDO -- APA rated Medium Density Overlay exterior glue.

2.5 BUILDING PAPER

A. Asphalt-saturated felt conforming to ASTM D 226 or D 250, Type I, plain non-perforated.

PART 3 EXECUTION

3.1 GENERAL

A. Use only skilled workers and the highest standards of the craft.

B. Plan work in advance and perform in proper sequence to facilitate prompt and continuous progress of the work.

C. Lay out, cut, fit, and install all rough carpentry items.

D. Anchor sufficiently to ensure rigidity and permanence and as noted on Drawings.

E. Provide for installation and support of other work.

3.2 CONDITIONS OF SURFACES

A. Verify that surfaces to receive rough carpentry materials are prepared to exact grades and dimensions.

3.3 INSTALLATION

A. Plates

1. Set level and flush with outside face of concrete or masonry unit walls or as shown on the Drawings.

2. Anchor into concrete or masonry unit walls with specified anchors.

3. Location and spacing of plate anchorages shall be as shown or if not shown in conformance with current local building codes.

B. Engineered Trusses: See Drawings for requirements and Section 06 17 53, Shop-Fabricated Wood Trusses.

C. Roof Sheathing

1. Install plywood with face grain perpendicular to supports, using panel with continuous end joints over two or more spans staggered between panels and locate over supports.

2. Allow minimum space 1/16-inch (1.6 mm) between end joints and 1/8-inch at edge joints for expansion and contraction of panels.

3. Support edge joints by use of ply clips or lumber blocking, unless noted otherwise on Drawings.

D. Fastener Requirements:

1. Connections for wood members shall be in accordance with the Contract Drawings and Section 06 05 23, Wood, Plastic, and Composite Fastenings.

2. The number and size of nails connecting wood members shall not be less than that set forth in Table 2304.9.1 of the IBC.

END OF SECTION

SECTION 06 17 53

SHOP-FABRICATED WOOD TRUSSES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for design, manufacture, and supply of wood trusses as shown on the Drawings and as specified.

B. Section includes:

1. Design and performance criteria.
2. Lumber.
3. Metal connecting hardware.
4. Manufacturing requirements.

1.2 RELATED SECTIONS

A. Section 06 05 23 - Wood, Plastic, and Composite Fasteners.
B. Section 06 10 00 - Rough Carpentry.

1.3 DEFINITIONS

A. BCSI*:* Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses jointly produced by the Structural Building Components Association and the Truss Plate Institute.

B. Contractor: The person who contracts with the OWNER, who constructs the Building in accordance with the Construction Documents and the Truss Submittal Package. The term "CONTRACTOR" shall include those subcontractors who have a direct contract with the CONTRACTOR to construct all or a portion of the construction.

C. Cover/Truss Index Sheet: Sheet that is signed and sealed by an Oregon licensed Professional Engineer, by the Truss Design Engineer, and shall contain the following information: (1) identification of the Building, including Building name and address, lot, block, subdivision, and city or county; (2) identification of Construction Documents by drawing number(s) with revision date; (3) specified Building Code; (4) computer program used; (5) roof dead and live loads; (6) floor dead and live loads; (7) wind load criteria from a specifically defined code (e.g., *ASCE 7*) and any other design loads (such as ponding, mechanical loads, etc.); ; (8) a listing of the individual identification numbers and dates of each Truss Design Drawing referenced by the Cover/Truss Index Sheet; and (9) name, address, date of drawing and license number of Truss Design Engineer.

D. Framing Structural System: Completed combination of Structural Elements, Trusses, connections, and other systems, which serve to support the Building's self-weight and the specified loads.

E. Truss: Individual metal-plate-connected wood component manufactured for the construction of a Building.

F. Truss Design Drawing: Written, graphic and pictorial depiction of an individual Truss that includes the information required in the Standard.

G. Truss Design Engineer: Person who is licensed to practice engineering as defined by the Legal Requirements of the Jurisdiction in which the Building is to be constructed and who supervises the preparation of the Truss Design Drawings.

H. Truss Designer: Person responsible for the preparation of the Truss Design Drawings.

I. Truss Manufacturer: Person engaged in the fabrication of Trusses.

J. Truss Placement Diagram: Illustration identifying the assumed location of each Truss.

K. Truss Submittal Package: Package consisting of each individual Truss Design Drawing, and, as applicable, the Truss Placement Diagram, the Cover/Truss Index Sheet, Lateral Restraint and Diagonal Bracing details designed in accordance with generally accepted engineering practice, applicable *BCSI* defined lateral restraint and diagonal bracing details, and any other structural details germane to the Trusses.

1.4 DESIGN

A. Trusses shall be designed in accordance with the Standard and, where any applicable design feature is not specifically covered herein, design shall be in accordance with the applicable provisions of the latest edition of the American Forest & Paper Association's (AF&PA's) *National Design Specification® (NDS®) for Wood Construction* and all applicable Legal Requirements.

B. Truss Manufacturer shall furnish Truss Design Drawings and Calculations prepared in accordance with all applicable Legal Requirements and signed and stamped by an Oregon licensed Professional Engineer.

C. The Truss Manufacturer shall furnish a Truss Placement Diagram, which shall provide, at a minimum, the location assumed for each Truss based on the Truss Manufacturer's interpretation of the Construction Documents.

D. The Truss Manufacturer shall submit the Truss Submittal Package to the OWNER and ENGINEER for review and approval prior to the manufacturing of the Trusses.

E. The Truss Design Drawings shall include, at a minimum, the information specified below (per the Standard):

1. Building Code used for Design, unless specified on Cover/Truss Index Sheet.

2. Slope or depth, span and spacing.

3. Location of all joints and support locations.

4. Number of plies if greater than one.

5. Required bearing widths.

6. Design loads as applicable, including:

    a. Top Chord live load (for roof Trusses, this shall be the controlling case of live load or snow load);

    b. Top chord dead load;

    c. Bottom chord live load;

    d. Bottom chord dead load;

    e. Additional loads and locations;

    f. Environmental Load Design Criteria (wind speed, snow, seismic, and all applicable factors as required to calculate the Truss loads); and

    g. Other lateral loads, including drag strut loads.

7. Adjustments to Wood Member and Metal Connector Plate design values for conditions of use.

8. Maximum reaction force and direction, including maximum uplift reaction forces where applicable.

9. Metal Connector Plate type, manufacturer, size, and thickness or gauge, and the dimensioned location of each Metal Connector Plate except where symmetrically located relative to the joint interface.

10. Size, species, and grade for each Wood Member.

11. Truss-to-Truss connection and Truss field assembly requirements.

12. Calculated span to deflection ratio and/or maximum vertical and horizontal deflection for live and total load and K_{CR} (creep factor) as applicable.

13. Maximum axial tension and compression forces in the Truss members.

14. Fabrication tolerance per the Standard.

15. Required Permanent Individual Truss Member Restraint location and the method of Restraint/Bracing to be used per the Standard.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber:

1. identified by grade mark of a lumber inspection bureau or agency approved by the American Lumber Standards Committee.

2. Of the size, species, and grade as shown on the Truss Design Drawings, or equivalent as approved by the Truss Design Engineer/ Truss Designer.

3. In accordance with Article 2.3, Lumber of Section 06 10 00, Rough Carpentry.

4. Adjustment of value for duration of load or conditions of use shall be in accordance with the latest edition of the National Design Specification for Wood Construction (*NDS)*.

5. Fire retardant treated lumber, if applicable, shall meet the specifications of the fire retardant chemical manufacturer, the Truss design and the Standard and shall be re-dried after treatment in accordance with the American Wood-Preservers' Association (AWPA) Standard *C20 Structural Lumber – Fire Retardant Treatment by Pressure Processes*. Allowable values must be adjusted in accordance with *NDS*. Lumber treater shall supply certificate of compliance.

B. Metal Connector Plates:

1. Manufactured by a Truss Plate Institute (TPI) member plate manufacturer.

2. Shall not be less than 0.036 in. thick (20 gauge).

3. Meet or exceed *ASTM A653/A653M* grade 33.

4. Galvanized coating, meeting, or exceeding *ASTM A924/924M*, coating designation G60. Working stresses in steel are to be applied to effectiveness ratios for plates as determined by test and in accordance with the Standard.

5. In highly corrosive environments, special applied coatings or stainless steel may be required as noted on the Contract Documents.

6. At the request of the ENGINEER, a TPI member plate manufacturer shall furnish a certified record that materials comply with steel specifications.

2.2 MANUFACTURING

Trusses shall be manufactured to meet the quality requirements of the Standard and in accordance with the information provided in the final approved Truss Design Drawings.

PART 3 EXECUTION

3.1 HANDLING, INSTALLING, RESTRAINING AND BRACING

A. Trusses shall be handled during manufacturing, delivery and by the CONTRACTOR at the job site so as not to be subjected to excessive bending.

B. Trusses shall be unloaded in a manner so as to minimize lateral strain. Trusses shall be protected from damage that might result from on-site activities and environmental conditions. Trusses shall be handled in such a way so as to prevent toppling when banding is removed.

C. CONTRACTOR shall be responsible for the handling, installation, and temporary restraint/ bracing of the Trusses in a good workmanlike manner and in accordance with the recommendations set forth in the latest edition of *BCSI*.

D. Apparent damage to Trusses, if any, shall be reported to Truss Manufacturer prior to erection.

E. Trusses shall be set and secured level and plumb, and in correct location. Each Truss shall be held in correct alignment until specified permanent restraint and bracing is installed.

F. Cutting and altering of Trusses is not permitted. If any Truss should become broken, damaged, or altered, written concurrence and approval by a Registered Design Professional is required.

G. Concentrated loads shall not be placed on top of Trusses until all specified restraint and bracing has been installed and decking is permanently nailed in place. Specifically avoid stacking full bundles of plywood or other concentrated loads on top of Trusses.

H. Truss Submittals and any supplementary information provided by the Truss Manufacturer shall be provided by the CONTRACTOR to the individual or organization responsible for the installation of the Trusses.

I. Trusses shall be permanently restrained and braced in a manner consistent with good building practices as outlined in *BCSI* and in accordance with the requirements of the Construction Documents. Trusses shall furthermore be anchored or restrained to prevent out-of-plane movement so as to keep all Truss members from

simultaneously buckling together in the same direction. Such permanent lateral restraint shall be accomplished by: (a) anchorage to solid end walls; (b) permanent diagonal bracing in the plane of the web members; or (c) other suitable means.

J. Materials used in temporary and permanent restraint and bracing shall be furnished by CONTRACTOR.

END OF SECTION

SECTION 07 21 00 - THERMAL INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Applications of insulation specified in this Section include rigid foam board and loose-fill type systems.

B. The extent of insulation work is shown on Drawings and indicated by provisions in this Section.

C. Section includes:

1. Building insulation.
2. Installation.

D. Related Requirements:

1. Section 06 10 00 - Rough Carpentry.

1.2 SUBMITTALS

A. Submit a complete list of products, product information, types, and grades for approval by the ENGINEER prior to beginning building construction.

1.3 PRODUCT HANDLING

A. General Protection:

1. Protect insulations from physical damage and from becoming wet, soiled, or covered with ice or snow.

2. Comply with manufacturer's recommendations for handling, storage and protection during installation.

PART 2 PRODUCTS

2.1 MATERIALS

A. R Value: Minimum R value shall be as shown in Drawings or as required by current Oregon Energy Efficiency Specialty Code.

B. Stud Walls and Ceilings

1. Insulation in framed walls and ceilings shall be fiberglass batting with kraft paper faced with stapling flanges.

2. Insulation for ceiling shall be batt insulation style.

3. Manufacturer: Owens/Corning Fiberglass, Manville, or equal.

C. Light Shafts and Vent Ducts

1. Insulation in framed skylight light shafts and vent ducts in attic spaces shall be rigid cellular polyurethane, polystyrene, or polyisocyanurate foam board insulation.

D. Loose-Fill Insulation

1. Perlite insulation shall conform to ASTM C549.
2. Cellulose fiber loose-fill insulation shall conform to ASTM C739.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Installer must examine substrates and conditions under which insulation work is to be performed and must notify CONTRACTOR in writing of unsatisfactory conditions.

B. Do not proceed with insulation work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

C. Install insulation system in accordance with manufacturer's recommendations or requirements.

D. Set vapor barrier faced units with vapor barrier to warm side (winter) of construction.

E. Do not obstruct ventilation spaces, except for firestopping.

END OF SECTION

SECTION 07 41 13 - METAL ROOF PANELS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish and install a standing seam interlocking panel metal roof system with concealed fasteners where shown on the Drawings and as specified herein.

B. Section includes:

1. Metal roof panels
2. Metal finishing
3. Roofing membranes
4. Slip sheeting
5. Fasteners
6. Fabrication of metal roof panels

C. Related Requirements:

1. Section 06 05 30 - Wood, Plastic, and Composite Fasteners.
2. Section 06 10 00 - Rough Carpentry.
3. Section 06 17 53 - Shop-Fabricated Wood Trusses.

1.2 REFERENCE STANDARDS

A. ASTM International (ASTM):

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

2. ASTM A792 - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

3. ASTM D2626 - Standard Specification for Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing.

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.

D. Samples, to include preformed panel, seam, fastener, base sheet, finish sheet, ridge, and trims.

1.4 QUALITY ASSURANCE

A. Use skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. In addition to complying with requirements of governmental agencies having jurisdiction, comply with:

1. Underwriters' Laboratories, Inc., Class 90 wind uplift.

2. Underwriters' Laboratories, Inc., UL 790, Class A roof assembly a fire rating.

3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) -- Pertinent recommendations contained in the "Architectural Sheet Metal Manual".

C. Warranty: Installer and manufacturer shall furnish a written 5-year warranty stating that they will be responsible for replacement at their cost of any portion of the roof system that leaks due to defects in material or installation.

1.5 DELIVERY, HANDLING AND STORAGE

A. Comply with manufacturer's requirements for product delivery, handling, and storage.

PART 2 PRODUCTS

2.1 MATERIALS

A. Panels:

1. 13-1/2-inch maximum width

2. Continuous length

3. Interlocking

4. Hot-dipped zinc coated steel sheets, ASTM A653, Grade C, ASTM A792 zinc coating, surface treated for maximum coating performance

5. Minimum 26-gauge thickness.

B. Metal Finish:

1. Polyvinylidene fluoride resin (minimum 70 percent resin) finish coat applied over baked-on compatible prime coat.

2. One-mil minimum total coating system thickness.

3. Color: In manufacturer's standard color as selected by OWNER.

C. Roofing Membrane: Comply with ASTM D2626, Type 1, 30-pound.

D. Slip sheet:

1. Rosin-surfaced building paper weighing not less than 3 pounds per 100 square foot.

2. Manufacturer: W.R. Meadows Red Rosin Paper or equal.

E. Anchors: 1-inch long, large head galvanized wood screws.

2.2 FABRICATION

A. Shop fabricate to the maximum extent practicable.

B. Brake-form to the indicated profiles, length and width.

2.3 ACCEPTABLE MANUFACTURERS

A. Bruce & Dana, Inc., Salem, Oregon
B. ASC Pacific, Inc., Tacoma, Washington
C. Ray F. Becker, Co., Portland, Oregon
D. Taylor Metal Products, Salem, Oregon

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. Do not allow the installed work of this Section to be used as a storage space for other materials.

2. Do not permit unnecessary walking on the finished roof. Require all personnel to wear rubber-soled shoes when installing or walking on the finished surfaces.

3. Install per approved submittal drawings only.

4. Discrepancies between Site conditions and Drawings as approved shall be brought to the attention of the Engineer for resolution.

B. Apply the specified roofing membrane over the entire area to be covered by sheet metal roofing.

1. Start at the low edge, and place succeeding courses shingle fashion, lapping edges 2-inch minimum.

2. Lap the membrane with flashings as necessary to provide a positive barrier against penetration of water.

C. Apply the specified slip sheet over the entire assembly, scatter nail to sheathing as required to hold in position prior to application of metal panels.

D. Install concealed anchor cleats at minimum 18-inch centers into roof sheathing.

E. Install preformed metal panels in strict accordance with manufacturer's approved written installation instructions.

1. Do not drive fasteners through panels or seams.

2. Do not use tools or methods that scratch or mar the finish on exposed surfaces.

3.2 CLEANING AND PROTECTION

A. Damaged Units: Replace panels and other components of the Work which have been damaged or have deteriorated beyond successful repair by means of finish touch-up or similar minor repair procedures.

B. Cleaning:

1. Remove protective coverings and strippable films (if any) at time in project construction sequence which will afford greatest protection of Work.

2. Clean finished surfaces upon completion of Work as recommended by panel manufacturer.

C. Protection: Installer shall advise the CONTRACTOR of protection and surveillance procedures, as required to ensure that Work of this Section will be without damage or deterioration at time of substantial completion.

END OF SECTION

SECTION 07 60 00 - FLASHING AND SHEET METAL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish and install flashing and sheet metal work, including gutters and downspouts, as indicated on the Drawings and by provisions of this Section.

B. Section includes:

1. Galvanized metal flashings
2. Prefinished galvanized downspout and gutter

1.2 REFERENCE STANDARDS

A. ASTM International (ASTM):

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

2. ASTM G90 - Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight

1.3 SUBMITTALS

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

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Samples of flashing design, size, and color for approval
2. Preparation instructions and recommendations
3. Storage and handling requirements and recommendations
4. Installation methods

1.4 DELIVERY, STORAGE, AND HANDLING

A. Per manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Pre-finished Galvanized Steel Sheet:

1. Steel Sheet: 24-gauge, commercial quality.

2. Finish: Complying with ASTM A653, ASTM G90 for hot-dip galvanizing.

    a. Pre-finished with baked-on polyester coating, not less than 1.0-mil thick.

3. Color: Provide material in color selected by Owner.

B. Galvanized Steel Sheet:

1. Steel Sheet: 24-gauge minimum, commercial quality.

2. Finishing: Galvanized, with minimum of 0.20 percent copper content. Complying with ASTM A653, G90 for hot-dip galvanizing, mill phosphatized, unless otherwise indicated.

C. Miscellaneous Materials and Accessories

1. Solder: Except as otherwise indicated or recommended by metal manufacturer, provide 100 percent lead free solder for tinning and soldering galvanized metal joints.

2. Visually Exposed Fasteners: Stainless steel pop rivets with heads finished to match color of pre-finished metal material.

3. Concealed Fasteners: Zinc coated, type as required and recommended by manufacturer for materials and substrates involved.

4. Mastic Sealant -- Polyisobutylene, non-hardening, non-skinning, non-migrating sealant typical for flashing lap joint applications.

2.2 FABRICATED UNITS

A. General

1. Shop fabricate metal counter flashings, cap and sill flashings, and similar items to comply with profiles and sizes shown, and to comply with standard industry details as shown by SMACNA in the “Architectural Sheet Metal Manual.”

2. Comply with metal producers’ recommendations for tinning, soldering, and cleaning flux from galvanized metal fabrications. Provide stainless steel rivets at exposed fastenings in pre-finished metal fabrications.

3. Form exposed sheet metal work without oil-canning, buckling and tool marks, true to line and level with exposed edges folded back to form hems.

4. Where movable joints are required for proper installation of mastic sealant, in compliance with SMACNA standards.

B. Pipe Jack Sleeve Fastenings

1. Fabricate pipe, roof penetration sleeves from galvanized material fully tinned and soldered at seams. Provide stack sleeve of diameter 1/2-inch greater than penetrating pipe and same height above with 3-inch high conical base and embedment flange 12-inch greater than diameter of base. Furnish flanges at top of stack sleeve for attachment of counter flashing cap.

2. Fabricate counter flashing cap with interior pipe sleeve and conical cap to fit over pipe and stack sleeve. Size interior sleeve to tightly fit pipe diameter and to into pipe not less than 3 inches. Size conical cap to extend not less than 3 inches below top of stack sleeve with space above to permit not less than 1-inch pipe movement. Rivet counter flashing cap to flanges of stack sleeve.

C. Counter Flashings

1. Fabricate counter flashings from galvanized material to size and profiles shown in 10-foot minimum lengths with continuous 20-gauge galvanized cleat at hemmed lower drip edge.

2. Where top leg of counter flashing is not covered by other applied materials or otherwise supported, provide with integral hemmed sealant dam and anchor to wall substrates with 1/8-inch by 1-1/2-inch galvanized float bar, prepared with fastener holes drilled or punched at 8-inch on center. Coordinate size of holes with anchors to be used. Form sealant dam with 3/4-inch minimum outward-turned hemmed leg.

3. At inside and outside corners, provide double lapped, tinned and fully soldered assemblies, shop assembled prior to installation. Do not solder flashing corners after installation other than to render remedial surface repairs. If joint separation should occur, remove flashings and re-solder as required.

D. Cap Flashings

1. Fabricate lap seamed cap flashings from galvanized material with hemmed drips on both sides and continuous 20-gauge galvanized cleat at front edge.

2. Shop assemble cap end-to wall closure flashings with double lapped, riveted, and mastic sealed construction. Provide vertical legs with sealant dam as required for counter flashings.

E. Wall Flashings

1. Fabricate wall flashings from galvanized material with flat locked, mastic filled vertical seams spaced not greater than 4 feet on-center.

2. Form as required to closely follow substrate profile and interlock with counter and cap flashing assemblies without exposed fasteners. Secure to walls with 20-gauge galvanized cleat concealed by edge hems.

PART 3 EXECUTION

3.1 GENERAL

A. Comply with manufacturer's instructions and recommendation for handling and installation of flashing and sheet metal work.

B. Coordination:

1. Coordinate Work with other work for the correct sequencing of items which make up the entire membrane or system of weatherproofing and rain drainage.

2. Coordinate Work of this Section with interfacing and adjoining work for proper sequence of each installation.

C. It is required that the flashing and sheet metal work be permanently water-tight, and not deteriorate in excess of manufacturer's published limitations.

D. Provide flashing and sheet metal work which is fully compatible with interfacing or adjoining work to ensure the best total assembly performance for weather resistance and durability.

3.2 INSTALLATION OF METAL WORK

A. Comply with details and profiles as shown and comply with SMACNA "Architectural Sheet Metal Manual" recommendations for installation of the work.

B. Non-Moving Seams: Provide sealed flat-lock seams, except as otherwise indicated. Comply with metal producers' recommendations for tinning, soldering and cleaning the joints of soldered work.

C. Provide for thermal expansion of all exposed sheet metal work exceeding 20-foot running length, except as otherwise indicated.

D. Conceal fasteners and expansion provisions wherever possible. Fold back edges on concealed side of exposed edges, to form a hem and stiffen material.

E. Provide flashing reglets as shown or as required to seal work to existing substrates. Seal assembled joint with sealant as indicated.

F. Do not proceed with the installation of flashing and sheet metal work until curb and substrate construction, blocking, and other construction to receive the work is completed.

G. Examine the substrate and the conditions under which flashing, and sheet metal work is to be performed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 CLEANING AND PROTECTION

A. Clean visually exposed metal surfaces and other surfaces indicated to be painted. Remove corrosive substances, including soldering flux, which might cause deterioration of metal surfaces or final finish.

B. Provide surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration at time of acceptance by Owner.

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 MATERIALS

A. Type A Sealant

1. Application: General building sealant.

2. Material: One component polyurethane sealant.

a. Vulkem 116, as manufactured by Tremco.
b. Sonolastic NP1, as manufactured by BASF.

B. Type B Sealant

1. Application - General building sealant for wide joints.

2. Materials - Self leveling one component polyurethane.

    a. Vulkem 45, as manufactured by Tremco

C. Filler Gasket (Backer Rod) Cord Strip

1. Ethafoam, as manufactured by Dow Chemical
2. Sonolastic Closed-cell Backer Rod, as manufactured by Sonneborn
3. Equal, as approved by ENGINEER

PART 3 EXECUTION

3.1 PREPARATION

A. Surfaces to receive caulking materials shall be thoroughly clean 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.

C. Clean metal surfaces with solvents and wipe dry while the surface is still wet with solvent.

3.2 INSTALLATION

A. Primers and Bond Breakers

1. Apply to surfaces as required; verify with manufacturer.

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.

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.

END OF SECTION

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard hollow metal doors and frames.

B. Related Sections:

1. Division 08 Section 08 71 00 "Door Hardware" for door hardware for hollow metal doors.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.

2. Details of doors, including vertical and horizontal edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

4. Locations of reinforcement and preparations for hardware.

5. Details of each different wall opening condition.

6. Details of anchorages, joints, field splices, and connections.

7. Details of accessories.

8. Details of moldings and removable stops.

C. Other Action Submittals:

1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

E. Provide two material Samples for each color of Kynar Finish.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to finish of factory finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements:

1. Ceco Door Products; an Assa Abloy Group company.
2. Fleming Door Products Ltd.; an Assa Abloy Group company.
3. Steelcraft; an Ingersoll-Rand company.
4. Approved equal.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 metallic coating.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

E. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6 to 12 pounds per cubic foot density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

A. Provide 1-3/4-inch thick doors of materials and ANSI/SDI-100 grades and models specified below, or as indicated on drawings or schedules:

1. Exterior Doors: Level 3, Model 3 – Seamless (with center rail)

a. Exterior doors shall be minimum 16-gauge galvanized or galvanealed steel with both lock and hinge rail edge of door intermittently welded, filled, and ground

smooth the full height of door. Exterior doors shall be insulated with a solid slab of expanded polystyrene or polyurethane foam permanently bonded to the inside of each face skin. The top of all doors shall be closed flush by the addition of a 16-gauge screwed-in top cap and sealed to prevent water infiltration. The bottom channel shall include weep-holes.

1) Ceco Door, Inc.
2) Curries, Inc.
3) Steelcraft, Inc.
4) Approved equal.

B. All doors shall be reinforced for hardware as shown below where necessary to preclude the use of thru-bolts.

1. Exit Devices: 14-gauge
2. Door Closers: 12-gauge

C. All doors shall be beveled 1/8-inch in 2-inch and shall have top and bottom channels of not less than 16-gauge, flush or inverted, welded to the face sheets. Doors shall have a full height 14-gauge hinge rail reinforcement channel, or individual 10-gauge hinge reinforcements.

D. All doors to conform to ANSI-A250.4 Level "A" criteria and shall be tested to 1,000,000 operating cycles and 23 twist tests. Certification of Level "A" doors is to be submitted with approval drawings by supplier upon request. Do no bid or supply any type or gauge of door not having been tested and passed these criteria.

2.4 STANDARD HOLLOW METAL FRAMES

A. Provide hollow metal frames for doors of types and styles as shown on the drawings and schedules. Conceal fastenings unless otherwise indicated.

1. Exterior Frames: Level 2, 16-gauge, galvanized or galvanealed

2. Security Grade Frames: 14-gauge

a. Ceco: SU Series
b. Curries: M Series
c. Steelcraft: F Series

B. All frames over 36-inch in width shall be 14-gauge.

C. Fabricate frames with mitered and faces only welded corners, re-prime at the welded areas. All welds to be flush with neatly mitered or butted material cuts.

D. All frames shall have minimum 7-gauge hinge reinforcements, 14-gauge lock strike reinforcing, and 12-gauge closer reinforcing.

E. All frames shall have minimum 7-gauge hinge reinforcements with an additional high frequency 12-gauge hinge reinforcement welded to the top hinge, 14-gauge lock strike reinforcing, and 12-gauge closer reinforcing.

F. Provide temporary shipping bars to be removed before setting frames.

G. Except on weatherstripped frames, drill stops to receive three silencers on strike jambs of single frames and two silencers on heads of double frames.

H. Provide minimum 0.0179-inch thick steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

2.5 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Astragals: Provide overlapping astragal on one leaf of pairs of doors where indicated. Extend minimum 3/4-inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on center and as follows:

1) Three anchors per jamb up to 60 inches high.

2) Four anchors per jamb from 60 to 90 inches high.

3) Five anchors per jamb from 90 to 96 inches high.

4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.

5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.

4. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section 08 71 00 "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.

2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.

3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

G. Stops and Moldings: Provide stops and moldings around steel panel where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

2. Provide loose stops and moldings on inside of hollow metal work.

2.6 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Finish Coat:

    a. Door - Kynar 2-Mil Finish - Gun Metal Grey
    b. Frame –Kynar 2-Mil Finish – color replication of stainless steel

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16-inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

2. Alignment: Plus or minus 1/16-inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16-inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

4. Plumbness: Plus or minus 1/16-inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

b. Install frames with removable glazing stops located on secure side of opening.

c. Install door silencers in frames before grouting.

d. Remove temporary braces necessary for installation only after frames have been properly set and secured.

e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

f. Field apply bituminous coating to backs of frames that are filled with grout containing anti-freezing agents.

2. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16-inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

b. Alignment: Plus or minus 1/16-inch, measured at jambs on a horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16-inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

d. Plumbness: Plus or minus 1/16-inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

D. Steel Panel: Comply with installation requirements in hollow metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches on center and not more than 2 inches on center from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

SECTION 08 62 00

OPERABLE SKYLIGHTS

PART 1 GENERAL

1.1 DESCRIPTION

Provide operable bronze anodized aluminum frame acrylic dome skylights where shown on the drawings, as specified herein and as needed for a complete and proper installation.

1.2 RELATED SECTIONS

A. 07 41 13 Metal Roof Panels
B. 07 60 00 Flashing and Sheet Metal
C. 07 65 00 Flexible Flashing
D. 07 92 00 Sealants and Caulking
E. 08 80 00 Glazing

1.3 QUALITY ASSURANCE

Employ only qualified journeymen mechanics in this work; apprentices may be employed on the work under the direction of qualified journeymen in accordance with trade regulations.

1.4 SUBMITTALS

A. Product Data: For each type and size of skylight. Include the following:

1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.

2. Rated capacities, thermal performance, required certification compliance information, operating characteristics, and furnished accessories.

B. Maintenance Data: For skylights to include in maintenance manuals.

C. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

D. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

E. Samples for selection: Glazing assembly, frame material and color options.

PART 2 PRODUCTS

2.1 SKYLIGHTS

A. White acrylic dome with aluminum frame complete with non-corroding operating hardware, integral condensate gutter, insulated curb and full weather seal gasketing. Locking arms shall hold open the dome a full 90 degrees allowing removal of equipment through the roof. The hinge for dome shall be located on the long side of the skylight. Provide an integral interior operator with interior hasp and padlock for security.

B. Air leakage shall not exceed 0.3 cfm/sf tested at a pressure of at least 1.57 psf in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400, or 0.5 cfm.sf tested at a pressure of at least 6.24 psf in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

C. Size as indicated on Drawings.

D. NFRC Certified.

E. Compliance with applicable OSHA requirements.

F. Integral 9-inch curb for mounting.

G. Maximum assembly U-Factor = 0.50

H. Maximum assembly SHGC = 0.40

I. Manufacturer/Model: Alumilite acrylic solar heat blocker glazing, model AL-SD as manufactured by Bristolite Daylighting Systems, or approved equal.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify opening is ready to receive work of this Section.
B. Test operation of assembly prior to installation.

3.2 INSTALLATION

A. Install and anchor assembly per manufacturer's written installation instructions.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section includes the requirements for furnishing and installing door hardware as designated in the Contract.

1. Furnish door hardware in accordance with hardware groups scheduled. Coordinate with existing plant master keying system.

2. Furnish templates and hardware list of hardware as required.

1.2 RELATED SECTIONS:

A. Section 08 11 13 - Hollow Metal Doors and Frames.

1.3 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. A115.1 – Specification for Standard Steel Door and Frame Preparation for Mortise Locks and 1-3/8” and 1-3/4” Doors.

2. A156.18 – Materials and Finishes.

B. American Society for Testing and Materials (ASTM)

1. E90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

2. E152 – Fire Tests of Door Assemblies.

3. E283 – Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.

C. Door and Hardware Institute (DHI) - A115 Series

1. RL - Recommended Locations for Builders Hardware for Standard Steel Doors and Frames.

D. Underwriter Laboratories (UL)

1. 10B – Fire Tests of Door Assemblies

E. Oregon Structural Specialty Code (OSSC)

F. NFPA 101: Life Safety Code

1.4 SUBMITTALS

A. Comply with the requirements of Section 01 33 00, Submittal Procedures.

B. Product Data: Submit manufacturer's product data for each item of door hardware, installation instructions, and maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

1. Final hardware schedule, coordinated with doors, frames, and related Work to ensure proper size, thickness, hand, function, and finish of door hardware.

2. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:

a. Type, style, function, size, and finish of each hardware item.

b. Name and manufacturer of each item.

c. Fastenings and other pertinent information.

d. Location of each hardware set cross-referenced to indications on the Drawings both on floor plans and in door and frame schedule.

e. Explanation of all abbreviations, symbols, and codes contained in schedule.

f. Mounting locations for hardware.

g. Door and frame sizes and materials.

h. Keying information.

C. Templates for doors, frames, and other Work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.5 QUALITY ASSURANCE

A. Supplier shall have a factory direct status with all manufacturers specified.

1.6 PROJECT CONDITIONS

A. Coordinate the Work with other directly affected Sections involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.

B. Provide construction cylinders during Project's construction through arrangement with the specified cylinder manufacturer. Return-for-credit arrangements with cylinder manufacturer at the end of construction.

C. Coordinate Owner's keying requirements during the course of the Work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Manufacturers

1. Acceptable Manufacturers:

a. Butts and Hinges: McKinney, Stanley. "MCK, STN"
b. Lockset and Latchset: Best lock. "BST"
c. Cylinders: Best lock. "BST"
d. Overhead Closers: LCN, Norton. "LCN, NTN"
e. Stops: Quality, Rockwood. "QLTY, RWD"
f. Gasketing: Pemko."PEM"
g. Thresholds: Pemko. "PEM"
h. Latch Guards: Glynn-Johnson. "GLN"
i. Astragals: Pemko. "PEM"

B. General

1. Fasteners

a. Furnish necessary screws, bolts, and other fasteners of suitable size and type to anchor the hardware in position for long life under hard use.

b. Where necessary, furnish fasteners with toggle bolts, expansion shields, sex bolts, and other anchors according to the material to which the hardware is to be applied and according to the recommendations of the hardware manufacturer.

c. Provide fasteners, which harmonize with the hardware as to finish and material.

2. Where butts are required to swing 180 degrees, furnish butts of sufficient throw to clear the trim.

3. Furnish silencers for doorframes at the rate of 3 for each single door and 2 for each door or pair of doors; except weather-stripped doors and doors with light seals, smoke seals or sound seals.

4. Tools and Manuals: Deliver to the Owner 1 complete set of adjustment tools and 1 set of maintenance manuals for locksets, closers and panic devices in accordance with Project close-out requirements.

C. Keying

1. Provide two permanent keys for each lock installed.

   a. Master Key System: Cylinders are operated by a change key and a master key.

   b. Keys: Nickel silver.

      1) Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

      2) Notation: "DO NOT DUPLICATE."

   c. Quantity: In addition to one extra key blank for each lock, provide the following:

      1) Cylinder Change Keys: Three.
      2) Master Keys: Five

D. Hinges

1. Provide butt hinges of the five-knuckle, full mortise type, having two or four ball or iolite bearing as noted, stainless steel pins, and complying with ANSI A156.1.

2. Provide all out-swinging doors to the exterior with butt hinges of the stainless steel or non-ferrous materials, with non-removable pins of the set screw.

3. Hinge size: Door 1-3/4" in thickness to 38" in width shall be provided with 4-1/2" x4" butt hinges provided with at least two ball or oilite bearing; wider and heavier doors with 5"x4-1/2" extra heavy butt hinges provided with four ball or iolite bearing.

4. Number of hinges per door leaf: Provide 3 hinges per leaf for door up to 86" high, one additional butt hinge for each additional 30" of height, or fraction thereof.

E. Locksets and Latchsets

1. Cylinders: Furnish and install all screw-in type cylinders and keyways to establish the facility standard. Provide Bestlock 5AAA cylinders.

2. Lock Type: For all exterior doors where cylindrical locksets or latches are called for, provide locks of the Best 9K Heavy Duty Lever Type, with backset of 2-3/4", unless otherwise noted. Provide all locks for the entire Project from the same manufacturer. Doorknob style, always unlocked from interior, keyed lock from exterior, door remains locked from exterior.

3. Design: Provide lever handles at all locksets of the Best 9K Series, unless otherwise noted.

4. Strikes: Provide each lockset, handset, or deadlock with a box strike. Provide standard type strikes with extended lips where required to protect adjacent trim from being marred by latch bolt. Verify cutout types provided in metal frames.

5. All padlocks shall be provided and installed by the Owner when it takes over the operation of the facility. During construction, provide temporary construction padlocks as needed. Provide the Owner a minimum of five construction keys for use during the construction period.

F. Closers

1. General

   a. Comply with SSC, Section 905.3 and Section 1003.3.1.5 for maximum effort to operate doors.

   b. Closers are attached with sex bolts.

   c. Adjust closers in accordance with manufacturer's directions for size of door.

   d. Provide modern closers having:

      1) Full rack and pinion with steel spring and non-gumming, nonfreezing hydraulic fluid.

      2) Provide complete set of separate controls for regulating sweep speed, latch speed, backcheck, and backcheck positioning. Sizes as recommended by reviewed manufacturer.

2. Door Surface Applied Modern Closers

   a. Provide drop plates at doors having narrow frames.
   b. Product: LCN or approved equal.

3. Quantity: Provide each leaf in pairs of doors scheduled to receive closers.

G. Stops and Holders

1. It is the intent of these specifications that each door leaf is provided with a door stop.

   Built-in stops in door closers, wall bumpers, and overhead stops shall satisfy the requirements of this paragraph. Provide stops of proper size and height to prevent doors from hitting walls of fixed objects.

2. It is the intent of these specifications that each door leaf is provided with a door holder.

   a. Heavy duty lever type door holders shall be provided at each interior and exterior door.

H. Thresholds

1. Thresholds shall conform to BHMA A156.21. Thresholds for exterior doors shall be extruded aluminum and shall provide proper clearance and an effective seal with specified gasketing. Threshold shall be set in a full bed of mastic.

2. Provide countersink, flathead screws, same material and finish as threshold.

I. Door Bottom

1. Door Bottoms shall be surface type with aluminum housing cover, anodized clear finish. Door bottoms shall have a neoprene seal and shall be actuated by the opening and closing of the door. The door bottoms shall exclude light when the door is in the closed position and shall inhibit the flow of air through the unit.

2. Provide countersink, flathead screws, same material and finish as door bottom.

J. Gasketing

1. Gasketing shall be compressive type seal, silicon based, self-adhesive product for use on steel door frames with steel doors for 20 minutes and1-hour B labels. Air leakage rate of weather-stripping shall not exceed 0.5 cubic feet per minute per linear foot of crack when tested in accordance with ASTM E283 at standard test conditions.

2. Provide countersink, flathead screws, same material and finish as door gasketing.

K. Silencers

1. Provide each door with a press-metal frame with rubber silencers. Omit at doors to receive gasketing. Provide each single door with three silencers, each pair of doors with four.

L. Finishes

1. All hardware shall have brushed chrome finish (626) for interior and exterior installation typically, unless noted otherwise.

   a. Provide over steel base metal (BHMA 626), typical, where required by code.

   b. Provide over bronze base metal (BHMA 612) for exterior installations and unheated spaces expose to the weather, unless otherwise noted. Exterior installations include exit doors to covered exterior pads and walkway locations, loading dock areas, areaways, and where noted.

2. All thresholds and weatherstrip shall be fabricated of extruded aluminum, clear anodized finish, to match specified finish of other aluminum, unless noted otherwise.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and requirements of AMSI/NFPA 80, and DHI. Use the templates provided by the hardware item manufacturer.

B. Provide architectural finish hardware with all necessary (plus prudent spares) screws, bolts, or other devices or fastenings of suitable size and type to secure the hardware in position for heavy use and long life, harmonizing as to material and finish. These fastening shall be furnished, were necessary, with expansion shields or other approved anchors according to the material to which it is applied and as recommended by the manufacturer. Secure all hardware to concrete with expansion sleeve anchors as indicated by best current practice; plastic or "Rawl" plugs will not be permitted. Hardware screws shall be of sufficient length to firmly engage backing and shall be fully threaded. All screws normally exposed to view, including all screws for butt hinges, shall have "Phillips" heads, finish to match hardware.

C. Keying:

1. Owner will remove construction plugs and install permanent cylinders as required.

2. The master key chart will be furnished by the Owner. The Owner is responsible for all keying and permanent keys. Contractor shall provide construction cylinders and keys as required during construction.

3.2 FINISHING

A. Typical: Brushed chrome, unless noted otherwise.

B. Adjusting, Cleaning and Demonstrating

1. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made. The operation of the ventilation system does not cause doors to slam shut or fail to close completely.

   a. Adjust operation of all doors to meet ADA and SSC, Section 905.3 and Section 1003.3.1.5 for requirements for opening force.

   b. Where door hardware is installed more than 1 month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area.

   c. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

C. Clean adjacent surfaces soiled by hardware installation.

D. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.

3.3 SCHEDULE OF DOOR HARDWARE GROUPS

A. Exterior Double Doors (Group 1)

12	EA	HINGE	5BB1-HW 4.5 X 4.5	626	IVE
2	EA	EXTENSION FLUSH BOLT	458B26D	626	IVE
1	EA	LOCKSET	93K7D15D	626	BST
1	EA	STRIKE	S3	626	BST
1	EA	CYLINDER (key from exterior, Interior always unlocked)	86B	626	BST
1	EA	ASTRAGAL	by door mfgr	---	---

2	EA	SURFACE CLOSER	4011	626	LCN
1	SET	GASKETING	S44D (HEAD & JAMBS)	BRN	PEM
6	EA	SILENCERS	SR64		IVE
1	EA	THRESHOLD	271A		PEM
1	EA	RAIN GUARD	346c		PEM
1	EA	DOOR SWEEPS	18061CNB	626	PEM
2	EA	DOOR STOP	475		RWD
2	EA	DOOR HOLDER	460		RWD

B. Exterior Single Door (Group 2)

6	EA	HINGE	5BB1-HW 4.5 X 4.5	626	IVE
1	EA	STRIKE	S3	626	BST
1	EA	LOCKSET (key from exterior, Interior always unlocked)	93K7D15D	626	BST
1	EA	SURFACE CLOSER	4011	626	LCN
1	SET	GASKETING	S44D (HEAD & JAMBS)	BRN	PEM
3	EA	SILENCERS	SR64		IVE
1	EA	THRESHOLD	271A		PEM
1	EA	RAINGAURD	346c		PEM
1	EA	DOOR SWEEPS	18061CNB		PEM
1	EA	DOOR STOP	475		RWD
1	EA	DOOR HOLDER	460		RWD

END OF SECTION

SECTION 08 91 19 - FIXED LOUVERS

PART 1 GENERAL

1.1 DESCRIPTION

A. SCOPE:

1. This Section includes intake and exhaust stationary air louvers and accessories.

B. Section Includes:

1. Louvers
2. Screens

C. Related Sections

1. Section 07 92 00 – Sealants and Caulking
2. Section 09 90 00 - Painting and Coatings

1.2 SUBMITTALS

A. Manufacturer's catalog and/or other data confirming conformance to specified design, material, and equipment requirements.

B. Certified results of pressure drop test data and water penetration data. The equipment list should identify each louver with an equipment number and indicate the room or structure in which it is located.

C. Louvers shall bear the AMCA certified ratings seal for both air performance and water penetration.

1.3 REFERENCE STANDARDS

A. Aluminum Association (AA):

1. AA 45 - Designation System for Aluminum Finishes.

B. Air Movement and Control Association (AMCA) International:

1. AMCA Standard 500 - Test Methods for Louvers, Dampers, and Shutters.

C. ASTM International (ASTM):

1. ASTM B221 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

PART 2 PRODUCTS

2.1 MANUFACTURERS

Manufacturers include Greenheck, and Ruskin, or equal.

2.2 MATERIALS

A. Frame: ASTM B221, 6063-T52 extruded aluminum alloy
B. Fasteners: Aluminum
C. Bird Screen

2.3 EQUIPMENT

A. BLADES:

1. Material: ASTM B221, 6063-T52 extruded aluminum alloy

2. Blades shall be of the combination of fixed and adjustable, drainable type with interlocking blade braces to provide an uninterrupted horizontal line.

3. Blades for all louvers shall be minimum 0.081-inch thick.

4. Slideable interlocked mullions shall have provisions for expansion and contraction.

B. FRAME:

1. Material: ASTM B221, 6063-T52 extruded aluminum alloy

2. The frame shall be minimum 0.081-inch thick by 4 inches deep.

3. The louver frame shall be assembled by welding.

4. The head, sill, and jamb shall be one-piece structural members and shall have an integral calking slot and retaining bead.

C. SCREEN:

1. Material: Aluminum wire mesh

2. The louver shall be furnished with a removable insect screen constructed of No. 24 mesh and secured within a 10-gauge extruded aluminum frame.

3. The screen shall be mounted on the interior louver face but independent of the louver.

D. Fasteners: Aluminum.

E. Finish:

1. Unless otherwise specified, all louvers shall receive an AAMA 2605, 70 percent fluoropolymer paint finish after assembly.

2. Minimum coating thickness shall be 0.7-mil.

3. Color to match door.

2.4 FABRICATION

A. General: Fabricate louvers to comply with requirements indicated for design, dimensions, materials, joinery, and performance.

B. Assemble louvers in shop to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Maintain equal louver blade spacing to produce uniform appearance.

E. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances of louvers, adjoining construction and perimeter sealant joints.

F. Include supports, anchorages and accessories required for complete assembly.

G. Provide vertical mullions of type and at spacing's indicated but not more than recommended by manufacturer, or 72 inches on center, whichever is less. At horizontal joints between louver units, provide horizontal mullions except where continuous vertical assemblies are indicated.

H. Provide sill extensions and loose sills made of same material as louvers where indicated or required for drainage to exterior and to prevent water penetrating to interior.

I. Join frame members to one another and to fixed louver blades as follows, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary:

1. With fillet welds, concealed from view.

2. With fillet welds, concealed from view; or mechanical fasteners; or a combination of these methods; as standard with louver manufacturer.

2.5 ACOUSTICAL WALL LOUVERS

A. Acoustical louvers shall be furnished and installed as shown. The CONTRACTOR shall submit certified data from a laboratory substantiating the acoustical performance. Static pressure drop shall not exceed 0.10 inches W.C. at 800 fpm.

B. Transmission loss characteristics shall have at least the following values:

Octave Band Center Frequency (Hz.)

125	250	500	1000	2000	4000	8000
17	12	16	22	23	21	21

C. Acoustical performance shall be established by ASTM E90 tests in an accredited laboratory. Transmission loss shall be supplied by the manufacturer with submittal drawings.

D. The louvers provided and installed shall have interior configurations, namely blade and air passage widths, that are identical to the approved test units. For openings not falling into a standard louver dimensional configuration, a combination of units shall be chosen based on the most economical treatment using standard sizes.

E. Aluminum bird and insect screens shall be provided in removable frames on the interior.

F. Provide gravity or motorized dampers as shown on the Drawings.

G. Acoustical louvers shall be Ruskin model ACL-845, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Locate and place louver units plumb, level, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items that cannot be refinished in the field to the shop, make required alterations and refinish entire unit, or provide new units.

F. Protect nonferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that are in contact with concrete, masonry or dissimilar metals.

G. Install concealed gaskets, flashings, joint fillers and insulation, as louver installation progresses, where required to make louver joints weathertight. Comply with Section 07 92 00 for sealants applied during installation of louver.

3.2 FINISHING

A. Adjusting and Protection

1. Protect louvers from damage of any kind during construction period including use of temporary protective coverings where needed and approved by louver manufacturer. Remove protective covering at time of Substantial Completion.

2. Restore louvers damaged during installation and construction period, so that no evidence remains of correction work. If results of restoration are unsuccessful, as judged by the OWNER'S Representative, remove damaged units and replace with new units.

a. Clean and touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

B. Cleaning

1. Periodically clean exposed surfaces of louvers that are not protected by temporary covering to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

2. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Rinse surfaces thoroughly and dry.

END OF SECTION

SECTION 09 90 00

PAINTING AND COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the protective coating of all specified surfaces including all surface preparation, pretreatment, coating application, touch-up of factory coated surfaces, protection of surfaces not to be coated, cleanup, and appurtenant work, all in accordance with the requirements of the Contract Documents.

1.2 REQUIREMENTS

A. This Section is applicable to coated pipe, steel, concrete and other surfaces listed in the coating schedule at the end of this Section. Pipe corrosion protection systems, galvanizing and anodizing, as may be required, are specified elsewhere within the contract documents.

B. The Coating System Schedule at the end of this Section summarizes the surfaces to be coated, the required surface preparation and the coating systems to be applied. Coating notes on the Drawings are used to show exceptions to the schedules, to show or extend the limits of coating systems, or to clarify or show details for application of the coating systems.

C. Related Work Specified in Other Sections: Shop coatings and/or factory finishes on fabricated or manufactured equipment may be specified in other divisions. Some items with factory finishes or corrosion resistant finishes may be scheduled or directed to be painted by the Engineer to unify a wall finish or color scheme, at the Engineer's discretion.

D. Exclusions: Do not coat the following surfaces unless specified or directed elsewhere:

1. Stainless steel, aluminum, copper, brass, bronze and other corrosion-resistant material (except for valve bodies and piping);

2. Electrical switch-gear and motor control centers having factory finish;

3. Fencing;

4. Multiple coated factory finished baked enamel or porcelain products;

5. Concealed areas such as ducts, piping, and conduits:

6. Items specified elsewhere for special linings and coatings.

E. Damaged Factory Finish: If directed by the Engineer, refinish the entire exposed surfaces of equipment chipped, scratched or otherwise damaged in shipment or installation.

F. All coating coming in contact with potable water or untreated pumped raw water from well shall be NSF approved.

1.3 RELATED SECTIONS

A. Section 05 50 00 - Metal Fabrications.
B. Section 08 11 13 - Hollow Metal Doors and Frames.
C. Section 08 91 19 - Louvers.
D. Section 09 20 10 - Gypsum Wallboard.
E. Section 33 11 10 - Water Utility Distribution and Transmission Piping.
F. Section 33 12 16 - Water Utility Distribution and Transmission Valves.
G. Section 33 12 19 - Fire Hydrants.
H. Section 40 05 13 - Common Work Results for Process Piping.
I. Section 40 05 23 - Common Work Results for Process Valves.

1.4 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

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

1. "Architectural Specification Manual" by the Painting and Decorating Contractors of America (PDCA), 333 Taylor Avenue North, Seattle, Washington 98109.

2. "Systems and Specifications" - Volume 2 of Steel Structures Painting Council (SSPC).

3. National Sanitation Foundation (NSF) Standard No. 61.

B. References herein to "NACE" shall mean the published standards of the National Association of Corrosion Engineers, P.O. Box 986, Katy, TX 77450.

C. American Water Works Association (AWWA):

1. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.

2. AWWA C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.

3. AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-inch and Larger - Shop Applied

4. AWWA C209 - Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Pipelines.

5. AWWA C210 - Liquid Epoxy Coating for Exterior and Interior of Steel Pipe.

6. AWWA C213 - Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

7. AWWA C214 - Tape Coating systems for the Exterior of Steel Water Pipelines.

D. Federal Specifications

1. DOD-P-23236A(SH) Military Specification, Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast.

1.5 SUBMITTALS

A. In accordance with Section 01 33 00, Submittals.

B. Coating Materials List: Provide a coating materials list which indicates the manufacturer and the coating number, keyed to the coating systems herein.

C. Coating Manufacturer's and Applicator Information: For each coating system to be used, provide the following listed data:

1. Manufacturer's data sheet for each product used, including statements on the suitability of the material for the intended use.

2. Manufacturer's instructions and recommendations on surface preparation and application.

3. Colors available for each product and each coat.

4. Compatibility of shop and field applied coatings (where applicable).

5. Material safety data sheet (MSDS) for each product used.

6. The manufacturer’s recommended products and procedures for field coating repairs and field preparation of field cut pipe ends.

7. The name of the proposed coating applicator shop along with certification that the applicator shop is qualified and equipped to apply the coatings systems as specified.

8. Manufacturer's certificate of compliance with the specifications and standards signed by a representative in the manufacturer's employ.

9. Samples -- Provide painted surface areas at the job for approval of main color selections, or submit sample on 12-inch sample of substrate using required finish system at Engineer’s discretion.

1.6 QUALITY ASSURANCE

A. Provide a minimum of 3 days advance notice of the start of any field surface preparation work of coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.

B. All such work shall be performed only in the presence of the Engineer, unless the Engineer has granted prior approval to perform such work in its absence.

C. Observations by the Engineer, or the waiver of observation of any particular portion of the work, shall not relieve the Contractor of its responsibility to perform the work in accordance with these Specifications.

D. Surface Preparation: Evaluation of blast-cleaned surface preparation work will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE standard TM-01-70.

E. Scaffolding: Shall be erected and moved to locations where requested by the Engineer to facilitate observations. Additional illumination shall be provided by the Contractor to cover all areas to be observed.

F. Paint Products: No request for substitution shall be approved which decreases the film thickness designated or the number of coats to be applied, or which offers a change from the generic type of coating specified. Painting shall be done at such times as the Contractor and Engineer may agree upon in order that dust-free and neat work be obtained. All painting shall be in strict accordance with the manufacturer's instructions and shall be performed in a manner satisfactory to the Engineer.

G. Manufacturer's Representative: Require coating manufacturer's representative to be at job site when the first day's coating application is in progress and periodically during progress of the work.

H. Labels: Deliver to the job site in the original sealed containers with manufacturer's name, product name, type of product, manufacturer's specification or catalog number or federal specification number, and instructions for reducing where applicable.

I. Colors:

1. Colors will be selected from manufacturer's standard colors as reviewed by Engineer and approved by the Owner.

2. Colors for special coatings that are limited in their availability and color selection will be chosen on the basis of manufacturer's standard colors, provided that the manufacturer's product line represents a color range comparable to similar products of other manufacturers.

J. Flame Spread: Provide paint materials which will result in a Class II finish for all coated surfaces in exit corridors, and a Class III finish for all other interior rooms or areas.

K. Film Thickness Testing:

1. On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gage such as Mikrotest model FM, Elcometer model 111/1EZ, or approved equal.

a. Each coat shall be tested for the correct thickness.

b. No measurements shall be made until at least 8 hours after application of the coating.

2. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using wet film gage readings and destructive film thickness tests.

1.7 DELIVERY, HANDLING AND STORAGE

A. Deliver in labeled containers as specified above and store in a locked room accessible for inspection. Comply with fire and health regulations.

B. Provide adequate heat and forced mechanical ventilation for health, safety and drying requirements. Use explosion-proof equipment. Provide face masks.

C. Protect adjacent surfaces with suitable masking and drop cloths as required. Remove cloths or waste from the project daily.

D. Apply to surfaces under recommended environmental conditions and within the limitations established by the material manufacturer.

1. Do not apply coating in snow, rain, fog or mist; or when the relative humidity exceeds 85 percent; or to damp or wet surfaces, unless otherwise permitted by the coating manufacturer's printed instructions.

2. Coating application may be continued during inclement weather only if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the paint manufacturer during application and drying periods.

1.8 PROTECTION

A. Follow all safety recommendations of manufacturer regarding ventilation and danger from explosion or breathing paint fumes or skin exposure, and all applicable O.S.H.A. and other regulations.

B. Protect surface adjacent to work being coated from overspray, drips or other damage.

1.9 EXTRA STOCK

A. Provide threegallons of each type and color, fully labeled, at completion of job.

PART 2 PRODUCTS

2.1 GENERAL

A. Definitions:

1. The terms "paint," "coatings" or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, tape and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means minimum dry film thickness.

B. General: Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer, all of which shall be plainly legible at the time of use.

C. Use coating materials suitable for the intended use and recommended by their manufacturer for the intended service.

D. Compatibility: In any coating system, only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, subject to the approval of the Engineer, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

E. Colors: All colors and shades of colors of all coatings shall be as selected or specified by the Engineer. Each coat shall be of a slightly different shade, to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the Owner. Color pigments shall be lead-free.

F. Protective Coating Materials: Products shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the provide the names of not less than 10 successful applications of the proposed manufacturer's products demonstrating compliance with this specification requirement.

G. Substitute or "Or-Equal" Submittals: Unless otherwise specified, materials are from the catalogs of the companies listed herein. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the companies listed. Provide satisfactory documentation from the firm manufacturing the proposed substitute or "or equal" material that said material meets the specified requirements and is equivalent or better than the listed materials.

H. The cost of all testing and analyzing of the proposed substitute materials that may be required by the Engineer shall be paid by the Contractor. If the proposed substitution requires changes in the contract work, the Contractor shall bear all such costs involved and the costs of allied trades affected by the substitution.

2.2 INDUSTRIAL COATING SYSTEMS

A. General

1. Provide and apply the industrial coatings systems which follow as listed in the coating schedule, as required by these specifications and as directed by the Engineer.

2. Coat all existing and new exposed interior or exterior surfaces and submerged and intermittently submerged surfaces as indicated, except as specifically excluded in Part 1 of this section or on the drawings or finish schedules.

3. Coating System Numbers listed below shall be used as the Coating System code letter, and shall be used on any coating submittals or correspondence.

B. Industrial coating systems shall be as follows

1. Coating System 100

a. Location -- Exposed, unprimed, non-galvanized, non-submerged metal surfaces, both interior and exterior including piping and structural steel.

b. Surface Preparation -- As specified herein.

c. Coating System -- Apply prime coat and topcoat, 4.0-6.0 mils each coat of Tnemec Series 66-2 Hi-Build Epoxoline, or approved equal. Color as selected by Owner.

2. Coating System 101

a. Location -- Exposed metal surfaces, shop primed, both interior and exterior including piping, railings, ladders, steel doors, and any other metal items not otherwise specified.

b. Surface Preparation -- As specified herein.

c. Coating System -- Apply shop prime coat 3.0 mils DFT Tnemec Series 90-97 Tneme-Zinc, one coat 4.0 - 6.0 mils DFT Tnemec Series 66 Hi-Build Epoxoline, and 3.0 - 4.0 mils DFT of Tnemec Series 1095, or approved equal. Color as selected by Owner.

3. Coating System 102

a. Location -- Unprimed or non-galvanized, continuously or intermittently submerged metal items, both interior and exterior including piping, structural steel and all other metal items not otherwise specified.

b. Surface Preparation -- As specified herein.

c. Coating System -- Prime, intermediate and topcoat, 4.0-6.0 mils each coat of Tnemec Series 20 Pota-Pox, or approved equal. Color as selected by Owner.

4. Coating System 103

a. Location -- Vertical concrete walls, exterior, below finish grade, not exposed to view.

b. Surface Preparation -- As specified herein.

c. Paint System -- Apply two coats 9.0-10.0 mils each, Carboline Bitumastic 50, or approved equal.

5. Coating System 104

a. Location – Non-submerged, exposed to view, PVC piping.

b. Surface Preparation -- As specified herein.

c. Coating System -- Apply one coat, 4.0-6.0 mils Tnemec Series 66-2 Hi-Build Epoxoline, or approved equal. Color as selected by Owner.

2.3 SPECIAL PIPE AND SEVERE SERVICE COATING SYSTEMS

A. General

The following coatings are for buried pipe and surfaces used in severe service conditions. The manufacturers' products listed in this paragraph are materials which satisfy the material descriptions of this paragraph and have a documented successful record for long term submerged or severe service conditions. Proposed substitute products will be considered as indicated within the paragraph entitled " ‘Or-Equal’ Clause” in Section 01100, Special Provisions.

B. Special pipe and severe service coating systems shall be as follows

1. Coating System 200 -- Cement Mortar Coating

    a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

    b. Surface Preparation - As specified herein.

    c. Coating System -- A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than one-part Type V cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane-Forming Compounds for Curing Concrete" ASTM C 309-81, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped by at least 6 inches. At the ENGINEER's discretion, the hot applied coal tar epoxy coating may be used as the curing membrane for the mortar coating.

2. Coating System 201 -- Hot Applied Coal Tar Epoxy Coating

    a. Location -- Exterior surface of concrete pipe and cement-mortar coated pipe and fittings.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- The hot applied coal tar epoxy shall be a solvent free 100 percent solids coal tar epoxy chemically compatible with hydrating cement and suitable for application on moist surfaces of freshly placed cement mortar or concrete and properly prepared cured surfaces. The coal tar epoxy coating material shall be Amercoat 1972B or approved equal. The finish coal tar epoxy coating shall have a minimum DFT of 26 mils.

3. Coating System 202 -- Coal-Tar Epoxy Coating System

    a. Location -- Exterior surface of buried steel pipe, fittings and other ferrous surfaces.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- High build, 2-component amine or polyamide cured coal-tar epoxy shall have a solids content of at least 68 percent by volume, suitable as a long-term coating of buried surfaces, and conforming to AWWA C210. Prime coats are for use as a shop primer only. Prime coat shall be omitted when both surface preparation and coating are to be performed in the field. The coal-tar epoxy coating system shall include:

1) Prime coat (DFT = 1.5 mils), Amercoat 83HS, Tnemec P66, or equal.

2) Finish coats (2 or more, DFT = 18 mils), Amercoat 78 HB, Tnemec 46 H-413, or equal.

3) Total system DFT = 19.5 mils.

4. Coating System 203 -- Fusion Bonded Epoxy

   a. Location -- Ferrous surfaces of sleeve couplings, steel pipe and fittings.

   b. Surface Preparation -- As specified herein.

   c. Coating System -- The coating material shall be a 100 percent powder epoxy applied in accordance with the ANSI/AWWA C213 "AWWA Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines". The coating shall be applied using the fluidized bed process.

      1) Liquid Epoxy -- For field repairs, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a DFT 16 mils. The liquid epoxy shall be a 100 percent solids epoxy recommended by the powder epoxy manufacturer.

      2) Coating (DFT = 16 mils), Scotchkote 203, or equal.

      3) Total system DFT = 16 mils.

5. Coating System 204 -- Hot, Coal-Tar Enamel

   a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

   b. Surface Preparation - As specified herein

   c. Coating System -- Coal-Tar Enamel materials and procedures shall be in accordance with ANSI/AWWA C203. This system shall consist of a primer layer, coal-tar enamel layer, coal-tar saturated nonasbestos felt outerwrap and a finish coat. Total system DFT = 188 mils.

6. Coating System 205 -- Hot Applied Tape

   a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

   b. Surface Preparation -- As specified herein.

   c. Coating System -- Tape coating materials and procedures shall be in accordance with ANSI/AWWA C203. This system shall consist of a cold-applied liquid primer and heated coal-tar base tape. Total system DFT = 50 mils.

7. Coating System 206 -- Cold Applied Tape

    a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Tape coating materials and procedures shall be in accordance with ANSI/AWWA C209. Prefabricated tape shall be Type II. The system shall consists of a primer layer, inner layer tape of 35 mils, and an outer layer tape of 35 mils. Total system DFT = 70 mils.

8. Coating System 207 -- PVC Tape

    a. Location -- Small galvanized steel pipe and fittings.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Prior to wrapping pipe with PVC tape, the pipe and fittings shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half lapped for a total thickness of 40 mils.

9. Coating System 208 -- Mastic

    a. Location -- Pipe and fitting joints, and general buried surface coating repair and touch up.

    b. Surface Preparation - As specified herein.

    c. Coating System -- Mastic shall be a one-part solvent drying heavy bodied thixotropic synthetic elastomeric coating with chemically inert resins and fillers and an average viscosity of 650,000 CPS at 77 degrees Fahrenheit, thereby requiring generous applications by hand or trowel. Total coat thickness shall be 30 mils, minimum. Mastic shall be Protecto Wrap 160 H or approved equal and be fully compatible with pipeline coating systems.

10. Coating System 209 -- Polyethylene Encasement

    a. Location -- Ductile iron, steel and concrete cylinder pipe and fittings

    b. Surface Preparation -- None required.

    c. Coating System -- Except as otherwise specified, application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

2.4 ARCHITECTURAL COATING SYSTEMS

A. General

"Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or topcoat.

Fungus Control: Submit evidence for all paints attesting the passing of Federal Test Method Standard No. 141, Method 6271.1 showing no fungus growth or other approved test results.

Apply to surfaces under recommended environmental conditions and within the limitations established by the material manufacturer. Acrylics require 60 degrees Fahrenheit (°F) and above temperature and below 50 percent relative humidity. Apply water-based paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 50°F and 90°F unless otherwise permitted by the paint manufacturer's printed instructions.

B. Architectural coating systems shall be as follows

1. Coating System 300

    a. Location -- Vertical, exterior concrete masonry unit walls exposed to view.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Apply prime, intermediate and top coat, 75 ft^2/gal, 100 ft^2/gal and 100 ft^2/gal respectively for each coat of Tnemec Series 156 Envirocrete or approved equal. Color as selected by Owner.

2. Paint System 301

    a. Location -- Vertical concrete exterior walls and flat concrete exterior roofs and slabs exposed to view.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Apply two coats 6.0-9.0 mils (100 ft^2/gal) each coat, Tnemec Series 156 Envirocrete, or approved equal. Color as selected by Owner.

3. Paint System 302

    a. Location -- Interior concrete masonry unit walls and interior and exterior wood walls, ceilings and other wood surfaces or composite wood not otherwise specified, exposed to view.

b. Surface Preparation – As specified herein.

c. Coating System – Prime as specified by coating manufacturer. Apply two coats 6.0 – 9.0 mils (100 ft^2/gal) each coat, Tnemec Series 156 Envirocrete, or approved equal. Color as selected by Owner.

4. Paint System 303

a. Location – Exterior cementitious board or trim, wood surfaces, or composite wood not otherwise specified, exposed to view.

b. Surface Preparation -- As specified herein.

c. Coating System -- Apply an alkyd primer as recommended by the manufacturer, 2 mils. Apply finish coats (two or more coats 6 mils total) of single component, water based acrylic latex coating, Tnemec Series 6, Carboline 3350 or equal. Total DFT = 8 mils. Color as selected by Owner.

5. Paint System 304

a. Location -- Interior drywall surfaces not otherwise specified, exposed to view.

b. Surface Preparation - As specified herein.

c. Coating System -- Apply two coats 2.0 - 3.0 mils each coat of single component, water based acrylic latex coating, Tnemec Series 6, Carboline 3350 or equal. Color as selected by Owner.

6. Paint System 305

a. Location -- Exterior concrete masonry surfaces not otherwise specified, exposed to view.

b. Surface Preparation -- Surfaces shall be cleaned with a manufacturer's approved chemical cleaner and power washed. Surfaces shall be completely dry, free from efflorescence, oils, paint and other contaminants before the coating system is applied. Coating system shall be applied according to the manufacturers published recommendations. A manufacturer's representative shall be present during application of the coating system, if required by the manufacturer's warranty.

c. Coating System -- Apply two coats of masonry water retardant material. The system shall be clear, non-staining, silane-modified-siloxane, Fabrishield 161, Rainstopper 1500, or equal.

PART 3 EXECUTION

3.1 STORAGE, MIXING AND THINNING OF MATERIALS

A. Manufacturer's Recommendations: Unless otherwise specified herein, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating shall be strictly observed.

B. All protective coating materials shall be used within the manufacturer's recommended shelf life.

C. Storage and Mixing: Coating materials shall be protected from exposure to cold weather, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application.

D. Coatings of different manufacturers shall not be mixed together.

3.2 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification.

1. Solvent Cleaning (SSPC-SP1) -- Removal of oil, grease, soil, salts and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion or steam.

2. Hand Tool Cleaning (SSPC-SP2) -- Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC-SP3) -- Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing and grinding.

4. White Metal Blast Cleaning (SSPC-SP5) -- Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC-SP6) -- Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC-SP7) -- Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust and loose paint.

7. Near-White Blast Cleaning (SSPC-SP10) -- Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. High- and Ultra High- Pressure Water Jetting (SSPC-SP12): Water jetting at high- or ultra-high-pressure to prepare a surface for recoating using pressure above 10,000 psi.

9. Surface Preparation of Concrete (SSPC-SP-13) - Surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems.

10. Industrial Blast Cleaning (SSPC-SP14): Blast cleaning to remove all visible oil, grease, dust and dirt, when viewed without magnification

3.3 CORRECTIONS AND CLEANUP

A. At completion of Work, any damaged, de-laminated or defaced coated surfaces shall be touched up, restored and left in first class condition.

B. Any coated or finished surfaces damaged in fitting or erection shall be restored.

C. If necessary, and at the discretion of the Engineer, an entire wall shall be refinished rather than spot finished.

D. Upon completion and prior to final acceptance, all equipment and unused materials accumulated in the coating process shall be removed from the site and any spillage, spatter spots or other misplaced coating material shall be removed in a manner which will not damage surfaces.

E. Perform required patching, repair and cleaning to the satisfaction of the Engineer.

F. Cooperate and coordinate work with the work of other trades in the removal and replacement of hardware, fixtures, covers, switch plates, etc., as required for coating.

3.4 SURFACE PREPARATION

A. General

1. Prepare all surfaces scheduled to receive new coating systems as required to provide for adequate bonding of the specified coating system to the substrate material.

2. Request review of prepared surfaces by the Engineer prior to proceeding.

3. For existing coated surfaces, hand wash with cleaner or product recommended by coating manufacturer to properly prepare existing surface and provide for bonding of coating specified to follow. Remove any loose, peeling or flaking coating, or mildewed areas.

4. Surface preparation minimums shall be as follows:

    a. Exposed metal items, non-submerged, unprimed, non-galvanized both interior and exterior, including: piping, structural steel and all other metal items not otherwise specified, shall undergo surface preparation in accordance with SSPC-SP6, "Commercial Blast Cleaning".

    b. Exposed metal items, shop primed, both interior and exterior including: piping, steel doors, steel ladders to be painted, and railings, and all other metal items not otherwise specified, shall undergo surface preparation in accordance with SSPC-SP1, "Solvent Cleaning"; SSPC-SP2, "Hand Tool Cleaning"; and SSPC-SP3, "Power Tool Cleaning" as may be required to remove grease, loose or peeling or chipped paint.

    c. Metal items, unprimed or non-galvanized, continuously or intermittently submerged, both interior and exterior including: piping, structural steel and all other metal items not otherwise specified, shall undergo surface preparation in conformance with SSPC-SP10, "Near-White Blast Cleaning".

    d. Stainless Steel: Non-submerged and submerged, exposed piping and fittings, both interior and exterior shall undergo surface preparation in accordance with SSPC-SP1, "Solvent Cleaning".

    e. Polyvinyl Chloride (PVC): Non-submerged, both interior and exterior, process piping and plumbing, shall be lightly sanded prior to application of the specified coating system to follow.

    f. Non-submerged Concrete: Clean all concrete surfaces of dust, form oil, curing compounds or other incompatible matter. Etch and prime if required by manufacturer for specified coating products to follow. Allow minimum 28-day cure of concrete prior to application of coating systems.

    g. Concrete Masonry Units: Repair all breaks, cracks and holes with concrete grout. The surface must be free of dirt, dust, loose sand and other foreign matter. Brush clean. Allow minimum 28-day cure of concrete joint mortar and repair grout prior to application of coatings system.

    h. Wood: Wood surfaces shall be thoroughly cleaned and free of all foreign matter with cracks, nail holes and other defects properly filled, smoothed and sandpapered to fine finish. Wipe clean of dust.

3.5 PRIME COATING

A. Exposed Steel: Prime coat all exposed steel in accordance with SSPC PS 13.01 for epoxy-polyamide coating systems. Prime coats shall be applied following completion of surface preparation requirements as specified in paragraph 3.4.A.1 above.

B. Galvanized Metal: After surface preparation specified above, prime galvanized metal items receiving paints as specified with Tnemec Series 66 Hi-Build Epoxaline or equal, verifying with manufacturer before application the compatibility with coatings specified to follow.

C. Shop Primed Metal: Where indicated on the Drawings or coating schedule, and following the surface preparation procedures specified in paragraph 3.4.A.2 above, apply intermediate and topcoats of the specified paint system to shop primed metal. The Contractor shall verify with the manufacturer(s) representative of the item(s) to be painted, before application, the compatibility of shop primers with the specified intermediate and topcoat coating systems.

D. Non-Shop Primed Metal and Piping: Prime coat all exposed metal and piping, except stainless steel, received at job site following completion of surface preparation requirements as specified in paragraph 3.4.A.1 above. Prime paint in accordance with SSPC PS No. 13.01 for epoxy-polyamide primers. Epoxy-polyamide primers shall conform to the standards set forth in SSPC Paint Specification No. 22.

E. Concrete Masonry Units: After surface preparation specified above, prime coat as specified in the coating schedule found elsewhere in the specifications.

F. Wood Surfaces: Following surface preparation specified above, prime coat exterior exposed wood surfaces with appropriate coating system as specified in the painting schedule.

3.6 FIELD PRIME

A. Wherever shop priming has been damaged in transit or during construction, the damaged area shall be cleaned and touched up with field primer specified herein or returned to the shop for resurfacing and re-priming, at the Engineer’s discretion.

B. Metal items delivered to the job site unprimed shall be cleaned and primed as specified herein.

3.7 APPLICATION

A. Thickness:

1. Apply coatings in strict conformance with the manufacturer's application instructions.

2. Apply each coat at the rate specified by the manufacturer to achieve the dry mil thickness specified.

3. If material must be diluted for application by spray gun, build up more coating to achieve the same thickness as undiluted material.

4. Correct apparent deficiency of film thickness by the application of an additional coat.

B. Porous Surfaces: Apply paint to porous surfaces as required by increasing the number of coats or decreasing the coverage as may be necessary to achieve a durable protective and decorative finish.

C. Blast-Cleaned Ferrous Metal Surfaces: To be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations, and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe coating for these areas.

F. Special attention shall be given to materials which will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Ventilation: Adequately ventilate enclosed rooms and spaces during painting and drying periods.

H. Drying Time: Do not apply next coat of coat until each coat is dry. Test non-metallic surfaces with moisture meter. The manufacturer's recommended drying time shall mean an interval under normal condition to be increased to allow for adverse weather or drying conditions. Coating manufacturer's representative shall verify by cure testing, complete cure of coatings systems used for immersion service.

3.8 COATING SCHEDULE

The following schedule indicates the coating and paint systems previously specified that apply to the project. Additional comments are added which may modify or amend the specifications.

Coating & Painting Schedule

Coating Schedule

Item	Location	Material	Coating System	Color
Piping	Interior Piping (exterior pipe surface)	Ductile Iron	Coating System 102	Light Green
Piping	Interior Piping (interior & exterior surface)	Steel	Coating System 203	Light Green
Louvers	Building	Aluminum or steel	Factory coated per manufacturer	Match roof
Miscellaneous Metals, metal trim	Building (exterior surface)	Steel	Coating System 101	Match roof
Exterior Eves, Trim & Fascia	ASR Building, Pump Station, Ops Building	Fiber Cement	Coating System 303	Match roof
Metal Roof	Building	Steel	Factory coated per manufacturer	Gray
Exterior CMU	Building	CMU	Coating System 305	Clear
Interior CMU	Building	CMU	None	

NOTES: 1.Fusion bonded epoxy [ANSI/AWWA C213] can be substituted for coal tar epoxy. Potable water epoxy, NSF approved, shall be used for all surfaces in contact with potable water or untreated pumped raw water from wells.

2. Buried ductile iron piping coating is per Section 33 11 10, Water Utility Distribution and Transmission Piping.

END OF SECTION

SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 GENERAL

1.1 SUMMARY

A. Work under this Section includes requirements to furnish and install, complete, portable fire extinguishers.

B. Section includes:

1. Fire extinguishers

1.2 SUBMITTALS

A. Manufacturer, catalog data for each item including certifications and mounting information.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original, unopened protective packaging.

B. Store and handle products in accordance with manufacturer's instructions to protect them from damage.

PART 2 PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

A. General

1. All Extinguishers:

a. UL listing
b. Charged and ready for service

2. Provide heavy-duty brackets with clip-together strap for wall mounting.

3. Manufacturers: Products of the following, or equal, meeting these Specifications, may be used on this Project:

a. Amerex Corp.
b. Ansul Co.
c. General Fire Extinguishing Corp.
d. J.L. Manufacturing Co.

e. Kiddle Belleville
f. Larsen's Manufacturing Co.
g. Modern Metal Products
h. Potter-Roemer, Inc.
i. W.D. Allen Manufacturing Co.

B. Multi-Purpose Hand Extinguisher (F. Ext-1)

1. Tri-class dry chemical extinguishing agent.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.
6. Minimum UL Rating: 4A-60B:C, 10-pound (4.5-kilogram) capacity.

PART 3 EXECUTION

3.1 INSTALLATION

A. Portable Fire Extinguishers

1. Provide at locations shown on Drawings.

2. Mount hangers securely in position, in accordance with manufacturer's recommendations.

3. Top of Extinguisher: No more than 5 feet (1.5 meters) above the floor.

END OF SECTION

SECTION 11 05 00 - COMMON WORK RESULTS FOR EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing and operation of equipment and appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.

B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise specified or shown.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All equipment, products and their installation shall be in accordance with the following standards, as applicable and as specified in each section of these specifications:

1. ASTM International (ASTM)
2. American Public Health Association (APHA)
3. American National Standards Institute (ANSI)
4. American Society of Mechanical Engineers (ASME)
5. American Water Works Association (AWWA)
6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
7. American Welding Society (AWS)
8. National Fire Protection Association (NFPA)
9. Federal Specifications (FS)
10. National Electrical Manufacturers Association (NEMA)
11. Manufacturer’s published recommendations and specifications
12. Oregon Occupational Safety and Health Division (OR-OSHA)

B. The following standards have been referred to in this Section of the specifications.

1. ASTM International:

a. ASTM A48 - Specification for Gray Iron Castings.

b. ASTM A108 - Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.

2. American National Standards Institute (ANSI):

a. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.

b. ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys.

c. ANSI B46.1 - Surface Texture.

d. ANSI S12.6 - Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors.

3. American Society Mechanical Engineers (ASME):

a. ANSI/ASME B1.20.1 - General Purpose Pipe Threads (Inch).
b. ANSI/ASME B31.1 - Power Piping.

4. American Water Works Association (AWWA):

a. AWWA C206 - Field Welding of Steel Water Pipe.

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Furnish complete shop drawings for all equipment specified in the various sections, together with all piping, valves, and controls for review by the ENGINEER.

2. Include calculations showing equipment anchorage forces and the capacities of the anchorage elements where required.

C. Special Tools:

1. Supply one complete set of special tools where necessary for the assembly, adjustment, and dismantling of the equipment.

2. Tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal.

D. Spare Parts:

1. Obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment.

2. Furnish the name, address and telephone number of the nearest distributor for each piece of equipment.

3. Spare parts shall be supplied when indicated in the appropriate equipment specification sections.

E. Torsional and Lateral Vibration Analysis:

1. Where required by the individual equipment sections, provide a torsional and lateral vibration analysis of the equipment, in accordance with Section 01 13 00, Submittals.

2. Equipment shall be designed and constructed such that the natural frequency of the drive train is avoided by a minimum of 25 percent throughout the entire operating range.

3. Analysis shall be performed by a specialist experienced in this type of work and approved by the Engineer.

a. The specialist, or their assigned representative who shall similarly be experienced in this type of work and who shall be approved by the Engineer, shall visit the Site during startup and testing of the equipment to analyze and measure the amount of equipment vibration, certify that the operating frequency avoids the natural frequency by 25 percent, and make a written recommendation for keeping the vibration at a safe limit.

1.4 QUALITY ASSURANCE

A. Demonstrate all equipment meets the specified performance requirements. Provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment, who shall visit the Site to perform the following tasks:

1. Assist the Contractor in the installation of the equipment.

2. Inspect, check, adjust if necessary, and approve the equipment installation.

3. Start-up and field-test the equipment for proper operation, efficiency, and capacity.

4. Perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the ENGINEER.

5. Instruct the OWNER's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.

B. The costs of all inspection, startup, testing, adjustment, and instruction work performed by said factory-trained representatives shall be borne by the Contractor. When available, the Owner's operating personnel will provide assistance in the field testing.

C. Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts.

D. The type of finish shall be the most suitable for the application and shall be in accordance with ANSI B46.1.

E. Unless otherwise noted, all equipment furnished shall have a record from the same manufacturer of at least 3 years successful, trouble-free operation in similar applications.

1.5 DELIVERY, HANDLING, AND STORAGE

A. All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage.

B. Each item of equipment shipped shall have a legible identifying mark corresponding to the equipment number shown or specified for the particular item.

C. All equipment shall be protected from exposure to corrosion and shall be kept thoroughly dry at all times.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Hearing Protection:

1. At each high noise level location, where equipment produces noise exceeding 85 dBA at 3 feet or exceeding OSHA noise level requirements for operator safety, supply two pairs of high attenuation hearing protectors.

2. Ear protectors shall meet the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz.

3. Hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband.

4. Protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the CONTRACTOR and mounted in an approved location near the noise producing equipment.

B. Welding:

1. Unless otherwise specified or shown, all welding shall be by the metal arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS.

2. Qualification of welders shall be in accordance with the AWS Standards governing same.

C. Protective Coatings:

1. All equipment shall be painted or coated in accordance with Section 09 90 00, Painting and Coating, unless otherwise indicated.

2. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil.

3. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

D. All equipment subject to vibration shall be provided with restrained spring type vibration isolators or pads per manufacturer's written recommendations.

E. Shop fabrication shall be performed in accordance with the Specifications and the Engineer-approved shop drawings.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Design Loads:

1. All equipment supports, anchors, and restraint shall be adequately designed for static, dynamic, wind, and seismic loads.

2. The design horizontal seismic force shall be the greater of that noted in the general structural notes or as required by the governing building code (10 percent of gravity minimum).

B. Equipment foundations shall be as per manufacturer's written recommendations.

C. All equipment shall be mounted as shown on the manufacturer's standard details, unless otherwise shown or specified.

2.3 PIPE HANGERS, SUPPORTS, AND GUIDES

A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment.

2.4 FLANGES AND PIPE THREADS

A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125 or B16.5, Class 150, unless otherwise shown.

B. All pipe threads shall be in accordance with ANSI/ASME B1.20.1 and with requirements of Section 40 05 13, Common Work Results for Process Piping.

2.5 COUPLINGS

A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, three-piece spacer couplings or universal type couplings for extended shafts shall be installed.

B. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.

D. Where universal type couplings are shown, they shall be equipped with grease fittings.

2.6 BEARINGS

A. Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association (AFBMA).

B. All field-lubricated type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

C. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

D. Except where otherwise specified or shown, all bearings shall have a minimum B-10 life expectancy of 5 years or 20,000 hours, whichever occurs first.

E. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the manufacturer. Split type housings may be used to facilitate installation, inspection, and disassembly.

F. Sleeve type bearings shall have a Babbitt or bronze liner.

2.7 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA and RMA standards.

B. Unless otherwise specified, sheaves shall be machined from the finest quality gray cast iron.

C. All sheaves shall be statically balanced. In applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 feet per minute (fpm) may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper-lock or QD bushings as required.

E. Finish bored sheaves shall be furnished complete with keyseat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.8 GASKETS AND PACKINGS

A. Gaskets shall be in accordance with the requirements of Section 40 05 13, Common Work Results for Process Piping.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron type “V” packing shall be Garlock No. 432, John Crane “Everseal” or equal.

C. Packing around rotating shafts (other than valve stems) shall be “O” rings, stuffing boxes or mechanical seals, as recommended by the manufacturer and approved by the ENGINEER.

D. Refer to Section 43 21 52 for well pump seals.

2.9 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location.

B. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

PART 3 EXECUTION

3.1 WELDING

A. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions.

B. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed.

C. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions.

D. All sharp corners of material to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3.2 COUPLINGS

A. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

B. Installation shall be per equipment manufacturer's printed recommendations.

3.3 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate all necessary space and structural requirements, clearances, utility connections, signals, and outputs with his subcontractors.

B. If the packaged system has any additional features other than specified, the Contractor shall coordinate such features and furnish all material and labor necessary for a complete installation, as required by the manufacturer, at no additional cost to the Owner.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING AND VALVES

PART 1 GENERAL

1.1 SCOPE

This section covers the work necessary to furnish materials, labor equipment and services necessary to provide all domestic water piping, valves and equipment as shown on the drawings and specified herein.

1.2 QUALITY ASSURANCE

Install plumbing to meet requirements of local and states codes and provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

1.3 SUBMITTALS

Submittals shall include manufacturer's certificate of conformance; certified copies of test reports; documentation on piping; layout drawings showing type, spacing, maximum loads and materials for hangers and supports and manufacturers warranty statements.

PART 2 PRODUCTS

2.1 PIPING

A. Domestic water piping above ground, unless specified elsewhere, shall be Type "L", hard drawn, conforming to ASTM B88.

B. Domestic water piping underground, under floor slabs, or cast in concrete shall be Type "K".

C. Connections of copper tubing to steel or other metallic piping shall be made using insulating couplings or fittings that provide complete electrical isolation.

D. Flexible Water Heater Connectors: Corrugated seamless copper tubing with dielectric insulator; sweat or threaded connection

E. Polyvinyl Chloride (PVC) Water Pipe and Fittings: PVC pipe 4 inches and smaller shall be solvent welded, unless otherwise indicated on the Drawings. Pipe shall be schedule 40, Type 1 Grade I normal impact PVC pipe conforming to ASTM D1785 and D2467 and, unless schedule 80 pipe is indicated on the Drawings.

F. Flexible Plastic Tubing -- Flexible plastic pipe shall be standard weight polyethylene thermoplastic tubing conforming to ASTM D-1248 Type 1, Class A, Category 4, Grade E5

G. No galvanized steel pipe or fittings shall be used in this facility.

2.2 PLUMBING VALVES

A. Ball Valves 2 inches and under: Ball valves 2 inches and under shall be 400 lb. WOG with bronze body and trim, TFE seat ring, and fluorocarbon O-ring seals. The valve shall be of three-piece construction so that maintenance can be performed without disturbing the valve body after installation. Valves shall be Nibco T-590-Y or equal.

B. Globe Valves, Two (2) inches and Smaller: Type 2, Class 150 bronze globe valves with nonmetallic disc and union-ring bonnet. Manufacturers:

1. Crane Company; Crane Valve Group; Crane Valves
2. Crane Company; Crane Valve Group; Jenkins Valves
3. Crane Company; Crane Valve Group; Stockham Valves
4. Grinnell Corporation
5. Hammond Valve
6. Milwaukee Valve Company
7. NIBCO Inc.
8. Red-White Valve Corp.

C. Swing check valves 2 inches and under: Swing check valves 2 inches and under shall be Y-pattern check style and have a body constructed of 85-5-5-5 bronze conforming to ASTM B62. Check valves shall be capable of functioning in the vertical position. Swing check valve connections shall be standard threaded or threaded for fire hose connection where shown on plans. Check valves 4 inches and under shall be red-white Toyo, or approved equal.

D. Double check valve assemblies shall meet the requirements of the latest edition of AWWA Standard C-510, Double Check Valve Backflow Prevention Assembly, as modified herein. Unless otherwise noted on the drawings, the assembly shall be equipped with NRS resilient seated flanged shutoff valves.

E. Reduced-Pressure Backflow Preventers: Reduced-pressure assemblies ¾-inch through 2-inch shall consist of a differential pressure relief valve located between two independently acting "Y" pattern check valves, two full ported ball valve shut-offs and four test cocks. Mainline valve body and caps, including relief valve body and cover, shall be bronze. Check valves shall be center stem guided. All seat discs shall be reversible. The relief valve shall have a removable seat ring. Assemblies shall be certified in compliance with ASSE 1013, AWWA C511-89, and CAN/CSA B64.4, and

should be approved by the Oregon Health Administration. The reduced-pressure assembly shall be Febco Model 825Y, or approved equal

F. Pressure-Reducing and Relief Valves, 2 inches and under: Pressure-reducing and relief valves 2-inches and under shall be of the spring-loaded diaphragm type with a minimum pressure rating of 250 psi, bronze body, nickel alloy or stainless steel seat and threaded ends. These valves are limited to use in interior plumbing systems. Manufacturers:

1. A.W. Cash Valve Mfg. Corp
2. Fisher Controls Company
3. Mueller Company
4. Masoneilan
5. Watts Regulator Company
6. Wilkins Regulator
7. or approved equal

G. Water Hammer Arresters

1. In-Line, factory-sealed shock arresters with direct action bellows and screwed connections: Provide an isolation valve upstream of each water hammer arrester.

2. J. R. Smith Hydrotrol, or equivalent of Wade, Josam or Zurn: Sizes selected to suit the number of fixture units and the piping length, in accordance with PDI certification with allowance for the piping lengths.

PART 3 EXECUTION

3.1 INSTALLATION AND APPLICATION OF PLUMBING PIPING AND SPECIALTIES

A. Connection of copper tubing to steel or other metallic piping shall be made using insulating couplings or fittings such as to provide complete electrical isolation.

B. Care shall be taken that copper tubing or fittings are not permitted to come in contact with steel or other metallic piping, reinforcing steel, or other steel at any location.

C. Electrical checks shall be made between copper tubing and metallic elements to assure that isolation is maintained. Wherever electrical contact is demonstrated by such tests, the CONTRACTOR shall locate the point or points of contact and correct this condition.

D. The CONTRACTOR shall coordinate the work of roughing-in, wall and floor sleeves, pipe inserts, cutting of roof and floor construction to receive piping. Pipes below ceilings shall be held as high as possible without interfering with other trades.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER SPECIALTIES

PART 1 GENERAL

1.1 SCOPE

A. This section covers the work necessary to furnish materials, labor, equipment and services necessary to provide domestic water specialties as shown on the drawings and specified herein.

1.2 QUALITY ASSURANCE

Install plumbing to meet requirements of local and state codes and provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

1.3 SUBMITTALS

Submittals shall include manufacturers certificate of conformance; certified copies of test reports; documentation on plumbing fixtures; fabrication drawings for roof flashing and counterflashing; layout showing type, spacing, maximum loads and materials for hangers and supports and manufacturer's warranty statements.

PART 2 PRODUCTS

2.1 PLUMBING SPECIALTIES

A. Hose Bibbs and Hydrants

1. General: All hose bibbs and hydrants in exposed locations subject to freezing shall be of the non-freeze type. Where hose bibbs are connected to a non-potable water supply, they shall be provided with plastic or stainless steel warning signs "DO NOT DRINK," in clearly-legible letters and permanently attached at the hose bibb. Where shown, hose bibbs shall be provided with vacuum breakers as furnished by Crane Co.; American Standard; or equal.

2. Manufacturers, or Equal

   a. Non-Freeze Post-Type: Exposed bronze hydrant, post-type, depth of bury to suit local conditions, minimum 3 feet.

      1) Josam Mfg. Co., Series 71700
      2) J. R. Smith Mfg. Co., Series 5910
      3) Zurn Industries, Inc., Fig. Z-1385 or 1390
      4) Or approved equal.

b. Non-Freeze Wall-Type: Heavy-duty bronze hydrant with nickel-bronze face, stainless steel hinged cover, stainless steel recessed box and key. Length to suit wall. Zurn Industries, Inc., Fig. Z-1300-SS, or approved equal.

B. Wall-Mounted Hose Racks

The CONTRACTOR shall install wall-mounted hose racks at locations shown. Racks shall be of all welded steel construction, of minimum 8-gage sheet steel, hot dip galvanized after fabrication, and shall have a capacity to hold 100 feet of 3/4-inch or 1-1/2-inch hose.

C. Strainers (Metal Body)

1. Equipment Requirements: Strainers shall be of the Y-pattern or basket type with flush connections, bronze bodies and screwed ends for sizes 3-inch and smaller; and cast iron with flanged ends for sizes greater than 3-inch. They shall be designed for not less than 250 psi working pressure in sizes 3-inch and smaller, and 125 psi working pressure in sizes over 3-inch. Strainers shall be of the same size as the entering pipe and the screens shall have a free area of not less than three times the cross-sectional area of the pipe.

2. Screens: Unless otherwise indicated or required by the service fluid, the screen shall be of Type 316 stainless steel or monel construction, easily-removable, with the following mesh or perforations:

Strainer Size	Size of Perforations
1/4- through 2-inch	20 mesh
2 1/2- through 5-inch	20 mesh
6- through 8-inch	1/8-inch diameter
over 8-inch	3/16-inch diameter

3. Strainers shall be Spriax-Sarco, Type BT and IF-125, or equal:

D. Pressure Gauges

Pressure gauges shall be 3-1/2 inch diameter with stainless steel case, polycarbonate glass window, stainless steel movement, blowout disc and 1/4-inch NPT stainless steel lower connection. Gauges shall be Ashcroft Type 1009, glycerine-filled, or approved equal. Supply gauges complete with 1/4-inch Type 1095 stainless steel gauge cock and Type 11125 pressure snubber of porosity designation E.

The CONTRACTOR shall select the range of the pressure gauge such that under normal operating conditions the gauge will read from 40 to 70 percent of full scale.

E. Displacement-Type Water Meters, 2-inches and Smaller

AWWA C700 nutating-disc totalization meter with bronze case, threaded end connections, and 150-psig minimum working pressure rating. Registration in gallons or cubic feet, as required by OWNER. Manufacturers: Sensus SRII

2.2 INSULATION

A. All hot and cold water piping valves and fittings and vent piping shall be provided with one-inch thick insulation.

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. Fittings and valves shall be covered with the same material as the pipe, cut in segments to fit snugly without open spaces, held in place with copper wire or cement, and then covered with the same jacketing material as the pipe. 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. 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. All insulation shall be covered with smooth aluminum weatherproof metal or plastic performed 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 Type 3003 aluminum or stainless steel.

E. Manufacturers, or Equal

1. Armstrong Contracting and Supply Corporation
2. Certain-Teed Corporation
3. Manville
4. Owens-Corning Fiberglass Corporation

5. PPG Industries, Inc.

PART 3 EXECUTION

3.1 FIXTURE INSTALLATION

A. The CONTRACTOR shall provide chrome-plated rigid or flexible supplies to fixtures with angle stops, reducers and escutcheons.

B. All fixtures shall be installed and secured in place with wall supports, wall carriers, floor carriers and bolts.

C. Fixtures shall be sealed to wall and floor surfaces with sealant as indicated in Section 07 92 00, Sealants and Caulking. Color shall match fixture.

3.2 PLUMBING SPECIALTIES INSTALLATION AND APPLICATION

A. The CONTRACTOR shall coordinate the work of roughing-in, wall and floor sleeves, pipe inserts, cutting of roof and floor construction to receive pipes to required invert elevations. Pipes below ceilings shall be held as high as possible without interfering with other trades.

B. The CONTRACTOR shall install all plumbing specialties in accordance with manufacturer's printed instructions to permit intended performance.

3.3 PIPING INSULATION INSTALLATION

Piping insulation shall be installed in strict conformance with the manufacturer's recommendations.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.

2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.

3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.

4. National Environmental Balancing Bureau (NEBB):

   a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

   b. Procedural Standards for Measuring Sound and Vibration.

5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.2 SUBMITTALS

A. Informational Submittals:

1. Documentation of experience record of testing authority.

2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.

3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.

4. Written verification of calibration of testing and balancing equipment.

5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.3 QUALITY ASSURANCE

A. Air Balancing and Vibration Test Agency Qualifications: Have a proven record of at least five similar projects.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide materials, tools, test equipment, computers, and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

PART 3 EXECUTION

3.1 GENERAL

A. Adjust and balance exhaust and supply air systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.

3.2 AIR SYSTEM ADJUSTING AND BALANCING

A. Preparation: Prior to beginning the Work, perform the following activities:

1. Review Shop Drawings and installed system for adequate and accessible balancing devices and test points.

2. Recommend to ENGINEER dampers that need to be added or replaced in order to obtain proper air control.

3. Verify proper startup procedures have been completed on the system

4. Verify controls installation is complete and system is in stable operation under automatic control.

5. Verify test instruments have been calibrated to a recognized standard and are within manufacturer's recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.

2. Lock and mark final positions of balancing dampers with permanent felt pen.

3. Adjust or correct fan and airflow measurements as required for actual cubic feet per minute measured at Site elevation.

C. Equipment Data: Collect the following data and included in final report:

1. Type of unit

2. Equipment identification number

3. Equipment nameplate data (including manufacturer, model, size, type, and serial number)

4. Motor data (frame, horsepower (hp), volts, full load amps rate per minute (FLA rpm), and service factor)

5. Sheave manufacturer, size, and bore

6. Sheave centerline distance and adjustment limits

7. Starter and motor overload protection data

8. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.

2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.

3. Adjust Fan Air Volumes:

   a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.

   b. After final adjustments, do not operate motor above nameplate amperage on any phase.

   c. After final adjustments, do not operate fan above maximum rated speed.

   d. Perform airflow test readings under simulated or actual conditions.

4. Adjust outside air dampers, supply air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.

5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.

6. Read and record motor amperage on all phases for each test condition.

E. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
2. Adjust air volumes on exhaust and supply diffusers and grilles, with allowable variation of plus or minus 10 percent.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

F. Building Static Pressure: Measure building static pressure relative to outside in perimeter entrances during normal system conditions that would yield widest range in internal building pressure. Adjust accordingly to maintain minimum of 0.05-inch water column (WC) negative pressure in the room with entrance doors closed to outside.

3.3 FIELD QUALITY CONTROL

A. Vibration Performance Testing:

1. Upon completion of air system balance, perform vibration testing for all fans except restroom fan.

2. Take measurements at each bearing housing using calibrated electronic analyzer.

3. Measure velocity in direction parallel to rotating shaft, and in two directions perpendicular to shaft and to each other. Align measurement directions where possible to the horizontal and vertical planes.

4. Record log shall include equipment symbol or tag, location, identification, specified vibration velocity limits, and maximum measured velocity in each direction.

5. Notify ENGINEER if amplitude exceeds upper limit specified.

END OF SECTION

SECTION 23 09 13 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1 SUBMITTALS

A. Action Submittals: Manufacturer's product data, catalog cut sheets, installation instructions, and operations and maintenance information for specified products.

PART 2 PRODUCTS

2.1 PRODUCTS

A. General:

1. Specification applies to motorized control dampers and motorized control damper electric motor operators, except those furnished by fan manufacturer as packaged with fan equipment.

2. Dampers shall be two-position, parallel-blade type for open-close service.

2.2 MOTORIZED CONTROL DAMPERS (MCD)

A. Industrial Duty Motorized Dampers:

1. Frame: Frame: 5 inches by 1-inch by minimum 0.125-inch (127 millimeters by 25 millimeters by minimum 3.2 millimeters) 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.

2. Blades:

a. Style: Airfoil-shaped, single-piece.

b. Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.

c. Material: Heavy duty 6063-T5 extruded aluminum.

d. Width: Nominal 6 inches (152 millimeters).

3. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.

4. Seals:

    a. Blade Seals: Extruded neoprene type for ultra-low leakage from minus 72 to 275 degrees Fahrenheit (F) (minus 58 to 135 degrees Celsius (C)). Mechanically attached to blade edge.

    b. Jamb Seals: Flexible metal compression type.

5. Linkage: Concealed in frame.

6. Axles:

    a. Minimum 1/2-inch (13 millimeters) diameter, hex-shaped, mechanically attached to blade.

    b. Material: Galvanized steel.

    c. Coordinate number of axles with the required number of actuators such that one axle is provided for each actuator. Multiple actuator on a single axle is not allowed.

7. Performance Data:

    a. Temperature Rating: Withstand minus 72 to 275 degrees F (minus 58 to 135 degrees C).

    b. Capacity: Demonstrate capacity of damper to withstand ventilation system operating conditions.

    c. Closed Position: Maximum pressure of 13 inches water gauge (w.g.) (3.2 kilopascal (kPa)) at 12-inch blade length (305).

    d. Open Position: Maximum air velocity of 6,000 feet per minute (1,829 meter per minute).

    e. Leakage: Maximum 5.2 cubic feet per minute per square foot (0.6 cubic meter per minute per square meter) at 4 inches w.g. (1 kPa) for size 48 inches by 48 inches (1219 by 1219 millimeters).

    f. Pressure Drop: Maximum 0.03-inch w.g. (0.01 kPa) at 1,500 feet per minute (457 meters per minute) across 24-inch by 24-inch (610 by 610 millimeters) damper.

8. Accessories:

    a. Actuator: Refer to Article Motorized Control Damper Electric Motor Operators, for requirements.

b. Flange Frame: 1-1/2 inches (38 millimeters), roll formed as part of frame, double configuration.

c. Factory Sleeve: Minimum 20-gauge (1-millimeter) thickness, minimum 12-inch (305-millimeter) length.

d. Duct Transition Connection: Size and shape to mate with ductwork as shown on Contract Drawings.

9. Manufacturers and Products:

a. Ruskin; Model CD-50
b. American Warming and Ventilating
c. TAMCO

2.3 MOTORIZED CONTROL DAMPER ELECTRIC MOTOR OPERATORS

A. General:

1. Provide electric operators for motorized dampers.

2. Contract Drawings show only one motor per motorized damper. Select actual quantity of motors required to operate each damper in accordance with size of damper provided.

3. Coordinate exact quantity of damper motors with electrical work including sizing of electrical power supplies to ensure that necessary power, wiring, and conduit is provided for complete installation.

B. Electric Damper Operators:

1. Performance:

a. 24-volt (V) direct current (dc), two-position
b. Spring return
c. Fail Position: Damper Open

2. Mounting: External side plate

3. Ample power to overcome friction of damper linkage and air pressure acting on damper blades.

4. Furnished with external adjustable stops to limit stroke.

5. Operating Torque:

    a. Provide multiple independent damper sections, each with separate actuator, as needed to provide minimum of 120 percent of operating torque required by damper(s).

    b. Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 1-inch water column (WC) air pressure on damper blades. Operating torque shall be minimum of 7-inch-pounds per square foot of damper area for parallel blade dampers.

6. Manufacturers:

    a. Belimo
    b. Siemens Building Technologies
    c. Johnson Controls
    d. Honeywell

2.4 ELECTRIC THERMOSTATS

A. Room Thermostat for Process Spaces:

1. Two-position electric type for cooling applications
2. Temperature Scale: 0 to 125 degrees F, dial type gauge
3. External adjustments
4. Adjustable sensitivity
5. Insulating back where exterior wall mounting is indicated
6. Locking wire protective guard

PART 3 EXECUTION

3.1 INSTALLATION

A. Motorized Control Dampers:

1. Install at motorized control damper locations indicated on Contract Drawings and in accordance with manufacturer’s instructions.

2. Install square and free from racking with blades running horizontally.

3. Bracing:

    a. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

    b. Install at every horizontal and vertical mullion.

B. Motorized Control Damper Electric Motor Operators:

1. Install quantity of electric operators required for each motorized damper, whether or not all motors are shown on Contract Drawings.

2. Install operators in accordance with manufacturer's instructions.

3. Coordinate installation of operators with all trades to avoid interference with architectural features, structural members, and electrical lighting.

4. Electrical work shall include all wiring and conduit required for a complete installation of each motorized damper and shall be provided as part of the work of Division 26, Electrical.

END OF SECTION

SECTION 23 34 00 - HVAC FANS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Acoustical Society of America (ASA)
2. Air Movement and Control Association International (AMCA)
3. American Bearing Manufacturers Association (ABMA)
4. ASTM International (ASTM)
5. National Electrical Manufacturers Association (NEMA)
6. Occupational Safety and Health Act (OSHA)
7. Underwriters Laboratories Inc. (UL)

1.2 SUBMITTALS

A. Action Submittals: Provide for all products specified, as follows:

1. Unit tag number or equipment identification as referenced in Contract Documents.

2. Manufacturer's name and model number.

3. Descriptive specifications, literature, and drawings.

4. Dimensions and weights.

5. Fan sound power level data (reference 10 to power minus 12 Watts) at design operating point.

6. Fan Curves:

    a. Performance Curves Indicating:

        1) Relationship of flow rate to static pressure for various fan speeds.

        2) Brake horsepower curves.

        3) Acceptable selection range (surge curves, maximum revolutions per minute, etc.).

        4) Static pressure, capacity, horsepower demand, and overall efficiency required at the duty point, including drive losses.

7. Capacities and ratings.

8. Construction materials.

9. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.

10. Wheel type, diameter, revolutions per minute, and tip speed.

11. Motor and Power Data.

12. Manufacturer's standard vibration isolation accessories.

13. Factory finish system.

B. Informational Submittals:

1. Recommended procedures for protection and handling of products prior to installation.

2. Manufacturer’s installation instructions, including seismic anchorage and bracing requirements.

3. Factory test reports.

4. Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 FAN DRIVES

A. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.

B. Shaft Guard:

1. Provide shaft guard for each fan and drive not housed in its own fan enclosure.

2. Shaft guards shall be easily removable and enclose entire drive assembly, meeting federal and OSHA requirements.

3. Guard faces shall be constructed of expanded metal having minimum 60 percent free area for ventilation.

2.2 FINISHES

A. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.

1. Parts cleaned and chemically pretreated with a phosphatizing process.
2. Alkyd enamel primer.

3. Air-dry enamel topcoat.

B. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

C. Stainless Steel Parts: Finished smooth and left unpainted.

2.3 DIRECT DRIVE ROOF-MOUNTED DOWNBLAST FANS

A. General Description:

1. Fan arrangement shall be exhaust, see Fan Schedule

2. Sidewall mounted applications

3. Maximum continuous operating temperature 130 Fahrenheit (F) (54.4 Celsius (C))

4. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

B. Wheel:

1. Propeller shall be aluminum blade riveted to steel hub

2. A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft

3. Statically and dynamically balanced in accordance with AMCA Standard 204-05

4. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

C. Motors:

1. Motor enclosures: Totally enclosed fan cooled

2. Motors are permanently lubricated, sleeve bearing type on sizes 8-12 and ball bearing type on sizes 14-24 to match with the fan load and furnished at 120 voltage and single phase

3. Accessible for maintenance

D. Drive Frame:

1. Drive frame assemblies and fan panels shall be galvanized steel.

2. Drive frame shall have welded wire or formed channels and fan panels shall have pre-punched mounting holes, formed flanges, and a deep formed one-piece inlet venturi.

E. Disconnect Switches:

1. NEMA rated: 4X

2. Positive electrical shut-off

3. Wired from fan motor to junction box

4. Dampers:

a. Type: Gravity
b. Prevents outside air from entering back into the building when fan is off
c. Balanced for minimal resistance to flow
d. Galvanized frames with pre-punched mounting holes

5. Dampers Guards:

a. Guard material: Galvanized

b. Shall completely enclose the damper or wall opening on the discharge side of the fan.

F. Manufacturers and Products:

1. Greenheck; series G
2. Or approved equal

2.4 MOTORS

A. General:

1. Provide integral self-resetting overload protection on single-phase motors.
2. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Electrically commutated, permanent magnet type
2. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily
3. Solid state electronics
4. Shaft Type: Solid, carbon steel
5. Mounting: As required for fan arrangement

2.5 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved or die-stamped block type equipment identification number and letters indicated in this Specification and as shown on Drawings. All units shall include factory installed permanently attached nameplate displaying unit model and serial number.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fans level and plumb.

B. Labeling: Label fans in accordance with Article Accessories.

C. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

D. Connections:

1. Refer to Section 23 31 13, Metal Ducts and Accessories.
2. Isolate duct connections to fans.
3. Install ductwork adjacent to fans to allow proper service and maintenance.

3.2 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.

2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.

3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.

4. Verify that cleaning and adjusting are complete.

5. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.

6. Verify lubrication for bearings and other moving parts.

7. Verify manual and automatic volume control and dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:

a. Energize motor and adjust fan to indicated revolutions per minute.
b. Measure and record motor voltage and amperage.

2. Operational Test:

a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.

c. Test and adjust control safeties.

d. Replace damaged and malfunctioning controls and equipment.

3.3 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

END OF SECTION

SECTION 23 82 00

ELECTRIC UNIT HEATERS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Moving and Conditioning Association (AMCA): 300, Reverberant Room Method for Sound Testing of Fans

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1 IP/SI, Energy Standard for Buildings, Except Low-Rise Residential Buildings.

3. ASTM International (ASTM):

   a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

   b. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

4. Electrical Test Laboratories (ETL).

5. National Electrical Manufacturer's Association (NEMA).

6. National Fire Protection Association (NFPA):

   a. 70, National Electrical Code (NEC).
   b. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

7. Sheet Metal and Air Conditioning Contractors' National Assoc., Inc. (SMACNA): Ducted Electric Heat Guide for Air Handling Systems.

8. Underwriters Laboratories Inc. (UL): Product Directories.

1.2 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.

5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. PSC: Permanent Split Capacitor.
9. SWSI: Single Width, Single Inlet.
10. TEFC: Totally Enclosed, Fan Cooled.
11. UV: Ultraviolet
12. XP: Explosion Proof.

1.3 SUBMITTALS

A. Action Submittals:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for each unit.

2. Manufacturer's standard dip-applied protective coating and finish color product data.

B. Informational Submittals:

1. Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 ELECTRIC UNIT HEATER (EUH)

A. Characteristics:

1. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.

2. UL listed.

3. Meet requirements of National Electrical Code.

4. Three phase heaters shall have balanced phases.

5. Casing:

a. Heavy gauge steel casing.
b. Baked enamel finish.
c. Individual adjustable discharge louvers.
d. Protective air inlet louvers or fanguards.

6. Heating elements shall be one of the following types:

    a. Aluminum finned, copper clad, steel sheath.

    b. High mass, all steel tubular finned type, copper brazed, in fixed element banks.

    c. Nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.

    d. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.

    e. Corrosion-resistant steel fins brazed to tubular heating elements.

7. Fan and Motor:

    a. Totally enclosed motor.
    b. Direct drive fan.
    c. Sealed bearings. Permanently lubricated.

8. Controls:

    a. Thermal overload protection with automatic reset.

    b. Controls, transformers, and contactors shall be factory assembled, except wall mounted thermostats.

9. Installation: Wall mounted or suspended from ceiling. Refer to Contract Drawings.

B. Accessories and Features: Provide as follows:

1. Airflow discharge shall be horizontal.

2. Electrical Disconnect: NEMA 4.

3. Voltage: As indicated in Schedule.

4. Wall or ceiling mounting bracket.

5. Thermostat: Adjustable, integral to unit, low voltage with a minimum temperature range of 40 degrees F to 85 degrees F.

C. Manufacturers and Products:

1. Qmark; Type MUH.
2. Chromalox, LUH
3. Approved Equal

2.2 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.

2. Control voltage to indoor unit fan shall be 24 volts.

3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.

4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Unless otherwise stated, electric motors shall comply with the following:

a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.

b. Enclosure: ODP, unless specified otherwise.

c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.

d. Winding Thermal Protection: Manufacturer's standard.

e. Space Heater: Manufacturer's standard.

f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer's standard.

2.3 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved or die-stamped block type equipment identification number and letters as shown on the Contract Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in strict compliance with manufacturer's instructions. Maintain clearances around unit as listed in manufacturer's recommendations.

B. Bottom of unit shall be a minimum of 7 feet above finish floor, unless indicated otherwise.

C. Heater shall be permanently mounted in position indicated with a fixed power supply.

D. Install so obstructions do not block heater air inlet or outlet.

END OF SECTION

SECTION 26 05 00 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1 GENERAL

1.1 SUMMARY

A. Scope.
B. Definitions.
C. Reference Standards.
D. Quality Assurance.
E. Submittals.
F. Drawings.
G. Project Site Conditions.
H. Equipment Coordination.
I. Basis of Design.
J. Products.
K. Execution – General.
L. Testing.

1.2 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 relationships 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 REFERENCE STANDARDS

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
NECA-1	National Electrical Contractors Association – Standard Practices for

NFPA-70 NFPA-70E	Good Workmanship in Electrical Contracting National Electrical Code (NEC) Electrical Safety in the Workplace
IBC OAR	International Building Code Oregon Administrative Rules

1.5 QUALITY ASSURANCE

A. 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 Oregon Administrative Rules regulations concerning Listing requirements for electrical equipment.

B. 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.

C. DELIVERY AND STORAGE:

1. Delivery and storage per Section 01 66 00.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. 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.

    a. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

4. Interconnection diagram: The Contractor shall prepare interconnection diagrams depicting all cable requirements together with their actual terminations as specified.

5. 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 the project.

    b. For changes to the layouts shown on the contract documents, provide engineering design and calculations signed and sealed by a Professional Engineer registered in State of Oregon. Engineering design and calculations shall demonstrate that the proposed layout does not impair or significantly reduce the design structural strength.

6. Safety disconnect switch list including legend with equipment tag, equipment description, and power feeder circuit source and location information.

1.7 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 in AutoCAD 2020. 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.

1.8 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: The drawings show which areas are designated as hazardous (classified) in accordance with the NEC, NFPA 820.

C. SEISMIC: Electrical equipment supports, and anchorage shall be designed and installed in accordance to Section 01 73 23.

1.9 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: 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.

1.10 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.)

1.11 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

1.12 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 NEC 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 25 and 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.

1.13 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.

1.14 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. 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.

4. 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 into equipment and other termination points or bussing on the load side of the main breaker.

5. 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.

a. 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 jumpers 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 disconnect, 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.

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 as specified in Section 09 90 00.

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 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. 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.

E. 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: The Installed Motor Test Form, provided in 25 08 00 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 19 - LOW-VOLTAGE CONDUCTORS, WIRES AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions.
5. Submittals.
6. Products.
7. Execution.

1.2 SCOPE

A. This section specifies cables, conductors and fibers including:

1. Stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

2. Copper cables and coax cable rated 300-volt insulation used for data, communication, and signaling.

3. Fiber optic data cable used for data communication.

1.3 REFERENCE STANDARDS

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.

1. 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 Detection (CSMA/CD Access Method and Physical Layer Specifications
IEEE 802.3k	Supplement to ISO/IEC 8802-3, Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications: Layer Management for 10 Mb/s Baseband Repeaters
IEEE 802.4	Information Processing Systems--Local Area Networks--Part 4: Token-Passing Bus Access Method and Physical Layer Specifications
ANSI/NFPA 72	Installation, Maintenance, and Use of Protective Signaling Systems
ANSI/NFPA 72H	Testing Procedures for Signaling Systems

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from the date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 DEFINITIONS

A. LOW LEVEL ANALOG: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.

B. 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.

C. PULSE FREQUENCY: Counting pulses such as those emitted from speed transmitters.

D. HIGH LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mA transmission.

E. 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.

F. 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.

G. LOW VOLTAGE CONTROL: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

H. HIGH LEVEL AUDIO SIGNALS: Audio signals exceeding plus 4 dBm, including loudspeaker circuits.

I. RADIO FREQUENCY SIGNALS: Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

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. 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 MANUFACTURERS

A. Approved manufacturers are listed in the Cable Specification Sheets located at the end of this specification section.

2.2 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.

2.3 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 (-)	--	--	Gray
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.

2.4 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.

2.5 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.

2.6 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.

2.7 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).

2.8 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.

2.9 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 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

3.6 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

3.7 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.
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:	Individual 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 ASTM 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 5e, 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 1752A, Okonite, or approved equal.
Uses Permitted:	Conduit. Execution:
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 5e, 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 1533R, 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 $\pm$ 0.7 μm
Coating Diameter: 245 $\pm$ 5 μm Core Diameter: 62.5 μm
Attenuation: $\leq$ 0.35 db/km @ 1310 nm
$\leq$ 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

(1) Fiber Optic cable shall be suitable for installation in conduit runs within buildings.
(2) Fiber Optic cable shall be suitable for installation between buildings in outdoor conduit runs which share vaults with 600-volt cable.
(3) The contractor shall use zip cord jumper cables between patch/breakout panels and communications equipment.
(4) Fiber shall be terminated with ST style connectors unless otherwise shown on drawings or required by the submitted equipment manufacturer.
(5) Fiber Optic cables shall have number of fibers as shown in the documents.
(6) 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 5e, 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. Reference Standards.
3. Quality Assurance.
4. System Requirements.
5. Sizing.
6. Submittals.
7. Products.
8. Execution.

1.2 SCOPE

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 REFERENCE STANDARDS

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 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

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

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 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.

1.6 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.

1.7 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:

3. Concrete Box: Christy Concrete Products, Inc. Model #B1017 or Approved Equal.

4. 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.

PART 3 EXECUTION

3.1 INSTALLATION

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.

3.2 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.

3.3 EQUPMENT 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.

3.4 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.

3.5 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.

3.6 GROUNDING SYSTEM TESTS

A. 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.

1. 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.

2. A grounding system that shows greater than 2-ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded.

3. 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.

4. 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. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution.

1.2 SCOPE

A. This Section specifies requirements for design, furnishing and installation of support systems for electrical raceways, cables and enclosures.

1.3 REFERENCE STANDARDS

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 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 A48 REV A	Gray Iron Castings
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
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 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

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. 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	316 Stainless Steel
Outdoor	316 Stainless Steel	316 Stainless Steel
Submerged	316 Stainless Steel	316 Stainless Steel
Headspace	316 Stainless Steel	316 Stainless Steel
Chemical Corrosive	316 Stainless Steel	316 Stainless Steel
Process Corrosive	316 Stainless Steel	316 Stainless Steel

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 support materials shall adhere to Table A above unless specified otherwise on the drawings.

C. 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.

3.2 INSPECTION AND CERTIFICATION

A. The Owner will provide special inspection in accordance with Section 01 73 23 for seismic restraint and bracing systems.

END OF SECTION

SECTION 26 05 33 - RACEWAYS, BOXES, AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Installation.
7. 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.

B. 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.

1.3 REFERENCE STANDARDS

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 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 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

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 material.

1.5 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 INSTALLATION:

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	Power circuits directly buried	PVC4
Underground	Instrumentation, communications and data signals directly buried	PVC4
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.
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 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions.
5. Submittals.
6. Coordination.
7. Safety Requirements.
8. Delivery Storage and Handling.
9. Products.
10. Execution.

1.2 SCOPE

A. This section includes the requirements for trenching, backfilling and installation of underground ducts and ductbanks, and the design, fabrication, delivery and installation of pull boxes, handholes, manholes and vaults. The extent and location of "Underground Ducts and Raceways for Electrical Systems" Work is shown in the Contract Documents.

1.3 REFERENCE STANDARDS

A. ASTM (American Society for Testing and Materials)
B. NFPA 70 (National Fire Protection Association) - National Electrical Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

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 DEFINITIONS

A. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, used underground, embedded in earth or concrete.

B. Ductbank: 2 or more conduits or other raceway installed underground in the same trench or concrete envelope.

C. Handhole/Pull Box: An underground structure provided with an open or closed bottom, and sized to allow personnel to reach into, but not enter, for the purpose of installing, operating or maintaining equipment or wiring or both.

D. Manhole: An underground utility structure, large enough for a person to enter, with facilities for installing, operating and maintaining submersible equipment and cables.

E. Vault: An underground structurally solid utility structure including all sides, top and bottom, where entry is limited to personal qualified to install, maintain, operate or inspect the equipment or cable enclosed. The enclosure may have openings for ventilation, personnel access, cable entrance, and other openings required for operation of equipment in the vault.

1.6 SUBMITTALS

A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

B. Submittals shall include the following:

1. Product Data:

a. Duct-bank separators and components

b. Ducts, and accessories including elbows, end bells, bends, fittings and solvent cement

c. Vault, Manholes, Handholes, Pull Boxes and accessories

d. Warning tape and planks

2. Shop drawings:

a. Precast or Factory-Fabricated Underground Utility Structures:

1) Dimensioned plans, elevations, sections, details, attachments to other work, and accessories.

2) Duct entry provisions, including locations and duct sizes.

3) Reinforcement details.

4) Frame and cover design and manhole frame support rings.

5) Ladder details.

6) Grounding details.

7) Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

b. Factory-Fabricated Handholes, and Pull Boxes Other than Precast Concrete:

1) Dimensioned plans, sections, and elevations, and fabrication and installation details.

2) Duct entry provisions, including locations and duct sizes.

3) Frame and Cover design.

4) Grounding details.

5) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

6) Details, technical data and design calculations for frames and covers.

3. Quality Assurance and Testing:

a. Qualification data and test results from tests specified in "Quality Assurance" Article. Provide all information specified.

4. Duct-Bank Coordination Drawings as specified in "Coordination" Article.

5. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.

6. Qualification Data: For Professional Engineer and testing agency responsible for testing nonconcrete handholes and boxes.

7. Inspection report for factory inspections, according to ASTM C 1037.

8. Record Documents: Show dimensioned locations of underground ducts, handholes, and manholes from nearest building or permanent structure.

1.7 COORDINATION

A. Show duct profiles and coordination with other utilities and underground structures. Include plans and sections, drawn to scale and show bends and locations of expansion fittings. Revise locations and elevations from those indicated as required to suit field conditions and ensure that duct runs drain to manholes and handholes. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of

other utilities as determined by field verification. Contractor shall coordinate all modifications with the Engineer prior to final installation.

1.8 SAFETY REQUIREMENTS

A. Comply with safety and protection requirements of Section 26 00 00 - Electrical Work – General.

B. Perform Work in accordance with the safety requirements of the Department of Labor Occupational Safety and Health Administration, Volume 36, Number 75, Part II, Subpart P, “Excavations, Trenching, and Shoring,” and with Section 7 of the Manual of Accident Prevention in Construction as published by the Association General Contractors of America, Inc.

C. Educate supervisors and employees on safety requirements and practices to be followed during the course of the Work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Precast concrete handholes and pull boxes:

a. Utility Vault/Oldcastle Precast Group.
b. Utility Concrete Products, LLC.
c. Concast.
d. Or Approved Equal.

2. Fiberglass Handholes and Boxes:

a. Carson Industries LLC.
b. Christy Concrete Products.
c. Oldcastle Precast.
d. Quazite: Hubbell Power System, Inc.

e. Or Approved Equal.

3. Precast Manholes and Vaults:

a. Utility Vault / Oldcastle Precast Company.
b. Shaw PIPE; Division of Shawcor Co.
c. American Concrete.
d. American Concrete.
e. Or Approved Equal.

4. Duct Sealing Compound:

a. Polywater.
b. Filoform.
c. Or Approved Equal.

2.2 CONDUIT AND DUCTS

A. Metallic Conduit:

1. Galvanized Rigid Steel Conduit (GRC): ANSI C80.1

2. PVC-Coated Rigid Steel Conduit: ANSI RN 1. Coating thickness shall be 0.040 inch, minimum.

B. Nonmetallic conduit: Use underground only for medium-voltage and low-voltage applications

1. Rigid Plastic Conduit: NEMA TC 2, UL 651A, Schedule 40 and Schedule 80 PVC, rated for use with 90°C conductors under all installation conditions and labeled for underground use.

2. Liquid-Tight Flexible Nonmetallic Conduit (LFNC): UL 1660.

C. Conduit Fittings:

1. Steel Fittings: Zinc-coated, cast malleable, ferrous metal, threaded fittings, with neoprene cover gasket on each fitting installed outdoors.

2. PVC Conduit and Tubing Fittings: NEMA TC 3. Provide PVC fittings for PVC conduit and suitable watertight connections where PVC conduit connects to galvanized steel conduit.

3. Seal Bushings: O.Z. compound bushing on each conduit entering a building from outside underground and on each conduit passing from one space into another, which is normally at a lower temperature.

4. Hubs: Appleton “Hub” or “Hub-U” series, Thomas & Betts “370” series, Or Approved Equal hub on each conduit terminating in a box where a hub was not previously provided.

5. Unions: Appleton Type “EC”, Thomas & Betts “Erickson Coupling” conduit unions, Or Approved Equal where necessary.

2.3 DUCT SUPPORT/SPACERS

A. Rigid PVC spacers selected to provide [3 1/2”] minimum duct spacings and concrete cover depths indicated, while supporting ducts during concrete pour. Refer to drawing details for additional duct spacing requirements.

2.4 PRECAST CONCRETE HANDHOLES AND PULL BOXES

A. Comply with ASTM C 858 for design and manufacturing processes.

B. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom. Walls and bottom shall be constructed to support rating of cover. Frame and cover shall form top of enclosure.

1. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.

b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

3. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

4. Drain hole in base, 2-inch minimum diameter.

2.5 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

1. Color: Gray.

2. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.

3. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

4. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

5. Drain hole in base, 2-inch minimum diameter.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers made of reinforced concrete or cast iron.

C. Street Lighting: Reinforced plastic mortar designed and tested to temperatures of -50°F meeting ASTM D635-91 flammability test.

2.6 PRE-CAST MANHOLES AND VAULTS (AASHTO RATED)

A. Precast Concrete Units: Interlocking, mating sections complete with accessory items, hardware, and features as indicated on Drawings. Shall be capable of supporting designed loads that are expected at the installed location. Walls and floors shall be reinforced to support rated strength of covers. Include concrete knockout panels 1-1/2 to 2 inches thick for future conduit entrances and sleeves for ground rods.

B. Design structure according to ASTM C 858.

C. Structural Design Loading: See structural for loading information.

D. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.

2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

E. Ground Rod Sleeve: Provide a 3-inch PVC conduit sleeves in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct routed from the facility.

F. Joint Sealant: Continuous extrusion of asphaltic butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand the maximum hydrostatic pressures at the installation location with the ground water level at grade.

G. Source Quality Control: Inspect structures according to ASTM C 1037. Units shall be capable of supporting specified loads.

H. Drainage:

1. Provide two holes for drainage, two-inch minimum diameter, and provide at least two feet of gravel under manhole.

2.7 CAST-IN-PLACE MANHOLES AND VAULTS

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod. Structures shall be reinforced to support designed loads that are expected at the installed location. Manhole walls and floors shall be reinforced to support rated strength of cover.

B. Structural design loading for H20.

C. Drainage:

1. Provide two holes for drainage, two-inch minimum diameter, and provide at least two feet of gravel under manhole.

2.8 FRAMES AND COVERS

A. Handhole and Pull Box Covers:

1. Uncoated gray iron meeting ASTM A48, Class 35B or ductile iron meeting ASTM A536 Class 70-50-05 or 80-55-06.

2. Reinforced concrete or weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

a. Frame and Cover shall be capable of supporting designed loads see Structural for loading information.

3. Cover:

a. Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b. Cover Handle: Recessed.

c. Cover Hinges: Concealed, with hold-open ratchet assembly.

d. Cover to include insert of other devices to facilitate lifting.

e. Cover secured by tamper-resistant locking devices similar to REA or FARGO.

f. Machine cover-to-frame bearing surfaces.

g. Cast-in legend “ELECTRICAL”, “COMM” or “LIGHTING” as appropriate. Concealed hinges, with hold-open ratchet assembly.

h. Legend: Molded lettering, as indicated for each service.

B. Manholes and Vaults

1. Frames, Covers and Ring Components: Comply with structural design loading specified for manholes and vaults. See Structural for loading information.

2. Frame and Cover: Reinforced concrete or [uncoated gray iron meeting ASTM A48, Class 35B] or [ductile iron meeting ASTM A536 Class 70-50-05 or 80-55-06] capable of supporting designed loads.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b. Provide lifting points on manhole covers.

c. Cover Legend:

1) Manhole ID welded on to cover.

a) For electrical power manholes, identification shall be “ELECTRICAL #” where # is the manhole number.

b) For telecom manholes, identification shall be “COMM #” where # is the manhole number.

3. Manhole Ring Components: Precast concrete rings with dimensions and strength matched to those of highway rated roof opening.

a. Mortar for Ring and Frame and Cover Joints: Strength to match rated cover.

b. Where required, seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.

2.9 ACCESSORIES

A. Manhole and Vault Lifting Means

1. Pulling Eyes in Walls: Eyebolt with reinforcing bar fastening insert. 2-inch diameter eye, 1-inch by 4-inch bolt. Working load with 6-inch embedment in 4000 psi concrete: 13,000 pounds minimum tension.

2. Pulling and Lifting Irons in Floor: 7/8-inch-diameter, hot-dipped galvanized, bent steel rod, stress relieved after forming, and fastened to reinforced rod. Exposed

triangular opening. Ultimate yield strength: 40,000 pounds shear and 60,000 pounds tension.

B. Bolting Inserts for Cable Stanchions: Threaded precast channel inserts of hot-dipped galvanized or stainless steel; 3'-0" on center; 1/2-inch internal diameter by 2-3/4 inches deep, flared to 1-1/4 inch minimum at base. Tested ultimate pull-out strength: 12,000 pounds minimum.

C. Expansion Anchors for Installation After Concrete is Cast: Per section 05 05 19 – Post-Installed Concrete Anchors. Zinc-plated carbon steel wedge type with stainless-steel expander clip, 1/2-inch bolt size, 5300-pound rated pull-out strength, and 6800-pound rated shear strength minimum. Cast in-place inserts not allowed unless cast by vault manufacturer.

D. Cable Rack Assemblies – heavy duty non-metallic 50% glass reinforced nylon or other non-metallic material having equal mechanical strength, thermal resistance, chemical resistance, dielectric strength and physical properties.

1. Cable Stanchions: Nominal 36 inches high by 4 inches wide, with multiple arm mounting holes and recessed bolt mounting holes.

2. Cable Arms: Arranged for secure drop in attachment in horizontal position at any location on cable stanchion, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450 lb. minimum capacity to 20 inches with 250 lb. minimum capacity. Top of arm shall be nominally 4 inches wide and shall have slots along full length for cable ties.

E. Cable Support Insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.

F. Floor Grate: 1" thick PVC or HDPE Grate approximately the size of the floor.

G. Grounding: Ground per Section 26 05 26 – Grounding.

1. Ground Rods: Ensure rods are copper bonded 3/4-inch by 10-foot minimum.

2. Ground Rod Knock Out: 3-inch knock out for installation of ground rod.

3. Ground Rod Sleeves: 3-inch PVC conduit sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.

4. Ground Wire: Stranded bare copper, #2 AWG minimum.

5. Ground connections shall be compression type connectors, bolted and clamped type.

H. Duct Sealing Compound: Non-hardening, re-enterable, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35°F. Capable of withstanding temperature of 300°F without slump, capable of withstanding minimum 22' of water, and chemically resistant to gasoline, oils, acids and bases. Adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

I. Mechanical Link Seals: for conduit entering vaults or buildings.

2.10 DUCTBACK CONCRETE

A. Material: Provide in accordance with Section 03 30 00 - Cast-in-Place Concrete and as follows:

1. Gravel: 3/8" maximum.

2. Slump: 4" maximum.

3. Compressive strength: 3,000 psi at 28 days.

4. Color: Dye ductbank concrete red.

5. Reinforcing (except when GRC is used): Steel conforming to ASTM A15. Provide #4 rebar top and bottom, 2'-0" lap at splices (4 places minimum) and #4 @ 18" on center around perimeter with 3" minimum cover.

2.11 BACKFILL MATERIAL

A. Lower Trench Portion (surrounding ductbank): Sandy silt, clay silt, sand clay or other material free of stones and conglomerates larger than 2"

B. Upper Trench Portion (one foot above ductbank up to grade): On-site backfill material consisting of rock, soil or soil-rock mixture containing no rocks or lumps over 6"

C. Controlled density fill (CDF)

1. CDF shall be a mixture of Portland cement, fly ash, aggregates, water and admixtures proportioned to provide a non-segregating, self-consolidating and free flowing material which will result in a hardened, dense, non-settling and excavatable fill. CDF shall be batched to provide a flowing, non-segregating mix with a slump between 6" and 8".

2. CDF shall be used as fill above utilities wherever non-settling backfill is required.

D. Select Native Fill: Unsaturated excavated earth free of rocks, broken concrete and debris 6” and larger, and compacted in 12” lifts to prevent settlement.

E. Reinforced Concrete Ductbanks:

1. Below Concrete Encasement: 6” minimum compacted 5/8” minus crushed rock.

2. Above Concrete Encasement: 3” minimum sand.

3. Upper Trench:

a. Areas Under Pavement: Controlled Density Fill.
b. Areas Not Under Pavement: Select Native Fill.

F. Direct-Burial Conduit

1. Initial Bedding: 3” of sand below conduits.

2. Secondary Bedding: Unsaturated excavated earth free of rocks, broken concrete and debris 2” and larger, and compacted to 6” minimum above conduits.

3. Upper Trench:

a. Areas Under Pavement: Controlled Density Fill.
b. Areas Not Under Pavement: Select Native Fill.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Existing Utilities: Locate all existing utilities in the area prior to performing any excavation.

C. Existing manholes and handholes within the construction zones shall be provided with a ¾” steel plate cover to maintain protections of the manhole lids and covers. This includes, but is not limited, to construction areas, staging areas, and haul routes.

3.2 EARTHWORK

A. Comply with OSHA/WISHA safety standards for trenching, including stable slope and shoring requirements.

B. Depth: Refer to Drawings for trench depth requirements. Correct points of over-excavation using mechanically-compacted backfill to form a smooth trench bottom. Minimum cover according to NEC or Port Standards whichever is more stringent.

C. Width: Excavate to minimum width consistent with stability of sides.

D. Slope: Slope trenches so that conduit and ducts drain toward manholes and handholes and away from buildings and equipment.

E. Rock Excavation: Where rock pad is used for conduit trench, overexcavate 6" below the ductbanks and refill and compact with selected backfill material of same composition.

F. Muck Excavation: Where muck or unstable material is encountered, over-excavate and backfill to attain proper grade with coarse sand, gravel, or Controlled Density Fill.

1. Stockpile backfill material in an orderly manner; a sufficient distance from the trench to avoid overloading trench banks.

G. Bedding: The entire bottom of the excavation is to be firm, stable, and at uniform density.

H. Excavating for Manholes, Vaults Handholes, and Pullboxes: Provide 12" minimum clearance between outer surfaces of unit and embankment or timber used for shoring.

3.3 CONDUIT AND DUCT INSTALLATION

A. Refer to Specifications and Drawings for conduit and duct materials. Where not specified otherwise, use metallic conduit above and underground.

B. Metallic Conduit: Only use as specified in Section 26 05 33 - Raceways and Boxes.

C. Nonmetallic conduit: Use underground only.

1. Underground in Reinforced, Concrete-Encased Ductbanks: For medium-voltage low-voltage and communication applications. Use Schedule 40 Rigid Plastic Conduit as standard. Use rigid steel conduit on turns 45° or greater. Use Schedule 80 Rigid Plastic Conduit under roadways and in runway areas.

2. Underground Direct-Burial: For low-voltage applications only. Provide rigid plastic conduit, NEMA TC 2, Schedule 40 PVC (except rigid steel under roadways and either rigid steel or Schedule 80 in runway areas), with NEMA TC3 PVC conduit and tubing fittings.

D. All underground conduit shall be a minimum of two-inch standard trade size, except it is permissible to use one-inch conduit to lighting poles.

E. Use PVC fittings for PVC conduit and suitable water-tight connections where PVC conduit connects to galvanized steel conduit.

F. Install conduit and ducts as indicated on Drawings and according to manufacturer's written instructions.

G. Slope: For ductbanks and conduits without profiles, pitch ducts a minimum slope of 0.5% to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions. For ductbanks with profiles, install the ductbank at the elevation as shown on the drawings.

H. Curves and Bends: For all conduit systems (medium-voltage, low-voltage and communication) use manufactured galvanized rigid steel elbows for stub-ups at equipment and at building entrances with a minimum radius of 36 inches. Use manufactured long sweep bends with a minimum radius of 25 feet both horizontally and vertically at other locations. Do not exceed 20 degrees for field bends.

I. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

J. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Core drill entrances where knockouts do not exist.

K. Building Entrances: Transition from underground duct to rigid steel conduit 5 feet minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcing in ductbanks passing through disturbed earth near buildings and other excavations. Provide ductbank support at wall without reducing structural or watertight integrity of building wall.

2. Direct-Buried, Non-encased Duct Entering Non-waterproofed Walls: Provide a Schedule 40 galvanized-steel pipe sleeve for each duct. Caulk space between the conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.

3. Waterproofed Wall and Floor Entrances: Provide a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry

construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

L. Separation Between Direct-Buried, Non-Encased Ducts: Provide 3 inches minimum separation for like services, and 12 inches minimum between power and communication ducts.

M. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts or at 8 feet maximum, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concrete: Do not pour concrete until conduit installation has been approved. Spade concrete carefully during pours to prevent voids under and between conduits and at the exterior surface of the envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each ductbank between manholes or other terminations in one continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into the concrete on both sides of the joint near the corners of the envelope.

3. Reinforcing: Reinforce ductbanks where they cross disturbed earth and where indicated on Drawings.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and the concrete envelope can be poured without soil inclusions; otherwise, use forms.

5. Minimum Clearances Between Ducts: 3 inches between ducts and exterior envelope wall, 3 inches between ducts for like services, and 12 inches between power and communication ducts.

6. Depth: Except as otherwise indicated in the contract drawings, install top of duct bank at least 24 inches below finished grade in non-traffic areas and at least 24 inches below finished grade in vehicular traffic areas.

N. Stub-Ups: Use rigid steel conduit for stub-ups through concrete to equipment. Install insulated grounding bushings at the conduit terminations. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 2 feet beyond the edge of the pad. Couple steel conduits to the ducts with adapters designed for the purpose and then encase the coupling with 3 inches of concrete.

O. Sealing: Provide temporary closure at all duct terminations in manholes and vaults installed in this Project. Use sealing compound and plugs to withstand a minimum of 15 psi hydrostatic pressure.

P. Pulling Cord: Install 100-pound- test nylon cord in installed ducts, including spares.

Q. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of ductbank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.4 BACKFILLING

A. Backfill only after all necessary inspections and tests have been performed.

B. Remove all debris, rocks, broken concrete, and formwork before backfilling trenches.

C. Use Controlled Density Fill under pavement areas or wherever non-settling backfill is required.

D. Deposit backfill in layers with materials described in Article “Backfill Material.” Uniformly spread and compact backfill with suitable power tampers to the density of the adjacent soil and in such a manner so as not to disturb the alignment of the conduit. If settlement occurs, refill, compact and smooth off to conform to the surface of the ground.

E. Restore surface features at areas disturbed by excavation, and reestablish original grades.

1. Replace removed sod as soon as possible after backfilling is completed.

2. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other Work.

3. Restore vegetation and provide necessary topsoil, fertilizer, lime, seed, sod, sprigging, or mulching.

4. Replace disturbed paving.

3.5 VAULT, MANHOLE HANDHOLE AND PULL BOX INSTALLATION

A. Install as indicated on Drawings according to manufacturer's written instructions and ASTM C 891.

1. In areas which are subjected to vehicular traffic, install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

2. In areas which are not subject to vehicular traffic, install so that manhole lid is 2" above surrounding dirt or gravel, and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

3. Support units on a level bed of crushed stone or gravel, graded from the 1/2-inch sieve to the No. 4 sieve and compacted to the same density as the adjacent undisturbed earth.

4. Drainage: Where manholes have drain holes in the bottom, provide two feet minimum of gravel below the drain hole or provide a drain line to the nearest storm drain.

B. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated on Drawings. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

1. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for field-installed anchor bolts. Use a minimum of 2 anchors for each cable stanchion.

C. Train cables neatly around corners and secure to walls or ceiling using cable clamps with expansion anchors.

D. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

E. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring, encircling and in contact with enclosure, and with top surface secured to top of box cover frame. Bottom of ring shall rest on controlled density fill per Engineer of record.

1. Concrete: 3000 psi, 28-day strength with a troweled finish.

2. Dimensions: Minimum 10 inches wide by 12 inches deep or per Engineer of record.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 Grounding.

1. Handhole: Install two ground rods through floor in each medium voltage handhole and small manhole with top protruding 4” above floor.

2. Manholes and Vaults: Install four ground rods through floor in each medium voltage manhole with top protruding 4” above floor.

3. Ensure rods are copper 3/4 inch by 10 foot minimum.

4. Provide #4/0 ground wire in medium voltage ductbank.

5. Provide #4/0 bare copper ground wire in manhole, attached to wall, attached at 24 inches on center and mounted minimum 6 inches above floor.

6. Provide #2 stranded copper equipment ground minimum in each raceway in use.

3.7 IDENTIFICATION

A. Identify raceways, cables and equipment as specified in Section 26 05 53 - Electrical Identification.

3.8 TESTING AND CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2-inch greater than internal diameter of duct. Clean internal surfaces of vaults, manholes and handholes, including sump.

B. Duct Integrity: Swab out ducts with a mandrel 1/2 inch smaller in diameter than internal diameter of ducts.

C. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Coordination.
6. Products.
7. Execution.

1.2 SCOPE

A. This section includes identification of electrical materials, equipment, and installations. The extent and location of “Electrical Identification” Work is shown in the Contract Documents.

1.3 REFERENCE STANDARDS

A. NFPA 70E National Electrical Safety Code
B. NFPA 70 National Electrical Code
C. ANSI A13.1.,
D. ANSI Z535.4
E. 29 CFR 1910.144
F. 29 CFR 1910.145.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

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. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers’ technical literature, standard details, product specifications, and installation instructions for all products.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Submittals shall include the following.

1. Product Data for each type of product specified.

2. Schedule of identification nomenclature to be used for identification signs and labels.

1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 LABEL TYPES

A. Manufacturer’s standard products with colors prescribed by ANSI A13.1, NFPA 70, and these Specifications. Only temporary markings that are removable without damaging finish are permitted on equipment.

1. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Install labels and nameplates parallel to equipment lines. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

2. Provide engraved laminated phenolic plastic or melamine label for equipment as noted below. Securely attach engraved labels with blunt end, self-tapping stainless-steel screws with blunt ends. Sheet metal screws are not allowed. Provide white

letters on black background for normal power, white letters on red background for emergency power.

a. Provide 5/8-inch minimum height letters on the following equipment:

    1) Panelboards, provide labels and warning signs. Secure nameplates to inside surface of door where panel is recessed in finished locations.

    2) Switchboards/distribution centers, motor control centers and power centers, pad mounted transformers

    3) Secondary feeder breakers in distribution equipment

    4) Automatic and manual transfer switches. Labels shall include both normal and emergency source and load.

    5) Special equipment housed in cabinets, on outside door.

    6) Terminal junction boxes and data gathering panels

    7) Cable trays.

    8) UPS equipment

b. Provide 1/4-inch minimum height letters on the following equipment:

    1) Disconnects and starters for motors on fixed appliances and starters in MCCs

    2) Motor controllers and VFDs.

    3) Enclosed switches and circuit breakers

    4) Low voltage transformers

    5) Feeder circuit breakers in switchboards, switchgear, and distribution panelboards. Circuit breakers shall be labeled with destination panel name or load.

    6) Duplex receptacles (self-adhesive labels indicating panel and circuit number)

    7) Local control panels

    8) Raceways and junction boxes

    9) Instrumentation Labels

c. Refer to table and descriptions in subparagraphs below for acceptable labeling procedure:

Section	Title	Label Types														
		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
26 05 26	Grounding			⅝		X										
26 05 23	Control/Signal Transmission Media	X	X												X	
26 05 19	600-Volt or Less Wire and Cable	X	X			X									X	
26 05 13	Medium-Voltage Cables						X								X	
26 05 33	Raceways and Boxes															X
26 05 43	Underground Ducts and Manholes						X		X	X	X	X			X	
26 27 16	Cabinets and Enclosures			⅜												
26 05 36	Cable Trays			⅜							X	X				
26 27 26	Wiring Devices				¼											
no section	Electrical Power Monitoring and Control			⅜												
26 32 29	Rotary 400 HZ Converters			½							X					
26 32 13	Engine Generators			⅝							X					
26 33 53	Static Uninterruptible Power Supplies			⅝							X					
26 29 23	Variable Frequency Controllers			⅝							X					
26 12 00	Medium-Voltage Transformers			⅝							X		X			
26 35 33	Low-Voltage Power Factor Correction Capacitors			⅜	X								X			
26 13 00	Medium-Voltage Load Interrupter Switchgear			⅝							X		X			
26 13 26	Medium-Voltage Metal-Clad Drawout Circuit Breaker Switchgear			⅝							X		X			
26 18 39	Medium-Voltage Motor Controllers			⅝							X		X			
26 13 19	Medium-Voltage Pad-Mounted Vacuum Interrupter Switchgear			⅝							X		X			
26 11 16	Secondary Unit Substations			⅝												
26 28 16	Enclosed Switches and Circuit Breakers			⅝												
26 36 00	Transfer Switches			⅝												
26 23 00	Low-Voltage Switchgear			⅝												
26 24 13	Low-Voltage Switchboards			⅝												
26 09 26	Panelboards			½												
26 24 19	Motor-Control Centers			⅝												
26 29 13	Motor Controllers			⅜												
26 25 00	Low-Voltage Busway			⅜								X	X			
26 22 00	Dry-Type Transformers (600-Volt and Less)			½												
26 28 13	Fuses				X											
26 43 13	Transient Voltage Suppression			⅜												
26 51 00	Interior Lighting				X											
26 56 00	Exterior Lighting															
26 09 23	Lighting Controls			½												
28 31 00	Fire Alarm			½												
26 08 00	Acceptance Testing													X		

B. Heat-shrink preprinted tubes, flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200-degree F. Comply with UL 224.

C. Preprinted, flexible, self-adhesive vinyl label laminated with a clear weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Engraved melamine plastic laminate flat stock, 1/16-inch minimum thickness for sizes up to 15 square inches. Use 1/8-inch minimum for sizes larger than 15 square inches. Black with white letters for normal power systems and red with white letters for emergency power systems, with height as shown in table above unless specified otherwise. UV-inhibited when used outdoors. Secure with stainless steel drive screws, stainless steel self-tapping screws or stainless-steel oval-head 6-32 screws tapped into enclosure, or with stainless steel bolts with elastic stopnut.

E. Adhesive-backed plastic machine-printed labels, white with black letters. Indicate panel name and circuit number(s).

1. For Raceway at more than 600V, provide black letters on an orange field label with the legend, “HIGH VOLTAGE”. Indicate feeder number.

F. Plain-colored vinyl adhesive tape, 3-mil minimum by 1-inch wide minimum. Apply 1/2-inch minimum over-wrap through 2-inch minimum length. Refer to Section 26 05 19 – 600 Volt or Less Wire and Cable for color.

G. Engraved plastic melamine laminate flat stock. 1/16-inch minimum thickness for sizes up to and including 15 square inches, 1/8” thick for larger than 15 square inches. White background with black letters for normal power, red background with white letters for emergency power. Holes at each end for attachment with nylon ty-wraps.

H. Underground line warning tape with pre-printed warning message identifying type of system. Material shall be pigmented polyolefin, continuous-printed on one side, and compounded for unlimited life when direct buried. 6-inch minimum width by 4-mils thick. Tensile strength of 1750 psi.

1. Inscriptions for Red-Colored Tapes: ELECTRICAL LINE, HIGH VOLTAGE.

2. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATION CABLE, OPTICAL FIBER CABLE.

I. Underground metallic line-warning tape with pre-printed warning message identifying type of system. Material shall be detectable three-layer laminate consisting of printed pigmented polyolefin, a solid aluminum-foil core with a clear protective film that allows inspection of the continuity of the conductive core, and compounded for unlimited life

when direct buried. Use when metal-detection of line is required on Medium Voltage Systems. 6-inch minimum width by 4-mils thick.

1. Inscriptions for Red-Colored Tapes: "CAUTION: MEDIUM VOLTAGE ELECTRICAL LINE BELOW".

J. Warning signs: Baked Enamel on aluminum plate, punched or drilled for fasteners, with colors, legend, and size required for applications. ¼-inch grommets in corners for mounting. Minimum nominal size of 7 by 10 inches with 0.040-inch minimum thickness. OSHA standard wording where approved. Custom wording if required. Secure with non-corrosive fasteners.

1. Where applicable, provide labels for multiple power source warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES"

K. Warning labels: Self-adhesive, multicolor, flexible pressure-sensitive vinyl conforming to OSHA "Danger" and "Caution" standards. 2½ x1¾" minimum with black letters on yellow background. Label shall read: "WARNING! DO NOT USE AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL - CABLES ADDED AFTER INITIAL INSTALLATION REQUIRE POS/F & I APPROVAL." See Section 26 05 36 – Cable Trays.

1. Where applicable, provide labels for multiple power source warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES"

L. Stencils: Machine-punched patterns, nonfading waterproof paint with color and formulation appropriate for material and location. Minimum letter height shall be 1 inch.

M. Adhesive-backed metal labels manufactured with testing agency logo. Punched or engraved with actual settings and date. Label shall be 1/16-inch minimum thickness for sizes up to 15 square inches. Use 1/8-inch minimum for sizes larger than 20 square inches. Black with white letters for normal power systems and red with white letters for emergency power systems, with height as shown in table above unless specified otherwise.

N. Stainless-steel machine or hand-stamped wire marker plates with one hole at each end for attachment with non-corrosive fasteners that do 0.010-inch minimum thickness (for outdoor application).

O. Adhesive machine-printed plastic tape, cut to length, black with white letters unless specified otherwise. 3/8-inch minimum width of tape in unfinished areas only. Provide white lettering on red background when served by an emergency source.

2.2 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Floor Marking: Coordinate with the Port Electric Shop for painting working clearances on the floor in front of the equipment.

B. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior and interior).

PART 3 EXECUTION

3.1 INSTALLATION

A. Fasteners for labels and signs: Self tapping, blunt-ended stainless-steel screws, or stainless-steel machine screws with nuts and flat and lock washers. Sheet metal screws are not acceptable. Self-drilling screws are not allowed.

B. Install identification labels according to manufacturer's written instructions.

C. Install labels where indicated and as required by the Authority Having Jurisdiction and the Department of Labor and Industries. Locate for optimum viewing and without interference with the operation and maintenance of equipment.

D. Verify identity of each item before installing identification products.

E. Labeling abbreviations not permitted without F&I approval.

F. Temporary markings allowed only if removable without damage to equipment or enclosure finish.

G. System Identification Color-Coding Bands for Raceways: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

1. 208/120V Blue
2. 480/277V Yellow
3. Controls Black

H. Cable Ties: For attaching tags. Use general-purpose type, fungus inert, self-extinguishing, one-piece, self-locking Type 6/6 nylon, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In spaces handling environmental air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Coordinate names, abbreviations, colors, graphics and other designations used for electrical identification with corresponding designations used in the Contract Documents or as required by codes and standards. Use consistent designations throughout the Project. Labeling abbreviations are not allowed.

K. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish Work.

1. Coordinate installing electrical identifying labels prior to installing acoustical ceilings and similar finishes that conceal such items.

L. Clean surfaces of dust, loose material, and oily films before applying painted or self-adhesive identification products.

M. Painted Identification Products:

1. Prime surfaces according to manufacturer's instructions prior to applying painted labels:

a. For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces.

b. For concrete masonry units, use heavy-duty, acrylic-resin block filler.

c. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.

2. Apply one intermediate and one finish coat of paint.

3.2 IDENTIFICATION SCHEDULE

A. Panelboard Schedules:

1. Panelboard schedules shall utilize the POS standard panel schedule in Microsoft Excel format which has provision for totaling all loads and performing demand calculations by load category.

2. This schedule shall be updated with as-built information upon the completion of the project. The contractor shall post a hard copy of the revised panel schedule in any panel modified and submit an electronic copy of the panel schedule in Port standard excel format showing accurate as-built information to F&I.

B. Instrumentation Labels: Affix permanent type nameplate or tag on all field-mounted instruments, transmitters, pressure gauges, and control valves with proper identification number and service description.

1. Provide 3”x1” aluminum or stainless-steel tag stamped with the instrument loop number designation and the calibrated range.

C. Medium Voltage Raceways: Provide 5/8-inch-high stenciled or manufactured letters noting “HIGH VOLTAGE”, black letters on yellow background on all exposed feeder conduits where entering or leaving switchboards and along conduit runs at 25 feet on center.

D. Accessible Raceways, More Than 600 V: Self-adhesive vinyl labels. Install labels at all conduit penetrations and along length of exposed conduit run at 25-foot maximum intervals.

E. Accessible Raceways within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage.

1. Provide labels on all raceways, junction and pull boxes indicating panel designation and circuit number for all circuits in raceway or box, and conduit destination.

a. Conduit Label Example: B2-P4-23G-1/1,3,5, B-2601-9.

b. Provide labels at all locations where conduit penetrates walls, floors and ceilings, on both sides of penetration.

c. Provide labels at all ends or breaks in conduit runs such as electrical rooms, junction boxes, pull boxes, cabinets, maintenance holes, fire penetrations, etc.

d. Provide labels on each conduit entering junction or pull box within 12” of junction or pull box.

e. Provide labels at 25-foot maximum intervals along conduit runs.

f. Provide labels on all junction and pullboxes, including in accessible ceiling spaces and exposed in unfinished areas. Refer to specification sections for identification requirements for systems contained within.

g. Install labels parallel to equipment lines.

h. Labels in unfinished locations, including in accessible ceiling spaces and exposed unfinished areas shall be machine printed vinyl labels minimum ½ inch high, white with black letters. Labels in finished locations shall be adhesive-

backed plastic machine printed labels, minimum 3/8-inch-high, white with black letters.

i. Lettering shall be a minimum of ¼" high.

j. In finished locations, provide labels on inside of junction or pull box cover.

k. Provide red lettering when served by an emergency source.

F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for feeder and branch-circuit conductors.

a. Provide colored insulation when available, typically for wire sized #8 AWG and smaller.

b. Provide minimum 2-inch-wide band of colored plastic tape at all terminations and splices (where allowed). 3M Scotch No. 35, [ ], Or Approved Equal Electrical Color Coding Tape.

c. Colors for 480/277V 3Ø, 4-wire systems:

1) Phase A (left or top): Brown.
2) Phase B (center): Orange.
3) Phase C (right or bottom): Yellow.
4) Neutral: Gray.
5) Ground: Green.

d. Colors for 208/120V, 3Ø, 4-wire systems:

1) Phase A (left or top): Black.
2) Phase B (center): Red.
3) Phase C (right or bottom): Blue.
4) Neutral: White.
5) Ground: Green.
6) Isolated Ground: Green with yellow or orange stripe.

e. 575V, 3Ø, 4-wire systems:

1) Phase A (left or top): Brown with purple stripe.
2) Phase B (center): Orange with purple stripe.
3) Phase C (right or bottom): Yellow with purple stripe.
4) Neutral: Gray with purple stripe.

5) Ground: Green.

f. Colors for 120/240V, 1Ø, 3-wire systems: (non-standard)

1) Phase A: Black.
2) Phase B: Red.
3) Neutral: White.
4) Ground: Green.

g. For 240-delta systems (obsolete) the color of the high leg (approximately 200 volts to ground) shall be red. Label interior of all equipment “CAUTION: HIGH LEG IS OVER 120V TO GROUND. DO NOT USE FOR 120V CIRCUITS”.

h. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

2. Provide wire markers on each conductor in panelboards, gutters, pull boxes, outlet and junction boxes and at the load connection. Identify with branch circuit or feeder number for power and lighting circuits.

a. Install conductor labeling in panelboards and enclosures to ensure labels are visible.

G. Power-Circuit Conductor Identification, Medium Voltage: Provide labeling at all accessible locations including each termination or interconnection of wiring, and in vaults, pull and junction boxes, manholes, and handholes. Identify conductors with cloth type, split sleeve or tubing type wire and cable markers.

1. Label each cable with phase designation, operating voltage and circuit number.

2. Color Coding for Phase:

a. 4160Y/2400V AC 3Ø, 4-wire:

1) Phase A: Black/Pink.
2) Phase B: Red/Pink.
3) Phase C: Blue/Pink.
4) Neutral: White/Pink.

b. 4160V Delta AC, 3Ø, 4-wire:

1) Phase A: Black/Brown.
2) Phase B: Red/Brown.
3) Phase C: Blue/Brown.

c. 12,470V Delta AC, 3Ø, 4-wire:

1) Phase A: Black/Orange.
2) Phase B: Red/Orange.
3) Phase C: Blue/Orange.

3. Provide write-on tags or nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

H. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

1. Provide wire markers on each conductor in wire gutters, pull boxes, outlet and junction boxes and at the equipment connection. Identify with control wire number as indicated on schematics and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

J. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.

K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

L. Conductor Identification:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.

3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

M. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

N. Workspace Indication: Install floor marking tape or paint to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

O. Warning, Caution, and Instruction Signs:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Provide OSHA standard text where approved. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location. Mount permanently in an appropriate location. Comply with ANSI A13.1 standard color and design.

2. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

3. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

P. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/4-inch high lettering on 1-inch high label. Use white lettering on black field. Apply labels parallel to equipment lines.

Q. Outdoor Equipment: Engraved, laminated acrylic or melamine label, to comply with requirements listed above. Provide panel schedule printed on 8.5x11 paper in Port standard format in each panelboard. Insert folded schedule in schedule holder on inside of panel door. Posted panel schedule shall be updated to reflect all new work in panel. Include project completion date on schedule.

R. Provide self-adhesive tape labels on all receptacle cover plates. Labels shall be machine printed with black lettering on white or clear background.

1. Indicate source panel name and circuit number.

2. Provide red lettering on white or clear background for devices on emergency circuits.

3. Where receptacle faceplate is dark color, provide white letters on clear background.

END OF SECTION

SECTION 26 05 88

PREMIUM EFFICIENCY VERTICAL MOTORS

PART 1 GENERAL

1.1 SUMMARY

A. Work consists of vertical motors for vertical turbine pumps shown on the drawings and specified herein and in other divisions of the specifications. Motors shall be premium efficiency and furnished with the driven equipment.

B. The requirements of all other sections of the specifications are equally applicable to the work to be performed under this section. Motors and controls are specified elsewhere in this and other divisions of the specifications. In the event of conflicts, the more restrictive specifications shall apply.

C. Where two or more pump systems of the same type or size are required, all pumps shall all be produced by the same manufacturer.

D. Provide all labor, equipment and materials and perform all operations in connection with the installation and testing of pumps.

E. Coordinate and utilize all factory testing, installation, start-up and field-testing services supplied in conjunction with the pumping equipment.

F. Related Requirements:

1. Section 43 21 52 – Deep Well Vertical Turbine Pumps

1.2 SUBMITTALS

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

B. Complete motor data shall be submitted and include the following data:

1. Motor manufacturer.
2. Motor type or model and dimension drawing to include motor weight.
3. Nominal Horsepower.
4. NEMA Design.
5. Enclosure.
6. Frame size.
7. Winding insulation class and treatment.
8. Rated ambient temperature.
9. Service factor.

10. Voltage, phase and frequency ratings.
11. Full load current at rated horsepower for application voltage.
12. Starting code letter, or locked KVA, or current.
13. Special winding configuration.
14. Rated full load speed.
15. Guaranteed minimum Power Factor at 100, 75 and 50 percent of full load.
16. Guaranteed minimum efficiencies at 100, 75 and 50 percent of full load.
17. Starting torque.
18. Full load torque.
19. Breakdown torque.
20. Rated temperature rise at rated horsepower.
21. Full load current at rated voltage.
22. Current at no load on shaft at rated voltage.
23. Connection diagram.
24. Rtd – Resistance Temperature Detector: 100-ohm Platinum.
25. Superimposed load speed torque curve over motor speed torque curve.
26. Recommended spare parts list priced.

C. Operation and Maintenance Manual: Containing the required information for each pump section.

PART 2 PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and built for industrial service and be capable of operating successfully under the following applicable conditions.

1. 40 degrees C maximum ambient temperature.
2. Voltage variations to + 10% of nameplate rating.
3. Frequency variations to + 5% of nameplate rating.
4. Combined voltage and frequency variations to + 10% total, as long as frequency does not exceed + 5%.

2.2 ELECTRIC MOTORS

A. General: Electric motor driven pumps shall be premium efficiency with solid shaft electric motors, design B, high thrust, squirrel cage, induction type having NEMA weather protected type WP1 enclosures unless otherwise specified. Motors shall utilize adjustable spacer couplings. Motors shall be suitable electrically and mechanically to efficiently and effectively drive pumps. Motors shall operate in accordance with these specifications. Motors shall be sized such that the pump BHP shall not exceed the nameplate data at any location on the full-speed operating curve.

B. Unless specified otherwise, all materials, workmanship and tests shall conform with the applicable specifications to NEMA, IEEE, ASA and AFBMA.

C. Motor frame shall be steel or cast iron, aluminum shall not be permitted.

D. Motors shall be rated for operation at 460 VAC, 3 phase, 60 hertz, Service factor of 1.15 or greater. Motors shall be provide the minimum horsepower at the maximum rpm stated in Section 11101.

E. Motors shall be rated for premium efficiency. Rated efficiencies shall be based on NEMA standards MG1-12.536 or standards imposed by the local electric utility, which ever is more restrictive.

F. Motors shall be capable of full load operation with voltage variations of +/- 10% and frequency variation of +/- 5%.

G. Motor starting current shall not exceed 650% of motor full load current.

H. Insulation system: All motors shall be provided with Class "F" or better insulation systems except that motor lead insulation may be class "B" or better. Completed windings, when tested in accordance with IEEE #57 shall show a thermal rating not less than 150 degrees for 30,000 hours of life.

I. Windings shall be held firmly in stator slots to prevent coil shift. Stator windings shall be of high conductivity copper magnet wire. Completed stator windings shall be provided with a properly cured, uniform impregnation for mechanical rigidity, moisture resistance, and protection against winding failure from accumulation of foreign conductive matter. The completed insulation system shall be capable of withstanding phase to ground rms voltage of 600 volts continuous and 2,300 volts instantaneous.

J. All motors used with variable frequency drives shall be inverter duty, have a minimum of 1600 volt insulation on the windings, have insulated motor bearings and shaft grounding rings and shall be compatible with the VFD specified elsewhere in Division 16.

K. Rated temperature rise above 40 degrees C ambient temperature, at service factor load of 1.15 shall not exceed 90 degrees C.

L. Motors rated 50 Hp and larger shall be rated NEMA locked rotor Code G or better.

M. Motors shall be dynamically balanced to a maximum of .001 inches peak to peak amplitude.

N. Motors shall be equipped with anti-friction type thrust and guide bearings. Angular contact thrust bearings shall be used. Bearings shall be of sufficient capacity to withstand all static and dynamic thrust loads, both momentary and continuous,

imposed by the pump. Bearings shall provide minimum 3-year life based on continuous design thrust loads. For variable frequency applications, bearings shall be insulated, and shaft shall be grounded with a shaft-grounding/bearing protection ring.

O. Motor thrust bearings shall be lubricated with the lubrication system recommended by the manufacturer to provide optimum lubrication of bearings for long life and trouble-free operation. Motors lubricated with oil shall have visual level indicators and accessible fill and drain plugs for the oil reservoir.

P. Motors shall be equipped with non-reverse mechanisms which shall limit maximum reversal to 10 degrees of rotation.

Q. Motors shall be equipped with fabricated steel conduit boxes. The box shall be sized for two 350 MCM AWG conductors per phase and two #1 AWG ground conductors with stress cone terminations for main motor leads. Separate accessory terminal boxes shall be provided for space heater and temperature sensors.

R. Motor Nameplates shall include Manufacturer name, serial number, rated horsepower, service factor, frequency, phase, load voltage, full load amps, full load speed, design designation, locked rotor current and or designation, insulation class, temperature rise, maximum ambient temperature, NEMA efficiency, and full load power factor, time rating, model #, bearing identification, frame size, thermal protection, nominal and guaranteed efficiency.

S. Coating System: Manufacturers standard corrosion resistant coating.

T. Motors shall be as manufactured by General Electric Company, or US Motors.

2.3 MOTOR ACCESSORIES

A. Motor shall be equipped with a 120 volt, single phase space heater. The space heater shall maintain a motor temperature that is 15 degrees Fahrenheit above ambient temperature when the motor is not operating. Space heater leads shall be brought out to a separate auxiliary terminal box.

B. Motor shall be equipped with two 100 ohm platinum winding RTDs per phase. Upper and lower bearing case shall be equipped with 100 OHM platinum RTDs. RTD wiring shall be brought out to a separate auxiliary terminal box.

C. Motor shall be equipped with winding thermostats. Thermostats shall be snap action, bi-metal, temperature and shall be factory mounted integral to motor. Thermostats shall be provided with one normally closed contact with switch point pre-calibrated by manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. Install equipment and materials in a neat and workmanlike manner and align, level and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance, and repair.

3.2 WIRING

A. Arrange wiring in cabinets, panels and motor control centers neatly cut to proper length, and remove surplus wire. Apply stak-on or similar terminals to control wiring for connection to terminals, and bridle and secure in an approved manner. List all circuits emanating from power, distribution and lighting panelboards by function on the directory card. Identify all circuits entering motor control centers or other control cabinets by directory card listing terminal block number and function or by means of tags securely fastened to the conductors.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Testing.
7. 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 REFERENCE STANDARDS

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
ANSI/NETA ATS- 2009	Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems

C. 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 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

1.5 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 22 13 - LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution

1.2 SCOPE

A. This section covers the work necessary to furnish and install low voltage transformers.

B. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

C. The Contractor shall furnish and install single-phase or three-phase general purpose individually mounted dry-type transformers, self-cooled as specified herein, and as shown on the contract drawings.

D. System Characteristics

1. 480/277 VAC 3 PHASE 4 WIRE: 120/208 VAC 3 PHASE 4 WIRE
2. 480 VAC 1 PHASE: 120/240 VAC 1 PHASE
3. 120 VAC 1 PHASE: 24 VDC

1.3 REFERENCE STANDARDS

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. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

C. 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	Enclosures for Electrical Equipment (1,000 Volts Maximum)
NFPA 70	National Electrical Code
NFPA 70E	National Electrical Safety Code
UL 50	
UL 67	Underwriters Laboratories
NEMA	TP-1

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment first 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. PROCEDURES: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. 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.

2. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

3. Transformer Ratings including:

   a. KVA rating
   b. Primary & Secondary Voltage
   c. Taps
   d. Design Impedance
   e. Insulation class
   f. Sound level

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

PART 2 PRODUCTS

2.1 CANDIDATE MANUFACTURES/PRODUCTS

A. Candidate manufacturers and models are listed below. To conform to specified requirements, the manufacturer's standard product may require modification.

1. Eaton
2. Schneider Electric / Square D
3. GE
4. Approved Equal

2.2 DRY TYPE TRANSFORMERS

A. General: Provide all power transformer equipment as shown on the drawings in conformance with the following specification. All transformers shall be built in accordance with the latest revised IEEE, ANSI, and NEMA standards. All transformers shall conform to NEMA TP-1 standards.

B. Temperature Ratings: On all transformers, case temperature shall not exceed 30 degrees Centigrade rise above an ambient temperature of 40 degrees Centigrade. Terminal compartment shall be located to ensure termination of cable leads in temperature levels not to exceed 75 degrees Centigrade. Transformers shall be designed for full load operation at a maximum temperature rise of 115 degrees C.

C. Size: Voltage and KVA rating shall be as shown on the drawings. Provide continuous overload capability of 15%. Primary voltage windings shall have a BIL rating of 10 kV.

D. Enclosure: For general application, enclosures shall be drip-proof and rodent-proof. Ventilating openings shall be louvered; screening will not be acceptable. Design shall incorporate a built-in vibration dampening system. Finish shall be ANSI 60. Conform to the limited access requirements where applicable.

E. Core and Coil Assemblies: Transformer core shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly

clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.

F. Taps: Furnish a minimum of four taps, two above and two below rated voltage, each 2-1/2 percent, for ratings above five (5) kVA.

G. Tests: Provide routine tests as listed and described in ANSI specification No. C57.12.00, latest edition. Sound level tests shall be performed on the complete transformer assembly in accordance with the latest NEMA standards. Transformer 0-75 kVA shall conform to NEMA standards.

PART 3 EXECUTION

3.1 EQUIPMENT BASES

A. Provide equipment bases for all floor-mounted electrical equipment. Unless otherwise indicated, bases shall be poured-in-place concrete, nominally four inches high, and be one inch larger on all exposed edges than the equipment to be mounted. Bolt equipment to pad. Provide concrete pads and mounting provisions for all exterior equipment as indicated on the drawings or specified in other portions of the specifications.

3.2 SUPPORTS

A. Provide equipment bases for all floor-mounted electrical equipment. Unless otherwise indicated, bases shall be poured-in-place concrete, nominally four inches high, and be one inch larger on all exposed edges than the equipment to be mounted. Bolt equipment to pad. Provide concrete pads and mounting provisions for all exterior equipment as indicated on the drawings or specified in other portions of the specifications.

B. Provide Uni-strut or similar supports and backing for wall mounted equipment where structure is suited for such mounting.

3.3 DAMP AND WET LOCATIONS

A. Unless otherwise specified, all electrical enclosures in damp and wet locations shall be NEMA 4, stainless steel.

B. All conduit entries into equipment located in damp or wet locations shall be through the bottom or lower sides of enclosures. Top entry of conduits will not be allowed.

3.4 TESTING

A. Service Equipment shall be tested for proper operation and function in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 24 16 – PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Executions

1.2 SCOPE

A. This section specifies panelboards for lighting and power distribution.

B. Panelboards shall be labeled for arc-flash conditions in accordance with Section 26 05 73.

1.3 REFERENCE STANDARDS

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 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	Enclosures for Electrical Equipment (1,000 Volts Maximum)
NEMA PB 1	Panelboards
NFPA 70	National Electrical Code
UL 50	Cabinets and Boxes
UL 67	Underwriters Laboratories, Electric Panelboards
UL 489	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 1449	Surge Suppression Devices, Third Edition

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

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. PROCEDURES: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. 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.

2. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

3. Manufacturer's certification that bus bracing is capable of withstanding the specified short circuit condition.

4. Applicable contract close-out requirements as specified in Section 01 77 00.

5. Quantity and rating of circuit breakers provided with each panelboard.

PART 2 PRODUCTS

2.1 CANDIDATE MANUFACTURERS/PRODUCTS

A. Panelboards shall be fully rated with a main circuit breaker and shall be dead front type, bolt-on breaker type, with bus bar construction.

B. Candidate manufacturers and models are listed below. To conform to specified requirements, the manufacturer’s standard product may require modification.

1. Eaton
2. Schneider Electric / Square D
3. GE
4. Approved Equal

2.2 ARRANGEMENT AND CONSTRUCTION

A. The front of the panel shall have concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring loaded door pulls. The fronts shall not be removable with doors in the locked position. All panelboard locks shall be keyed alike.

B. Gutter space shall be provided on all sides of the breaker assembly to neatly connect and arrange incoming wiring.

C. Panelboard shall be composed of individually mounted circuit breakers designed to be removable without disturbing other breakers.

D. Panelboards shall have interior hinged face plates that can swing open while not disturbing the circuit breakers.

E. Panelboards shall be provided with factory installed breaker lock-out means allowing a padlock to lock the breaker in the “off” position.

F. Panelboards shall be mounted as shown on the construction documents.

G. A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the door. A typed panel schedule showing as-built configuration shall be provided by the contractor.

H. Panelboards shall have lockable Door-in-Door type covers.

I. Panelboard circuit breakers shall be provided with locking tabs to enable OSHA lockout/tagout.

2.3 BUS

A. Bus shall be tin-plated copper and shall have current ratings as shown on the panelboard schedules, sized in accordance with UL 67. Ratings shall be determined by temperature rise test. Minimum bus size shall be 100 amperes. Panel fault withstand rating shall be equal to the interrupting rating of the smallest circuit breaker in the panel.

B. Panelboards shall be provided with a separate ground bus and, where specified, with a full capacity neutral bus.

C. The neutral bus of power panels shall be mounted on insulated stand-offs.

2.4 CIRCUIT BREAKERS

A. Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers rated 120/208

volt and 120/240-volt alternating current shall have a minimum interrupting current rating of 10,000 amperes (symmetrical) at 240V AC. Circuit breakers rated 480-volt alternating current shall have a minimum interrupting current rating of 14,000 amperes (symmetrical) at 480V AC or as specified on the panelboard schedule.

B. Circuit breakers shall be bolt-on type.

C. Circuit breakers shall be listed in accordance with UL 489 for the service specified.

D. Load terminals of circuit breakers shall be solderless connectors.

2.5 FINISH

A. Panelboard cabinet shall be fabricated from hot-dip galvanized steel in accordance with UL 50. Panelboard fronts shall have a gray, baked enamel finish.

2.6 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 26 05 53.

PART 3 EXECUTION

3.1 GENERAL

A. The Contractor shall type in the circuit description on the circuit directory as shown on the final record drawings or panelboard schedule.

B. Provide “Circuit Directory and Circuit Identification” in accordance with NEC 408.4A and B. Each circuit shall be of sufficient detail to allow each circuit to be distinguished from other circuits. Circuit identification shall include load location and provide equipment or instrument Tag Number and Tag Description, where shown on the drawings.

3.2 TESTING

A. Panelboards shall be tested for proper operation and function in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 24 19 - MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals
5. Products.
6. Execution

1.2 SCOPE

A. Motor Control Centers as specified and as shown on the contract drawings shall be furnished and installed by the Contractor.

B. The drawings are the basis for required programming within the MCC for manual operation of the motor starters. The manufacturer or its designated field service group shall program, test, commission and certify operation of the MCC equipment.

1.3 REFERENCE STANDARDS

A. The Motor Control Center shall be manufactured and tested according to the latest applicable standards of the following agencies:

1. UL 845 – Motor Control Centers

2. NEMA ICS 18-2001 – Motor Control Centers

3. NEMA ICS 1-2001 – Industrial Control and Systems: General Requirements

4. NEMA ICS 2.3-2008 – Industrial Control and Systems: Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers

1.4 QUALITY ASSURANCE

A. REQUIREMENTS:

1. Section 26 05 00 General Requirements for Electrical Work.
2. Section 26 29 13.13 Across-the-line Motor Controllers
3. Section 26 43 13 Surge Protective Devices

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. Product Data: Submit manufacturer's printed product data.

B. Documents: Submit shop drawings for approval. Documents shall include all dimensions, weights, electrical ratings, wiring diagrams and required clearances.

C. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

D. Certificate of Compliance for Seismic Design of Nonstructural Components and Systems.

E. Manufacturer Seismic Qualification: The low voltage motor control center(s) shall meet and be certified to seismic requirements specified in the IBC 2015 International Building Code. Refer to Specification section 01 41 20.

1. The low voltage motor control center(s) shall be compliant with IBC 2015 parameters:

a. Building Occupancy Category (as defined in Table 1.1 from ASCE 2010): IV

b. Seismic Design Category: D

c. Site Class: C – Very dense soil and soft rock as defined in ASCE 7-10 Table 20.3-1

d. Ip – Importance Factor: 1.5 – Components must function after an earthquake for life safety purposes (Building Occupancy Code IV)]

e. Ss: Mapped Spectral Accelerations for Short Periods at 0.2 seconds – 1.3g

f. Sds – 5% Damped Design Spectral Response Accelerations for Short Periods at 0.2 seconds – 0.858G

g. z/h – Height factor ratio: 0.083. Note: Ratio is a calculated value equal to the floor the gear is installed on divided by 12. A 6th floor installation is a 0.5 value. A basement or ground floor installation is a 0.0 value.

1.6 QUALITY ASSURANCE

A. Manufacturer: For equipment required for the work of this section, provide products which are the responsibility of one manufacturer.

B. Manufacturer shall have had produced similar electrical equipment for a minimum of 5 years.

C. Manufacturer shall be ISO 9001 certified.

1.7 DELIVERY, STORAGE AND HANDLING

A. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manual. One (1) copy of this document shall be provided with the equipment at the time of shipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products from one of the following:

1. ABB
2. Allen Bradley
3. Group Schneider/Square D
4. Approved Equal

2.2 GENERAL REQUIREMENTS

A. STRUCTURES

1. The enclosure shall be NEMA Type 1A with gasketed doors. Vertical sections shall be constructed with steel divider sheet assemblies formed or otherwise fabricated to eliminate open framework between adjacent sections or full-length bolted-on side sheet assemblies at the ends of the MCC(s).

2. Vertical sections shall be 90" high excluding mounting sills, 20" wide and 20" deep for front mounting of units.

3. Vertical structures shall be divided into six (6) 12" space factors and shall accommodate six (6) full size NEMA size 1 or 2 Full Voltage Non-Reversing FVNR combination starters. MCC unit sizes shall be multiples of 1/2 space factor (6"). The vertical structures shall accommodate 6" high density and dual mounted units.

4. Back-to-back, front and rear unit mounting, structures shall be 21" deep maximum and shall accommodate 12 full size NEMA size 1 or 2 Full Voltage Non-Reversing FVNR combination starters per section.

5. 4" wide wireways shall be installed on 20" wide structures and 8" wide wireways on 24" wide structures. Wireways shall be completely isolated from all power

busses. The rear surface of the vertical wireway shall be painted white. A minimum of three (3) formed wire cable supports, extending the full depth of the vertical wireway shall be supplied in each vertical section. A separate hinged door shall cover the vertical wireway.

6. Each standard structure shall be supplied with a 12-inch top and six (6) inch bottom horizontal wireway that are continuous for the entire length of the MCC. The minimum horizontal wireway opening between sections is 40 square inches for the top and 30 square inches for the bottom horizontal wireway. A hinged door shall be supplied to cover the top horizontal wireway.

7. Doors are to be hinged in a manner that allows for the removal of individual doors without the removal of any door above or below. Unit doors shall be hinged on the left and vertical wireway doors on the right for unobstructed access to the units and associated vertical wireway. All doors shall be mounted on removable pin-type hinges and secured with steel quarter-turn, indicating type fasteners.

8. Wireways shall be completely isolated from bus compartments by suitable barriers. Sliding barriers between the horizontal bus and top horizontal wireway are not acceptable.

9. Removable top cover plates shall be provided for conduit entry to the top horizontal wireway and shall provide a minimum of 116 square inches of area for conduit location. Top cover plates shall be fabricated from 13-gauge steel.

10. All MCC structures shall be supplied with 1-1/8” high X 3” wide base channel sills that are continuous for the entire length of the shipping split. The base channel sills shall be fabricated of 7-gauge steel and shall be suitable for grouting the base channel sills in place, welding to leveling plates or securing to the floor with 1/2” anchor bolts. MCC structures shall be supplied with reversible bottom end cover plates to cover the bottom horizontal wireway and ends of the base channel sills. The bottom end cover plates shall be factory installed to cover the ends of the base channel sills to prevent entrance of dirt and rodents into the MCC when installed flush on the floor and shall be removable to expose the ends of the base channel sills if they are to be grouted into the floor.

11. A removable, full length lifting angle shall be provided for each shipping split of each MCC. The lifting angle shall be bolted to each side sheet or divider sheet of the shipping split to evenly distribute the weight of the MCC during lifting.

12. MCC’s shall be assembled in such a manner that it is not necessary to have rear accessibility to remove any internal devices or components.

B. BUSSING

1. The main horizontal bus shall be:

   a. Tin plated copper rated at 600 amperes with a conductivity rating of 100% IACS. The horizontal bus bars shall be fully sized to carry 100% of the rated current the entire length of the MCC. Horizontal bus bars shall be mounted edge wise and located at the top of the MCC. Tapered horizontal bus is not acceptable.] All power bus shall be braced to withstand a fault current of 42kA (rms symmetrical).

   b. The entire horizontal bus assembly must be located behind the top horizontal wireway at any amperage. Horizontal bus bars located behind usable unit space are not acceptable.

   c. The horizontal bus shall be isolated from the top horizontal wireway by a clear, flexible, polycarbonate, barrier allowing visual inspection of the horizontal bus without removing any hardware.

2. The vertical bus:

   a. Shall be rated 300 amperes. Vertical bus bars shall be fabricated of tin-plated solid copper bars with a conductivity rating of 100% IACS.

   b. The vertical bus assembly shall be isolated from the unit mounting space by means of a full height steel barrier. Provisions shall be made to close off unused unit stab openings in the vertical bus barrier with removable covers.

3. All bus ratings are to be based on a maximum temperature rise of 65ºC over a 40ºC ambient temperature.

4. Horizontal to vertical bus and horizontal bus splice connections shall be made with two (2) 3/8” grade 5 bolts and conical washers at each connection point. All connecting hardware shall be designed to be tightened from the front of the MCC without applying any tools to the rear of the connection.

5. The horizontal ground bus shall be rated 600-amp copper.

6. The neutral bus connection shall be rated 600-amp copper.

C. UNITS

1. Plug-in units shall connect to the vertical bus by means of self-aligning, tin plated copper stab-on connectors provided with spring steel back-up springs to insure positive connection to the vertical bus.

2. When vertical ground bus is specified, plug-in units shall include a ground stab which engages the vertical ground bus before the power stabs engage the vertical bus when the unit is inserted into the structure. When the plug-in unit is withdrawn from the vertical bus, the vertical ground stab shall release after the power stabs.

3. The interior of all MCC units shall be painted white, including unit top and bottom plates or isolation barriers.

4. All plug-in units 12" tall and larger will include two (2) auxiliary handles to aid in installation, removal and transporting plug-in units.

5. All plug-in units will include a racking mechanism to assure full engagement with the stab-on connectors with the vertical bus.

6. Plug-in units shall be provided with interference mechanism type draw-out to prevent complete removal of the plug-in unit from the structure in one motion. The interference mechanism shall also provide clear indication when the plug-in unit has been withdrawn to the "TEST" position.

7. A mechanical interlock shall be supplied on all plug-in units to prevent insertion or removal of a unit from the structure when the unit operator handle is in the ON position. This interlock may not be defeated.

8. Each 12" tall and larger plug-in unit shall be secured in the structure by two (2) readily accessible devices, one of which is tool operated. These devices shall be located at the front of the unit.

9. Plug-in units with NEMA Type B or C wiring shall be supplied with unit terminal block mounted within the unit, adjacent to the vertical wireway. For non-high density units, the terminal blocks shall be mounted on a movable bracket that maintains the terminals inside the unit structure for normal operation and pivots into the vertical wireway exposing the terminals for wiring, test and maintenance.

10. All plug-in units shall include a positive means of grounding the unit to the structure at all times.

11. The MCC unit disconnect operator shall operate in a vertical, up-down, plane. 6" units shall operate in a horizontal motion. All unit disconnects shall remain engaged with the disconnect device at all times, regardless of the unit door position. The operating handles shall be interlocked with the unit door so that the door can neither be opened with the disconnect device in the ON position, nor can the disconnect device be turned ON with the unit door open except by operation of a defeater mechanism. Indication of the disconnect device shall be clearly indicated by the position of the operating handle. When applied with circuit breaker devices, the handle shall also provide clear indication of a circuit breaker trip.

12. When pilot lights, push buttons or sector switches are specified. The devices shall be mounted in a formed metal device panel that is capable of accepting four (4) such devices in any combination. The device panel shall be secured to the unit door for normal operation, or mounted on the plug-in unit as required for unit removal and bench testing.

13. Pilot devices shall be heavy duty, oil tight 30mm devices with a NEMA 4 rating. Indicating lights shall be LED push-to-test type. Pilot device contacts shall be rated at 10A, 600 VAC (NEMA A600). The pilot device bodies shall be fabricated from metal.

14. Unit identification nameplate shall be provided for each unit. Nameplates shall be a black surface with white core. Engraving shall cut through the black surface exposing white lettering of the unit designation. Nameplates shall be 1" tall by 3 1/2" wide. Adhesives or glues are not an acceptable means of mounting unit nameplates.

D. WIRING

1. The wiring shall be NEMA Class 1.
2. All internal wiring shall be labeled using heat shrink type material.

E. COMBINATION MOTOR STARTERS

1. The combination motor starters shall be provided with a thermal magnetic circuit breaker unless noted otherwise on the drawings.

    a. Combination Motor Starters shall be rated equal to or greater than the AIC rating of the Motor Control Center.

2. Overload Protection

    a. The overload protection shall be:

        1) Allen Bradley E250 solid state overload relay with Class 10-30 protection multifunctional, electronic full motor protection. Detailed operating, service, and diagnostics data via Ethernet. Or approved equal.

3. Control Power

    a. Each starter unit shall be provided with an encapsulated control power transformer of sufficient size to accommodate the contactor coil burden plus all specified auxiliary devices.

F. FEEDERS

1. Feeder disconnects shall be thermal-magnetic circuit breaker.

2.3 SMART MOTOR STARTER

A. Motor starter units shall include a microprocessor based protective and control overload that provides NEMA class 10, 15, 20, 25, or 30, thermal trip characteristics, phase asymmetry (phase imbalance & phase loss) protection, stalled rotor protection, instantaneous over current (jam) and under current protection and provisions for connecting one thermistor. Upper and lower current limits shall be adjustable for tripping and monitoring.

B. The device shall provide an option of voltage and power monitoring as well as monitoring of power factor (cos-phi or loss of load) protection. Device shall have internal and external ground fault monitoring capabilities to an exacting 0.3-amp equipment protection. Additionally, the device shall have an option of monitoring three RTD's (PT100 or PT1000) temperature sensors or three NTC thermistor sensors.

C. All protective functions shall be programmed on the motor starter unit such that communication with the network connected control system is not required for operation in "hand" or "off" modes of operation.

D. The device shall have the ability to designate its inputs as external fault inputs for hardwiring into upstream or downstream parts of the application. Running status of the connected load shall be determined by monitoring motor current to give a true indication of running status. The device shall provide monitoring of operating hours, downtime hours, number of starts, overload trips and have permissible starting capabilities.

E. The device shall contain four digital inputs and three relay output points for use in controlling the motor starter. Output relays shall be programmable to either turn off or retain their status in the event of a control voltage loss or network failure.

F. The device shall also include on board logic elements including up to a total of six 3I/1O truth tables, two 2I/1O truth tables, and one 5I/2O truth table.

G. The device shall have up to four signal conditioners and four non-volatile elements with adjustable (edge rising with memory, edge falling with memory, inverting and non-inverting) conditions. Additional elements shall include up to four timers with adjustable (with closing delay, closing delay with memory, with off delay, with fleeting closing) conditions and four limit monitors for overshoots and undershoots of any of its analog signals.

H. The device shall communicate via Ethernet to a central master controller and provide motor current, in percent of the motor full load amps, input and output data, status

messages ON, OFF, under and over current warning and trip on a continuous cyclical basis.

I. The user shall have the ability to remotely monitor and program all programmable parameters, diagnostic data and operating data.

J. The device shall communicate at a maximum of 100Mbit Ethernet communication speed, and shall be auto baud rate sensing.

K. In the event of a communication network failure or PLC failure, the device shall operate as a stand-alone device. Upon restoration of the network, the device shall resume communication with the network.

2.4 NETWORK

A. The Motor Control Center shall be connected to the control system via the Ethernet switch located in the main control panel.

B. Motor Starters and VFDs shall be supplied with Ethernet communications.

2.5 METERING

A. Multifunction digital-metering monitors shall be, microprocessor-based unit suitable for three or four wire systems. Units shall communicate via:

1. Ethernet module

B. The meter shall be mounted on the door and shall meter at the Main Lugs

C. Metering Equipment

1. Provide a multi-function, high accuracy digital power metering instrumentation module equipped with LCD display. The power metering module shall provide simultaneous measurements for current, voltage and power parameters. Power meter shall be equipped with a communications port for Industrial Ethernet connection.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation shall be per the manufacturer's recommendations, written instructions, final shop drawings, and contract documents. Installation shall be coordinated with adjacent work to ensure proper sequence of construction, clearances and support.

B. The Motor Control Center shall not be placed in hazardous locations. The location shall be well ventilated and free from humidity, dust, and dirt. The temperature shall be no less than 32°F and no greater than 104°F. Protection shall be provided to prevent moisture from entering the enclosure.

3.2 TESTING

A. Perform factory and installation tests in accordance with applicable NEMA and UL requirements.

B. Provide technically certified personnel on site to perform pre-energization tests and provide certificate of proper installation.

C. During acceptance testing, provide technical personnel onsite with capability to diagnose errors, program MCC equipment and resolve any problems within the MCC system.

D. Provide services of manufacturer's representative for testing and commission per Section 01 75 00.

3.3 TRAINING

A. Provide 4 hours of onsite training for MCC maintenance.

B. Training shall include instruction on programming equipment supplied within the MCC center including the Power Meter and VFDs.

END OF SECTION

SECTION 26 27 16 - LOCAL CONTROL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Product Requirements.
6. Testing.

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 process equipment control descriptions in the Equipment Sections for system operation and interlock requirements.

1.3 REFERENCE STANDARDS

A. 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.

1. 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).

2. 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
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

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.

C. The assembled panels and individual components shall be UL Listed and labeled.

D. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 26 05 00 or UL recognized.

E. The control panels shall have factory applied UL 508A labels.

F. The intrinsic safety barriers required within a control panel shall be provide per UL 698A with factory applied labels as required by UL.

1.5 SUBMITTALS

A. Submittals requirements specified in: Section 01 33 00 and 26 05 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. Arrangement drawings of the panel enclosure indicating the front door and panel equipment arrangement and dimensions, and enclosure type.

b. List of materials and components with the layout drawings.

c. Data on all materials and components.

d. Heat calculations.

e. Nameplate schedule with character size and nameplate size.

2. Submittal drawing required:

a. Elementary/schematic diagrams.
b. Internal wiring connection diagrams.
c. External wiring interconnection diagrams including interlocks.
d. Power and control single line diagrams, where motor controllers are included.

3. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

4. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required".

1.6 PRODUCT REQUIREMENTS

A. The Vendor / Manufacturer package equipment and Contractor custom field panels shall adhere to the requirements in this specification and other sections of Division 26 and 40.

1.7 TESTING

A. Prior to shipment, the manufacturer shall test the functional operation of the control panels.

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. Saginaw
2. Hoffmann Enclosures, Inc.
3. Rittal.
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 75 watt in- candescent fixture with automatic “door activated” switch for every door. 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 00.

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 05 00..

2.6 INDICATING LIGHTS

A. Indicating lights shall be equipped with colored lenses as specified in Section 26 05 00.

2.7 SURGE PROTECTION

A. Surge protectors shall be provided at panel external terminal blocks signal circuits which extend to field devices. Surge protectors shall be Joslyn Model 1663-08, Taylor 1020FA, Transtector, 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 DESIGN AND FABRICATION

A. CONTROL CABINETS:

1. Install terminals on 2” standoffs.

2. Terminals shall be installed to allow a minimum of 2” of clear space be- tween the terminal and the wireway or any other components.

3. Coordinate terminals and wireway locations to account for the location of the conduit entrances into the cabinet (example: if the majority of the wiring is coming into the bottom of the cabinet, then mount the terminals at the bottom of the cabinet).

4. Provide separate wire ways for internal and field wiring.

5. Provide space at the bottom of the cabinet for the UPS if applicable.

6. Provide right angle connectors on cables if the cable connection prevents closing of access doors on equipment within the cabinet or on the control cabinet itself.

3.3 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.

3.4 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.

3.5 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. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution.

1.2 SCOPE

A. This Section specifies general use wiring devices consisting of receptacles, plugs, switches and appurtenances. Also covered in this section are plugs and receptacles used for motor disconnecting or isolation means.

1.3 REFERENCE STANDARDS

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.

1. 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

Reference	Title
UL 943	Ground-Fault Circuit Interrupters
UL 1010	Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

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. Submittal requirements specified in: Section 01 33 00.

B. Product Data:

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. Plugs and receptacles used for motor disconnecting and isolating means must be approved for such use.

    a. Non Metallic IP66/67 and NEMA 4X rated. Poly

    b. Disconnect rated.

    c. Provide units with current and HP ratings as required.

    d. Receptacles to include dead front shutter that deploys automatically when receptacle is removed.

    e. Plugs to be provided with spring assisted latching mechanism to secure in place when plugged into matching receptacle.

        1) Latching mechanism to include quick release button.

    f. Provide with two auxiliary / pilot contacts rated for 10 amps at 480 VAC.

        1) Where shown on the drawings or required by specific equipment, provide additional pilot contacts as required and as available within the product line.

2. Manufacturers: Crouse-Hinds “Arktite,” Appleton “Powertite,” Meltric “DS” or “DSN” series 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.

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 26 28 16.13 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions
5. Submittals.
6. Coordination.
7. Products.
8. Execution.

1.2 SCOPE

A. This section includes individually mounted enclosed switches and circuit breakers used for the following:

1. Service disconnecting means.
2. Feeder and branch-circuit protection.
3. Motor and equipment disconnecting means.

1.3 REFERENCE STANDARDS

A. NEMA AB 1 (National Electrical Manufacturers Association) - Molded Case Circuit Breakers.

B. NEMA FU1 (National Electrical Manufacturers Association) - Low Voltage Cartridge Fuses.

C. NEMA KS 1 (National Electrical Manufacturers Association) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

D. NETA ATS (National Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

E. NFPA 70 (National Fire Protection Association) - National Electrical Code.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment first start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.
B. RMS: Root mean square.
C. SPDT: Single pole, double throw.

1.6 SUBMITTALS

A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

B. Submittals shall include the following:

1. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

2. Shop Drawings: For each switch and circuit breaker.

a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

1) Enclosure types and details for types other than NEMA 250, Type 1.

2) Current and voltage ratings.

3) Short-circuit current rating.

4) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

5) Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

3. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches, accessories, and components will withstand seismic forces defined in Section 01 41 20.

a. Basis of Certification: Verify whether withstand certification is based on actual test of assembled components.

1) The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.”

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Field Test Reports: Submit written test reports and include the following:

a. Test procedures used.

b. Test results that comply with requirements.

c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

5. Manufacturer’s field service report.

6. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Section 01 77 00 - Project Closeout include the following:

a. Routine maintenance requirements for components.

b. Manufacturer’s written instructions for testing and adjusting switches and circuit breakers.

c. Time-current curves, including selectable ranges for each type of circuit breaker.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric.
3. Group Schneider/Square D
4. Siemens.
5. Or Approved Equal.

2.2 ENCLOSED CIRCUIT BREAKERS

A. Enclosed Circuit Breakers

1. Ground Fault protection type:

a. Required for solidly grounded wye service entrance switches over 150 Volts to ground, not exceeding 600 Volts and rated 1000 Amps and above.

2. Switch Duty (SWD) rated type for switching lighting fixtures. Note that energy code restricts use of circuit breakers as sole means of switching lighting circuits.

3. Auxiliary contacts: Provide as required by engineering considerations.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and two-pole configurations with 5 mA or 30 mA trip sensitivity.

7. Molded-Case Switch: Molded-case circuit breaker without trip units.

C. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted, Integral communication module with functions and features compatible with power monitoring and control system.

5. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

6. Auxiliary Switch: Two SPDT switches with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts, “b” contacts operate in reverse of circuit-breaker contacts.

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

8. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

D. Service Entrance: For enclosed circuit breakers identified for use as service equipment, provide solid neutral assembly and equipment ground bus.

2.3 ENCLOSURES

A. NEMA AB 1, NEMA KS 1 and UL 50 to meet environmental conditions of installed location.

1. Indoor Clean Locations: NEMA 250, Type 1.

2. Indoor Dusty Locations: NEMA 250, Type 12.

3. Indoor Wet or Damp Locations and Outdoor Dirty/Oily or Washdown Locations: NEMA 250, Type 4.

4. Outdoor Locations: NEMA 250, Type 3R.

5. Corrosive Locations: NEMA 250, Type 4X, stainless steel.

6. Hazardous Areas Indicated on Drawings: NEMA 250, Type [7] [8] [9].

2.4 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and tested enclosures before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 70 working space requirements and NECA 1.

B. Standard Mounting Height: Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Operating handle typically at 5'-0" above grade or finished floor.

C. Mount on substantial structure and secure to meet seismic zone 3 requirements. Comply with mounting and anchoring requirements specified in Section 01 41 20 - Seismic Requirements for Non-Structural Components and Systems.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses with rating indications facing outward.

F. Set adjustable parameters and provide testing and calibration as required by engineering considerations.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 - Electrical Identification.

B. Install enclosure nameplate with switch or circuit breaker designation, power source, source location, voltage, load served and load location.

1. Identify special conditions for shutting down load served.

C. Apply label inside door cover identifying NEMA fuse class and size of fuses installed.

D. Equipment used in emergency systems shall be labeled “Suitable for use on emergency systems” per NEC 700-3.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

1. Mark lugs after torqueing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to initially inspect, test, and adjust components, assemblies, and equipment installations, including connections. Verification will be by third party testing agency.

B. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.

2. Test continuity of each line- and load-side circuit.

C. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 OPERATION AND MAINTENANCE MANUALS

A. Comply with Section 01 78 23.13 - Operations and Maintenance Data and Part 1 of this specification.

END OF SECTION

SECTION 26 29 13.13 - ACROSS-THE-LINE MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution.

1.2 SCOPE

A. The extent and location of “Motor Controllers” Work is shown in the Contract Documents. This section includes motor controllers rated 600V and less that are supplied as enclosed units.

1.3 REFERENCE STANDARDS

A. IEEE C62.41 (Institute of Electrical and Electronics Engineers) - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. UL 489 - Molded Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

C. NEMA FU 1 (National Electrical Manufacturers Association) – Low Voltage Cartridge Fuses.

D. NEMA ICS 2 (National Electrical Manufacturers Association) - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

E. NEMA ICS 3 (National Electrical Manufacturers Association) - Industrial Control and Systems: Factory Built Assemblies.

F. NEMA ICS 5 (National Electrical Manufacturers Association) - Industrial Control and Systems: Control Circuit and Pilot Devices.

G. NEMA KS 1 (National Electrical Manufacturers Association) – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

H. NETA ATS (National Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

I. NFPA 70 (National Fire Protection Association) - National Electrical Code.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for electrical work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from the date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 SUBMITTALS

A. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

B. Submittals shall include the following:

1. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

2. Shop Drawings: For each motor controller.

a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

1) Enclosure types and details.

2) Factory-installed devices.

3) Nameplate legends.

4) Short-circuit current rating of integrated unit.

5) UL listing for series rating of overcurrent protective devices in combination controllers.

6) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

b. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

3. Field Test Reports: Written reports specified in Part 3.

4. Manufacturer's field service report.

5. Maintenance Data: For enclosed controllers and components to include in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Section 01 78 23.13 - Operations and Maintenance Data include the following:

    a. Parts list.

    b. Wiring schematics/diagrams and heater tables.

    c. Routine maintenance requirements for enclosed controllers and all installed components.

    d. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

6. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain controllers of a single type through one source from a single manufacturer in service for at least 10 years.

C. Listing and Labeling: Provide components, devices and accessories that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for intended use for the location and environment in which they are installed.

D. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, including clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen-Bradley
2. Eaton
3. General Electric
4. Group Schneider/Square D
5. Siemens
6. Or Approved Equal.

2.2 ENCLOSURES

A. NEMA ICS 6, Type to meet environmental conditions at installed location:

1. Indoor Clean, Dry Locations: NEMA 250, Type 1.
2. Indoor Locations Subject to Wet or Dry Contaminants: NEMA 250, Type 12.
3. Outdoor or Damp Locations: NEMA 250, Type [3R] [4].
4. Corrosive Locations: NEMA 250, Type 4X, stainless steel.
5. Hazardous Locations: NEMA 250, Type 7 to meet NFPA hazardous classification.

2.3 GENERAL

A. Provide reduced-voltage starters for centrifugal horsepower sizes for voltages and sizes as noted below:

1. 5 HP and larger - 208V, 3-phase
2. 5 HP and larger - 480V, 3-phase

B. Positive displacement loads shall have reduced voltage starters

2.4 STARTING METHODS MAY INCLUDE, BUT ARE NOT LIMITED, TO THE FOLLOWING

A. Manual
B. Magnetic Full Voltage Non-reversing (FVNR)
C. Magnetic Full Voltage reversing (FVR)
D. Magnetic Reduced Voltage Autotransformer (RVAT)
E. Magnetic Reduced Voltage Part Winding
F. Magnetic Reduced Voltage Wye Delta open or closed transition
G. Magnetic two speed one or two winding
H. Solid-state reduced voltage
I. Solid-state reduced voltage with contactor bypass
J. Solid-state soft start

2.5 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Configuration: Nonreversing OR Reversing OR Two speed.

2. Pilot Light:

a. Mounted in front of panel.
b. Red indicates “running”.
c. Green indicates “ready”.
d. Standard pilot lights are 120V, transformer type, push-to-test.

3. Additional Nameplates: FORWARD and REVERSE for reversing switches, HIGH and LOW for two-speed switches.

C. Fractional Horsepower Single Phase Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Configuration: Nonreversing OR Two speed.

2. Lockout means required in all applications.

3. Fault duty to meet available fault current.

4. Interchangeable overload heater elements.

5. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type or melting alloy type.

6. Red pilot light to indicate “running.”

7. Additional Nameplates: HIGH and LOW for two-speed controllers.

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Configuration: Nonreversing, reversing or two speed, depending on engineering considerations.

2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type or melting alloy type.

3. Red and Green pilot light.

4. Additional Nameplates: FORWARD and REVERSE for reversing controllers OR HIGH and LOW for two-speed controllers.

5. One each N.O. and N.C. reversible auxiliary contact.

E. Magnetic Controllers: Full voltage, across the line, electrically held.

1. Configuration: Nonreversing OR reversing, based on engineering considerations.

2. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: Size CPT at least one size above minimum VA requirements.

5. Melting Alloy Overload Relays:

    a. Inverse-time-current characteristic.

    b. Class 10 tripping characteristic.

    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

6. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.

    b. Class 10 tripping characteristic.

    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

    d. Ambient compensated where required by engineering requirements.

    e. Automatic resetting.

7. Solid-State Overload Relay:

    a. Switch or dial selectable for motor running overload protection. Software selectable is not acceptable.

    b. Sensors in each phase.

    c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

    d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

    e. IP addressable communication module.

8. One each N.C. and N.O. reversible isolated overload alarm contact.

9. External overload reset push button.

F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

1. Sizes 1 through 5 are standard for all applications.

2. Motor controller preferred features include:

a. Current sensor/microprocessor-type overload protection with adjustable parameters including overcurrent, ground fault, phase loss, phase unbalance, undervoltage and overvoltage.

b. Melting alloy or bimetallic strip type overload relays with ambient compensated inverse time-current characteristics are acceptable.

c. Control pushbuttons, industrial oil-tight type.

d. Push-to-test pilot lights.

3. Fusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.

b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

c. Auxiliary Contacts: Minimum two N.O./N.C. reversible contacts, arranged to activate before switch blades open.

4. Nonfusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.

b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

c. Auxiliary Contacts: Minimum two N.O./N.C. reversible contacts, arranged to activate before switch blades open.

5. MCP Disconnecting Means:

a. Use where available fault current is 65,000 Amps symmetrical or less.

b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted,

field-adjustable up to 1300% of motor FLA, short-circuit trip coordinated with motor locked-rotor amperes.

c. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

6. MCCB Disconnecting Means:

a. Use where available fault current exceeds 65,000 AIC.

b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

c. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

d. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

2.6 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.

B. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.

1. Configuration:

a. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank. Open or closed transition.

b. Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.

c. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

2. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT sized at least one size above the minimum VA requirements. Should an external power source be required, provide auxiliary contacts mechanically tied to the combination starter disconnect switch and wire so that control power within the motor starter module will be disconnected when the motor power disconnect is opened. The secondary of the CPT shall have one leg grounded. No switching of coils shall be allowed between the coil and the ground side.

5. Melting Alloy Overload Relays:

    a. Inverse-time-current characteristic.

    b. Class 10 tripping characteristic.

    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

6. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.

    b. Class 10 tripping characteristic.

    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

7. Solid-State Overload Relay:

    a. Switch or dial selectable for motor running overload protection. Software selectable controls are not allowed.

    b. Sensors in each phase.

    c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

    d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

    e. IP addressable communication module.

8. One each N.C. and N.O. reversible, isolated overload alarm contact.

9. External overload reset push button.

C. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.

1. Sizes 1 through 5 are standard for all applications.

2. Motor controller preferred features include:

   a. Current sensor/microprocessor-type overload protection with adjustable parameters including overcurrent, ground fault, phase loss, phase unbalance, undervoltage and overvoltage.

   b. Melting alloy or bimetallic strip type overload relays with ambient compensated inverse time-current characteristics are acceptable.

3. Fusible Disconnecting Means:

   a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.

   b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

   c. Auxiliary Contacts: Minimum two N.O./N.C. reversible contacts, arranged to activate before switch blades open.

4. Nonfusible Disconnecting Means:

   a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.

   b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

   c. Auxiliary Contacts: Minimum two N.O./N.C. reversible contacts, arranged to activate before switch blades open.

5. MCP Disconnecting Means:

   a. Use where available fault current is 65,000 Amps symmetrical or less.

   b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable up to 1300% of motor FLA, short-circuit trip coordinated with motor locked-rotor amperes.

   c. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

6. MCCB Disconnecting Means:

    a. Use where available fault current exceeds 65,000 Amps symmetrical.

    b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

    c. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

    d. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

2.7 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

A. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.

B. Reduced-Voltage Solid-State Controllers: An integrated unit with power semiconductors, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Configuration: Heavy duty, reversible OR non-reversible, depending on engineering considerations.

2. Starting Mode: Voltage ramping OR Current limit OR Torque control OR Torque control with voltage boost OR; field selectable, depending on application.

3. Stopping Mode: Coast to stop OR Adjustable torque deceleration OR Adjustable braking OR field selectable, depending on application.

4. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the power semiconductors. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.

5. Shorting and Input Isolation Contactor Coils, if required by project parameters: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors.

6. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.

7. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: Size CPT at least one size above minimum VA requirements.

8. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.

9. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:

    a. Adjusting motor full-load amperes, as a percentage of the controller's rating.

    b. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.

    c. Adjusting linear acceleration and deceleration ramps, in seconds.

    d. Initial torque, as a percentage of the nominal motor torque.

    e. Adjusting torque limit, as a percentage of the nominal motor torque.

    f. Adjusting maximum start time, in seconds.

    g. Adjusting voltage boost, as a percentage of the nominal supply voltage.

    h. Selecting stopping mode, and adjusting parameters.

    i. Selecting motor thermal overload protection class between 5 and 30.

    j. Activating and de-activating protection modes.

10. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:

    a. Controller Condition: Ready, starting, running, stopping.

    b. Motor Condition: Amperes, voltage, power factor, power, and thermal state.

    c. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted power semiconductors, line or phase loss, phase reversal, and line frequency over or under normal.

11. Controller Diagnostics and Protection:

    a. Microprocessor-based thermal protection system for monitoring power semiconductor and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.

    b. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.

    c. For controllers without integral disconnects, provide input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.

    d. For combination motor starter/disconnect, provide shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.

12. Remote Output Features:

    a. All outputs prewired to terminal blocks.
    b. Form C status contacts that change state when controller is running.
    c. Form C alarm contacts that change state when a fault condition occurs.

13. Optional Features:

    a. Analog output for field-selectable assignment of motor operating characteristics; 4 to 20-mA dc.

    b. Additional field-assignable Form C contacts, as indicated, for alarm outputs.

    c. Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

    d. Melting Alloy Overload Relays:

        1) Inverse-time-current characteristic.

        2) Class 10 tripping characteristic.

        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

e. Bimetallic Overload Relays:

1) Inverse-time-current characteristic.

2) Class 10 tripping characteristic.

3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

4) Ambient compensated.

f. Solid-State Overload Relay:

1) Switch or dial selectable for motor running overload protection. Software selectable controls are not allowed.

2) Sensors in each phase.

3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

5) IP addressable communication module.

g. One each N.C. and N.O. reversible, isolated overload alarm contact.

h. External overload reset push button.

C. Combination Reduced-Voltage Solid-State Controller: Factory-assembled combination of reduced-voltage solid-state controller, OCPD, and disconnecting means.

1. Fusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.

b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

c. Auxiliary Contacts: Minimum two N.O./N.C. reversible contacts, arranged to activate before switch blades open.

2. MCP Disconnecting Means:

a. Use where available fault current is 65,000 Amps symmetrical or less.

b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable up to 1300% of motor FLA, short-circuit trip coordinated with motor locked-rotor amperes.

c. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

3. MCCB Disconnecting Means:

a. Use where available fault current exceeds 65,000 Amps symmetrical.

b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

c. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

d. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

4. Molded-Case Switch Disconnecting Means:

a. UL 489, UL 489, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.

b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

2.8 MULTISPEED MAGNETIC CONTROLLERS

A. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.

1. Configuration: One or two winding, reversing or non-reversing, depending on project requirements.

2. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

3. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

   a. CPT Spare Capacity: Size CPT at least one size above minimum VA requirements.

5. Compelling relays shall ensure that motor will start only at low speed.

6. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.

7. Decelerating timer relays shall ensure automatically timed deceleration through each speed.

8. Melting Alloy Overload Relays:

   a. Inverse-time-current characteristic.

   b. Class 10 tripping characteristic.

   c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

9. Bimetallic Overload Relays:

   a. Inverse-time-current characteristic.

   b. Class 10 tripping characteristic.

   c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

   d. Ambient compensated.

10. Solid-State Overload Relay:

    a. Switch or dial selectable for motor running overload protection. Software selectable controls are not allowed.

    b. Sensors in each phase.

c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

e. IP addressable communication module.

11. One each N.C. and N.O. reversible, isolated overload alarm contact.

12. External overload reset push button.

C. Combination Multispeed Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.

1. Fusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.

b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

c. Auxiliary Contacts: Minimum two N.O./N.C. reversible contacts, arranged to activate before switch blades open.

2. Nonfusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.

b. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

c. Auxiliary Contacts: Minimum two N.O./N.C. reversible contacts, arranged to activate before switch blades open.

3. MCP Disconnecting Means:

a. Use where available fault current is 65,000 Amps symmetrical or less.

b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable up to 1300% of motor FLA, short-circuit trip coordinated with motor locked-rotor amperes.

c. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

4. MCCB Disconnecting Means:

    a. Use where available fault current is greater than 65,000 Amps symmetrical.

    b. UL 489, UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

    c. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

    d. Lockable Handle: Accepts 3/8-inch hasp padlocks and interlocks with cover in closed position.

2.9 VARIABLE-FREQUENCY CONTROLLERS

A. Refer to Section 26 29 23 - Variable Frequency Controllers.

2.10 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Buttons, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty, industrial oil-tight type.

1. Push Buttons: 120V, 20A, industrial grade, nylon, NEMA 13.

2. Pilot Lights: 120V LED transformer types, red “running” and green “ready”, push to test, mounted in front panel of each module.

3. Selector Switches: Rotary hand-off-auto mounted in front panel.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty with digital readout in hours.

F. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

G. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays as required by engineering considerations: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

H. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 and Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

I. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in enclosures installed outdoors.

J. Spare control wiring terminal blocks, quantity as indicated; unwired.

K. Current-Sensing, Phase-Failure Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.11 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and tested enclosed controllers before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive enclosed controllers for compliance with working space requirements of NEC Article 110-26, installation tolerances, and other conditions affecting performance.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 CONTROLLER INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks.

B. Install freestanding equipment on concrete bases complying with Section 03 30 00 - Cast-in-Place Concrete.

C. Enclosed Controller Fuses: Install fuses in each fusible switch.

D. Floor-Mounted Controllers: Install enclosed controllers on 3-1/2 -inch nominal-thickness concrete base. Concrete shall be rated minimum 3000 psi.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Seismic Bracing: Comply with requirements specified in Section 01 41 20 - Seismic Requirements for Non-Structural Components and Systems.

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. For individual magnetic motor starters, provide an overcurrent protection and disconnect device ahead of controller. This device shall be in an enclosure with lockout means.

H. Torque all lugs per manufacturer's written recommendations. When manufacturer's recommendations are unavailable, use UL 486A and UL 486B for torque values.

1. Place a spot of red paint on lugs after torqueing such that paint will be visibly disturbed if lugs are disturbed.

I. Install fuses in each fusible-switch enclosed controller.

J. Install fuses in control circuits if not factory installed.

K. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

L. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

M. Install power factor correction capacitors. Connect to the line or load side of overload relays as required by project parameters. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

N. Comply with NECA 1.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Section 26 05 19.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3. Provide auxiliary switch operated by disconnect switch mechanism to remove all foreign control power when disconnect switch is open.

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Electrical Sections. Drawings indicate general arrangement of raceways.

B. Ground equipment.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

1. Mark lugs after torqueing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.6 IDENTIFICATION

A. Identify enclosed controller components and control wiring according to Section 26 05 53 – Identification for Electrical Systems.

B. Label motor controller with engraved laminated-plastic nameplate with equipment designation, power source, source location, voltage/phase, load designation, location and horsepower.

C. Provide typed label inside motor controller door identifying motor nameplate horsepower, full-load amperes, code letter, service factor and voltage/phase rating.

D. Equipment used in emergency systems shall be labeled “Suitable for use on emergency systems” per NEC 700-3.

3.7 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pre-testing and adjusting solid-state controllers.

B. Prepare for acceptance tests as follows:

1. Remove all blocking used for shipment.

2. Test insulation resistance for each motor controller component, connecting supply, feeder, and control circuit. Use a 500-Volt Megger for 208- and 240-Volt systems, and a 1000-Volt Megger for 480-Volt systems.

3. Test continuity of circuit and equipment ground.

4. Verify proper rating of overcurrent protective device.

5. Verify correct conductor color-coding.

6. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the Engineer before starting the motor(s).

7. With motor disconnected, energize control circuit and test for correct functioning.

    a. Control switch test:

        1) Inspect all contacts and shunts. Clean contacts if required.

        2) Operate switch and note that all design functions are performed in proper sequence.

b. Check all auxiliary contacts for correct arrangement with coil de-energized (normally open or normally closed).

8. Check all motor for proper phase rotation.

C. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Section 7.16.1.

2. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than two weeks prior to Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: The Port shall have the option of performing its own infrared scan.

3. Certify compliance with test parameters.

4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

B. Set motor circuit protectors as low as possible without causing nuisance tripping.

C. Set motor overloads per manufacturer's tables for actual motor nameplate full-load amperes.

1. Where motor controllers with CT/Microprocessor overloads are employed, set all adjustable parameters per Engineer's instructions.

D. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

E. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Engineer before increasing settings. If initial setting of six times the motor nameplate FLA rating does not cause tripping, adjust settings down so that setting is as low as possible without causing nuisance tripping.

F. Set the taps on reduced-voltage autotransformer controllers as required as part of field certification.

G. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

H. Where motor controllers with CT/Microprocessor overloads are provided, set all adjustable parameters per Engineer's instructions.

I. Set field-adjustable circuit-breaker trip ranges.

3.9 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.10 STARTUP SERVICE

A. Verify that enclosed controllers are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Electrical Sections.

C. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION

SECTION 26 32 13 - STANDBY POWER SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. The work consists of furnishing electric generating set with features and accessories as specified herein and shown on the drawings. Standby Power System shall consist of a diesel engine-driven alternator rated 480/277-volt, 3-phase, 60 Hz; digital (micro-processor based) electronic generator set control system; sub-base fuel tank; and fuel transfer pump, if required. Minimum rating of the generating set will be as shown.

B. Automatic Transfer Switch (ATS), as described below.

1.2 GENERAL REQUIREMENTS

A. Materials and workmanship:

1. Materials and parts comprising the standby power system specified herein shall be new, unused, of current manufacture and of the highest grade, free from all defects.

2. Workmanship shall be the highest grade, in accordance with modern practice.

B. Parts and service: Bidders shall specify nearest location of permanent parts depots from which replacement parts may be obtained in necessary quantities at any time, day or night. Service facilities and personnel shall be equally available.

C. Contractor shall apply for fire/life safety permit after submittal approval.

1.3 GENERATOR SET PERFORMANCE

A. Steady-State Voltage Operational Bandwidth: 0.25% of rated output voltage from no load to full load.

B. Steady-State Voltage Modulation Frequency: Less than one Hz.

C. Transient Voltage Performance: Not more than 15 percent variation for 50 percent step-load increase; not more than 10 percent variation for 50 percent step-load decrease. Voltage recovers to remain within the steady-state operating band within 2 seconds.

D. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

E. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.

F. Transient Frequency Performance: Less than 4-Hz variation for a 50 percent step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within 2.5 seconds.

G. Output Waveform: At no load, harmonic content measured line-to-line or line-to-neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, does not exceed 50.

H. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at the system output terminals, the system will supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.

I. Temperature Rise of Generator: Within limits permitted by NEMA MG 1 when operating continuously at full-rated load, including 2 hours per 24 hours at 110 percent of rated capacity.

J. Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, is 7 seconds. Time period includes output voltage and frequency settlement within specified steady-state bands.

1.4 SUBMITTALS

A. Submittals after award of Contract shall be made in accordance with Division 1, General Requirements, and Section 26 05 00, General Requirements for Electrical Work.

B. Product Data: For each component. Include data on features, components, ratings, and performance. Include dimensioned outline plan and elevation drawings of engine generator set and other system components.

C. Shop Drawings: Show details of fabrication, piping, wiring, and installation of field-installed portions of system, including remote fueling station. Include general arrangement drawings showing locations of auxiliary components in relation to engine generator set and duct, piping, and wiring connections between generator set and auxiliary equipment. Show connections, mounting, and support provisions and access and workspace requirements.

1. Wiring Diagrams: Show details of power and control connections and differentiating between factory-installed and field-installed wiring.

D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article.

E. Field Test and Observation Reports: Indicate and interpret test results for compliance with performance requirements.

F. Certified Test Reports of Components and Accessories: For devices that are equivalent, but not identical, to those tested on prototype unit.

G. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet critical performance criteria.

H. Factory Test Reports: For units to be shipped for this Project showing evidence of compliance with specified requirements.

I. Exhaust Emissions Test Report: To show compliance with applicable, current regulations.

J. Sound measurement test report.

K. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.

L. Certificate of Compliance for Seismic Design of Nonstructural Components and Systems for generator set and automatic transfer switch

M. Field test report of tests specified in Part 3.

N. Maintenance data for system and components to include in the maintenance manuals specified in Division 1. Include the following:

1. List of tools and replacement items recommended to be stored at the site for ready access. Include part and drawing numbers, current unit prices, and source of supply.

2. Detail operating instructions for both normal and abnormal conditions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing equipment of types and capacities similar to those indicated for this Project and with a service center maintained by engine generator set manufacturer capable of providing training, parts, and emergency maintenance and repairs at the Project site with 24 hours maximum response time.

B. Source Limitations: Obtain engine generator set and auxiliary components from a single manufacturer with responsibility for entire system.

C. Listing and Labeling: Provide system components of types and ratings for which listing or labeling service is established and components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

D. Comply with NFPA 70.

E. Comply with NFPA 99.

F. Comply with NFPA 704, Hazard Identification signage.

G. Engine Exhaust Emissions: Comply with applicable federal, state, and local government requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty signed by Contractor and manufacturer, with single-source responsibility for engine generator and auxiliary components, agreeing to repair or replace items that do not meet requirements or that deteriorate as defined in this Section within the specified warranty period.

C. Warranty Period: 5 years (for engine-generator set) from date of Substantial Completion. Warranty shall cover 100% parts (except consumables, unless consumables were damaged by the failure) and labor.

1.8 MAINTENANCE SERVICE

A. Maintenance: Beginning at Substantial Completion, provide 12 months full maintenance by skilled employees of the manufacturer's designated service

organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies as used in the manufacture and installation of original equipment.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. MTU
B. Cummins
C. Generac
D. Approved Equal

2.2 SERVICE CONDITIONS

A. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 deg C to plus 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 3,000 feet (909 m).

B. Unusual Service Conditions: Engine generator equipment and installation is required to operate in the following conditions:

1. Applicable seismic requirements as defined in the International Building Code (IBC) for the location of installation.

2.3 DIESEL ENGINE-GENERATOR SET

A. Rating: The generator rating is summarized below:

1. Standby rating (kW) as shown on the drawings, 480/277 V, 60 Hz, three-phase, 4 wire, 0.8 Power Factor

B. Generator Set Performance: As specified in 1.3.

1. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

2. The generator set shall be capable of sustaining a minimum of 90% of rated kVA load at no more than 35% voltage dip applied to the generator set.

C. AC Generator, Regulator and Exciter Units.

1. The AC Generator shall comply with NEMA MG 1 and specified performance requirements. The generator shall be synchronous, four pole, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s). Exciter shall rotate integrally with generator rotor. All insulation system components shall meet NEMA MG1 standard temperature limits for Class H insulation systems. Actual temperature rise measured by resistance method at full load shall not exceed 105°C. The generator shall have 2/3 pitch stator winding. The subtransient reactance 15 percent maximum.

2. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices. The automatic voltage regulator shall be temperature compensated, solid-state design.

3. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include an under frequency rolloff torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 hertz. The torque-matching characteristic shall include differential rate of frequency change compensation to the maximum available engine torque and provide optimal transient load response. Regulators that use fixed volts per hertz characteristic are not acceptable. The voltage regulator shall have adjustable rheostat on control and monitoring panel to provide plus or minus 5 percent adjustment of output voltage operating band.

4. The generator shall be broad range, 12 lead reconnectable. Instrument transformers shall be mounted within generator enclosure. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage within the broad range.

D. Engine-Generator Set Controls

1. The controls shall be digital (microprocessor based) electronic, fully NFPA 110 compliant, and shall have automatic remote start capability from a panel-mounted 3-position (Stop, Run, Remote) switch.

2. Provide cycle cranking of 15 SEC (ON)/15 SEC (OFF) for three attempts (75 SEC). If engine fails to start, lockout the engine, and indicate overcrank on alarm status panel.

3. The control shall shut down and lock out upon:

    a. Failing to start (overcrank)
    b. Overspeed
    c. Low lubricating oil pressure
    d. High engine temperature
    e. Operation of a remote manual stop station.

4. The NEMA 1 enclosed control panel shall be mounted on the generator set with vibration isolators. A front control panel illumination lamp with ON/OFF switch shall be provided. Control panel shall provide a multi-line LCD display capable of displaying the following:

    a. Engine Oil Pressure

    b. Coolant Temperature

    c. DC Voltage

    d. Total Run Time (hours)

    e. Output AC Voltage, for each phase, simultaneously

    f. Output AC Amperage, for each phase, simultaneously

    g. Output Frequency

    h. Alarms and Warnings - as a minimum, the following alarms and warning shall be displayed upon activation:

        1) Overcrank shutdown
        2) Overspeed shutdown
        3) Low oil pressure shutdown
        4) High engine temperature shutdown
        5) High engine temperature pre-alarm
        6) Low engine oil pressure pre-alarm
        7) Low coolant temperature
        8) Low coolant level
        9) Low fuel
        10) Not in automatic start

5. Provide “dry” contacts for the following conditions, as a minimum. Contacts shall be rated 10 Amps at 120 VAC:

    a. Generator in “Auto”

b. Generator fail (common failure alarm)

c. Low fuel

d. Generator running

e. Tank Rupture (Leak)

f. Fuel Tank 90% Full (for remote fueling station)

g. Fuel Tank 95% Full (for remote fueling station)

h. Fuel Tank High Level (this is in addition to, and different from, the 95% full level. High level shall be higher than 95% full level)

6. Provide either (Contractor's Option):

a. A remote annunciator, to be installed at the remote fueling station; remote annunciator shall communicate with the generator control panel via a communications cable. Or,

b. Dry contacts for the alarms shown.

c. Minimum alarms (from "a" or "b", above) at remote fueling station shall be:

1) Leak
2) Fuel Tank High Level

E. Engine: The engines shall be 2 or 4 cycle, 1800 RPM, diesel.

1. Governing: The unit shall have an engine speed electronic governor to provide isochronous generator set frequency control. The governor shall be capable of parallel operation with the addition of load sharing controls.

2. Cooling Systems: The engines shall be cooled by a skid-mounted closed loop horizontal radiator systems, including centrifugal fan, coolant pump and thermostat temperature control. The cooling system shall be rated for full rated load operation in 122°F (50°C) ambient conditions. The size of radiator shall be adequate to contain expansion of total system coolant from cold start to 110 percent load condition. The cooling system, including cooling air flow paths, shall be designed to minimize noise. The cooling capability of the generator set shall be demonstrated by prototype tests on a representative generator set model. The provided engine thermostat shall regulate engine water temperature as recommended by the manufacturer. Provide a high-coolant temperature device to shut down the engine through the engine control panel when the engine

temperature exceeds 200°F. The engine cooling system shall be filled with an extended life coolant to protect the system to a temperature of 0°F.

3. Engine Fuel System: Comply with NFPA 30. Fuel: Diesel fuel oil grade DF-2.

4. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft.

5. Accessories: To include:

   a. An electric starter capable of three complete cranking cycles

   b. Block heater(s), size as recommended by manufacturer. Block heater(s) shall be 120V, 1-phase.

   c. Battery charger with “high charge” option

   d. Positive displacement, mechanical, full pressure, lubrication oil pump.

   e. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

   f. Fuel filter with replaceable spin-on canister element.

   g. Replaceable dry element air cleaner with restriction indicator.

   h. Flexible supply and return fuel lines.

   i. Engine mounted battery charging alternator, 45 ampere minimum, and solid-state voltage regulator.

   j. Starting batteries.

F. Bases: The engine-generator set will be mounted with vibration isolators on a heavy-duty steel base to maintain proper alignment between components. The engine-generator set shall incorporate a battery tray with battery hold down clamps within the base rails. The engine-generator sets will have Seismic Zone 3 isolator pads for mounting.

G. Main Circuit Breaker: Provide a generator mounted circuit breaker, molded case, 100% rated, 3 pole, NEMA 1/IP22, which will disconnect the generator from the supply circuit. Circuit breaker to be sized as shown. Breaker shall utilize a solid-state trip unit and shall have the electrical characteristics, rating, and modifications as shown. The breaker shall be UL/CSA Listed and connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set and shall have a metal nameplate that contains a

permanent record of the circuit breaker catalog number and maximum ratings. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker.

1. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated drawing. The solid-state trip circuit breaker shall include the following adjustments; each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments:

    a. An ampere trip setting (long time pickup) that is adjustable from 0.5 times (minimum) to 1.0 times the plug ampere rating, in 0.1 increments.

    b. An adjustable long time pickup delay, with a minimum of 5 different delay settings.

    c. A short time pickup trip setting that is adjustable from 2 times (minimum) to 9 (minimum) the long time ampere trip setting.

    d. An adjustable short time delay ramp function, with a minimum of 5 different delay settings.

    e. An instantaneous pickup that is capable of being disabled (preferable) or is adjustable from 1.5 times (or less) to 15 times (or greater) the long time ampere trip setting. Units that are capable of disabling the instantaneous pickup shall be configured with the instantaneous pickup disabled.

2. Main Circuit Breaker shall have a quick-make, quick break, over-center toggle type, trip-free mechanism to prevent holding contacts closed against a position between "ON" and "OFF" when tripped automatically. Breaker shall be common trip such that an overload or short circuit on any one pole will result in all poles opening simultaneously.

3. The interrupting capacity of the Main Circuit Breaker shall be 42 kAIC at 480 volts, minimum.

4. Provide a “Circuit Breaker Tripped/Off” status contact. Contact shall be rated 10 Amps at 120 VAC.

2.4 OUTDOOR SOUND ATTENUATED ENCLOSURE

A. The generator set shall be provided with an outdoor sound attenuated enclosure level 2, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (when

used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

B. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two-step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted.

C. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.

D. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.

E. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.

F. The enclosure shall include the following maintenance provisions:

1. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves

2. External radiator fill provision.

G. Provide an external emergency stop switch that is protected from accidental actuation.

H. Provide motorized louvers to minimize air flow through the enclosure when generator set is not operating. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation.

I. Inlet ducts shall include rain hoods.

J. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in an ambient temperature of up to 100F. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 70 dBA at any location 7 meters from the generator set in a free field environment.

K. The enclosure shall be insulated with non-hydroscopic materials.

2.5 SUB-BASE TANK

A. Provide a sub-base tank for the generator set. Sub-base tank shall be equipped for automatic, unattended operation.

B. Construction: Tank constructed shall have integral secondary containment per UL 142 listed. Sub-base tanks shall have structural integrity to support the engine-generator set. Minimum features shall include all welded construction, a lockable fuel filler cap, fuel gauge, low fuel level alarm, fuel line check valve and fittings for fuel supply, return, fill and vents.

C. Monitoring: Dry contacts wired to terminals in the control panel for a low level fuel alarm. Monitor for liquid in the secondary containment shall be provided per IFC 5004 2.2.5.

D. Venting: Normal atmospheric vent shall not be less than 12-ft above adjacent grade, nor located for trapped vapors under eaves, and at least 5 feet from building openings or property lines per IFC 5704.2.7.3.3. Normal atmospheric or emergency vents shall not be manifolded per IFC 5704 2.7.3.5. The tank emergency vents shall not vent inside a building or weather housing, IFC 5704 2.7.4.2 (UL2085 tanks are exempt from this requirement).

E. Fuel Filling & Fill/Spill Station: Filling, emptying, and vapor recovery openings shall be located outside the building or weatherproof housing, not less than 5 feet from building openings or lot lines per IFC 5704, 2.7.5.2. Fuel fill tube shall be installed to minimize static electricity by terminating within 6 inches of the tank bottom per IFC 5704, 2.7.5.5. Spill container with a capacity of not less than 5 gallons shall be provided for fill connection. Fill connections shall be positive no leak direct connection design. IFC 5704 2.9.7.8. Liquid tight cap as per IFC 5704 2.7.5.2.

F. An Overfill prevention valve shall be provided, set at 95% of capacity or sooner. An audible or visual alarm notifying fuel level is at 90% of tank capacity or sooner, per 5704 2.9.7.6 and 2.7.5.8. Mount remote alarm panel as shown on the Drawings.

2.6 AUTOMATIC TRANSFER SWITCH

A. Furnish and install where indicated a “programmed (delayed) transition” style, 3-pole (with solid neutral) automatic transfer switch with ratings, features, accessories, enclosures, etc. indicated on the drawings or noted herein. To maintain maintenance compatibility, automatic transfer switch shall be provided by engine-generator manufacturer.

B. The transfer switch equipment as specified herein shall be 100% equipment rated for continuous duty at the ratings shown on the plans and shall conform to the applicable

requirements for UL 1008 for emergency total system load. All transfer switch equipment supplied shall bear the UL label.

C. All main power contacts shall be rated for multiple fault interruptions per UL 489, and/or UL 1087. Main contacts shall have independent “break-before-make” transfer action which shall positively prevent dangerous “source-to-source” connections.

D. Automatic transfer switches specified herein shall consist of completely enclosed contact assemblies and a separately mounted control logic panel. Control power for all automatic transfer operations shall be derived from the line side of the source to which the load is being transferred.

E. Upon loss of phase-to-phase voltage of the normal power source on any phase to 70% of nominal, and after a time delay of 0-5 seconds (adjustable to meet conditions present) to override momentary dips and/or outages, starting of the emergency/standby power source shall be initiated. Transfer to the emergency standby power source shall take place 2-60 seconds (adjustable) after attainment of 90% of rated voltage and frequency of that source.

F. When the normal power source has been restored to 90% of rated voltage and after a time delay adjustable from 0-30 minutes (to insure the integrity of the normal power source), the load shall be retransferred to the normal source.

G. A time delay, adjustable 0-10 minutes, shall delay shutdown of the emergency/standby power source after retransfer to allow the generator to run unloaded for cool-down, after which the generator shall be automatically shut down.

H. If the emergency/standby power source should fail while carrying the load, transfer to the normal power source shall be made instantaneously upon restoration of the normal source to satisfactory conditions.

I. The following features/accessories shall be provided:

1. Auto/test switch to provide test operation of the automatic transfer switch by simulating a loss of the normal power source.

2. Pilot lights to indicate to which source the load is connected.

3. Pilot lights to indicate that an integral overcurrent protective device has tripped.

4. Plant exerciser timer providing automatic test operation of the emergency/standby power source at pre-selected intervals at least once per week, including a selector switch to select exercise with or without load or a bypass of the exercise period. The clock timer shall be provided with a digital readout and include a lithium battery backup to assure continuity of power to the clock timer for a minimum of 72 hours during an outage.

5. Provide “dry”, form C contacts for the following conditions, as a minimum. Contacts shall be rated 10 Amps at 120 VAC:

    a. ATS in “Normal” position
    b. ATS in “Generator” position
    c. “Normal” power source available
    d. ATS failure (common failure alarm)

J. Installation of all transfer switch equipment specified herein shall be in accordance with all applicable codes, standards, and practices. Installation of all transfer switch equipment specified herein shall be in accordance with the recommendations of the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. Install equipment and materials in a neat and workmanlike manner and align, level, and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance, and repair.

3.2 SUPPORTS

A. Provide hangers or other devices such as pads, anchors, etc., necessary for the support of the equipment.

B. Provide anchorage according to manufacturer’s written instructions, unless otherwise indicated.

3.3 INSTALLATION

A. Material and Equipment Installation: Follow manufacturer’s installation instructions explicitly, unless otherwise directed. Wherever any conflict arises between manufacturer’s instructions and these Contract Documents, follow Engineer’s direction, at no additional cost to the Owner. Keep copy of manufacturer’s instructions on the job site available for review at all times.

B. The Contractor shall be responsible and shall provide for the supply, installation adjustment, and startup of complete, coordinated systems, which shall reliably perform the specified functions.

C. Maintain minimum workspace around components according to manufacturer’s Shop Drawings and National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise installation and connection of the generator-set unit and to report results in writing.

B. Supervised Adjusting and Pretesting: Under supervision of factory-authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Load system using a variable resistive load bank simulating kW of loads for which unit is rated.

3.5 TESTING AND STARTUP

A. The following shall be provided:

1. The manufacturer shall provide a certified copy of a 4-hour full-load factory test of a prototype engine-generator unit of the same size as the one being provided with recordings of voltage, frequency, amperage, engine temperature, lube oil pressure, and load transfer results to the Engineer.

2. The actual generator unit shall be field tested with all standby loads picked up and operated for a minimum period of 4 hours. One electronic PDF copy of the test results shall be provided to the Engineer. This testing is to be accomplished only after control system startup and verification to ensure only the correct load is brought on line with the generator in operation.

3.6 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.7 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's maintenance personnel as specified below.

1. Conduct a minimum of 8 hours of training as specified in Section 01 75 00 Testing and Commissioning.

2. Schedule training with at least 7 days' advance notice.

3.8 SPARE PARTS

A. Provide the following spare parts for each generator unit

1. Three sets fuel oil filter elements and gaskets.
2. Three lubricating oil filter elements and gaskets.
3. Three coolant filter elements and gaskets.
4. One set of silicon coolant hoses.
5. One air cleaner filter element.
6. Fuses: 1 for every 10 of each type and rating, but not less than 1 of each.

END OF SECTION

SECTION 26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW- VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions.
5. Submittals.
6. Products.
7. Execution.

1.2 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers (MCC).

B. Provide a transient voltage suppression system that is suitable for application in IEEE C62.41 Category A, B and C3 environments, as tested by IEEE C2.11, C62.45.

1.3 REFERENCE STANDARDS

A. Provide SPD unit designed, manufactured, tested and installed in compliance with the following codes and standards:

1. IEEE C62.41, C62.43, C62.45, C62.48, C62.62 Institute of Electrical and Electronic Engineers

2. NEMA LS-1 National Electrical Manufacturer Association

3. NFPA 20, 75 and 780 National Fire Protection Association

4. NFPA 70 National Electric Code

5. UL 1449 4th Edition or later, UL 1283 5th Edition or later and UL 96A Underwriters Laboratories

6. IEC 801 International Electrotechnical Commission

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. Furnish a manufacturer’s full 5-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL Listing requirements, and any applicable national, state, or local electrical codes.

1.5 DEFINITIONS

A. TVSS - Transient Voltage Surge Suppression.
B. SAD - Silicon Avalanche Diode.
C. MOV - Metal Oxide Varistor.
D. SPD - Surge protective device.

1.6 SUBMITTALS

A. Furnish submittals in accordance with Section 26 05 00.

B. Product Data:

1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Specification.

2. Submit independent test data from a nationally recognized testing laboratory verifying the following:

a. Lifecycle testing
b. Overcurrent protection
c. UL 1449 4th Edition or later.
d. Surge current capacity.

C. Shop Drawings:

1. Provide electrical and mechanical drawings by the manufacturer that detail:

a. Unit dimensions.
b. Weights.
c. Components
d. Field connection locations.
e. Mounting provisions.
f. Connection details.
g. Wiring diagram.

D. Operation and Maintenance Manuals:

1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.7 COORDINATION

A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:

1. Liebert.
2. Eaton/Cutler Hammer.
3. Square D.
4. General Electric.

2.2 MANUFACTURED UNITS

A. Electrical Requirements

1. SPD ratings shall be consistent with the nominal system operating voltage, phase, and configuration.

2. Maximum Continuous Operating Voltage (MCOV):

a. The MCOV shall not be less than 115% of the nominal system operating voltage.

3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards. End of life mode to be open circuit. Unit with end of life short-circuit mode are not acceptable.

4. Unit shall operate without the need for an external overcurrent protection device (OCPD) and be listed by UL as such. Unit must not require external OCPD or replaceable internal OCPD for the UL Listing.

5. Operating Frequency:

a. 47 to 63 hertz.

6. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

B. Protection Modes:

1. Provide SPD protection modes as follows:

a. Line to Neutral (L-N).
b. Line to Ground (L-G).
c. Neutral to Ground (N-G).
d. Line to Line (L-L).

C. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

	Nominal Voltage	Configuration	L-N (Volts)	N-G (Volts)	L-G (Volts)	L-L (Volts)
Wye Models	120/208	Grounded Wye	700	700	700	1200
	277/480	Grounded Wye	1200	1200	1200	2000
	347/600	Grounded Wye	1500	1500	1500	3000

D. Environmental Requirements:

1. Storage Temperature:

a. -40 degrees to +60 degrees Celsius.

2. Operating Temperature:

a. 20 degrees to +60 Celsius.

3. Relative Humidity:

a. 5 percent to 95 percent.

4. Audible Noise:

a. Less than 45 dBa at 5 feet (1.5 m).

5. Operating Altitude:

a. Zero to 12,000 feet above sea level.

E. Enclosure:

1. Located in electrical equipment where indicated on the Drawings.

F. Internal Connections:

1. Provide low impedance copper plates for intra-unit connections:

   a. Attach surge modules using bolted connections to the plates for low impedance connections.

2. Size all connections, conductors, and terminals for the specified surge current capacity.

2.3 COMPONENTS

A. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable single-mode modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

B. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

C. Electrical Noise Filter – Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

1. Type 2 units with filtering shall conform to UL 1283 5th Edition.
2. Type 1 units shall not contain filtering or have a UL 1283 5th Edition Listing.

D. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

E. Thermal MOV Protection

1. The unit shall contain thermally protected MOVs. These self-protected MOVs shall have a thermal protection element integrated with the MOV and a mechanical disconnect with arc quenching capabilities in order to achieve overcurrent protection of the MOV. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

F. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. The use of plug in single-mode modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

G. Safety Requirements

1. The SPD shall minimize potential arc flash hazards by containing no single-mode plug in user serviceable / replaceable parts and shall not require periodic maintenance. SPDs containing items such as replaceable single-mode plug in modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

2. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.4 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

2.5 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.

2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.

3. The panelboard shall be capable of re-energizing upon removal of the SPD.

4. The SPD shall be integral to the panelboard and connected directly to the bus. Alternately, an integral SPD can be connected to a circuit breaker for disconnecting purposes, in the case a disconnect is required.

5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.

6. The SPD shall be of the same manufacturer as the panelboard.

7. The complete panelboard including the SPD shall be UL67 listed.

2.6 SWITCHGEAR, SWITCHBOARD, MCC AND BUSWAY REQUIREMENTS

A. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.

B. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, or busway.

C. The SPD shall be factory installed integral to the switchgear, switchboard, MCC, and/or bus plug at the assembly plant by the original equipment manufacturer.

D. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

E. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

F. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.

G. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.7 SERVICE ENTRANCE REQUIREMENTS

A. Service entrance located SPDs shall be tested and designed for applications within ANSI/IEEE C62.41 Category C environments.

2.8 ACCESSORIES

A. Unit status indicators:

1. Provide red and green solid-state indicators, with printed labels, on the hinged front cover to redundantly indicate on-line unit status:

a. The absence of the green light and the presence of the red light indicates that surge protection is reduced and service is needed to restore full operation.

B. Dry contacts for remote monitoring:

1. Electrically isolated Form C dry contacts (10A/125VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide on-line circuit, which tests and redundantly monitors individual components in all protection modes including neutral to ground:

1. Units that require external test sets or equipment are unacceptable.

D. Provide an integral disconnect switch located in-line with the SPD system enclosure:

1. External manual operator.

2. The switch shall disconnect all ungrounded circuit conductors from the SPD.

3. The integral disconnect switch shall be capable of withstanding, without failure, the maximum published surge current magnitude and short circuit current without failure or damage to the switch.

E. Interconnection Cable:

1. Interconnect the SPD to the power system using a manufacturer furnished assembly of low impedance coaxial cables installed in flexible conduit.

2. Cable designed to transmit transients with minimal voltage drop.

3. UL listed.

2.9 SOURCE QUALITY CONTROL

A. Permanently affix surge rating to the SPD.

B. Test the system at the component and fully assembled level, under surge conditions with alternating current power applied for a minimum of 1 hour:

1. Testing includes but not limited to:

a. Quality control checks.
b. Dielectric voltage withstand test per UL requirements.
c. UL ground continuity tests.
d. Operational and calibration tests.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Section 26 05 00.

B. Special Techniques:

1. Install the SPD with as short and straight conductors including ground conductor as practically possible.

2. Twist the SPD input conductors together to reduce input conductor inductance.

3. Follow the SPD manufacturer's recommended installation practices and comply with all applicable codes.

4. Interconnect the SPD to the power system using a manufacturer supplied interconnection cable consisting of low impedance coaxial cables installed in a flexible conduit.

5. Do not subject SPD to insulation resistance testing.

END OF SECTION

SECTION 26 50 00 - LUMINAIRES

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 luminaries (lighting fixtures) features and installation.

1.3 DEFINITION

A. Lighting terminology used herein is defined in IES RP-16.

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 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 70	National Electrical Code (NEC)

B. SPECIAL WARRANTY: In accordance with Section 01 10 00 provide a Special Warranty for LED luminaires. The Special Warranty shall include as a minimum the following:

1. A written 5-year on-site replacement material, fixture finish and workmanship. On-site replacement includes transportation, removal, and installation of new products. Finish warranty must include warranty against failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.

2. A written 5-year replacement material warranty for defective or non-starting LED source assemblies.

3. A written 5-year replacement material warranty on all power supply units (PSU).

4. A written 5-year replacement warranty for luminaires producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.

5. The warranty period shall begin on the date of Substantial Completion. The Contractor shall provide the Owner with appropriate signed warranty certificates. The Owner shall have received these certificates prior to final payment.

1.5 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. Manufacturer's descriptive catalog literature for all fixtures and accessories being installed under this section. Information shall include manufacturer, wattage, voltage, mounting configuration, and lamp type. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

3. Applicable operation and maintenance items.

4. Catalog information describing fixture make, materials, and dimensions.

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise specified, lighting materials, including fixtures, accessories, and hardware, shall conform to the requirements specified in the drawings. Lighting

fixtures shall be provided where specified on the drawings. The drawing's light fixture placement is diagrammatical in nature. The actual installation and fixture layout shall be coordinated with the various trades and equipment.

2.2 LAMPS

A. ACCEPTABLE PRODUCTS: Lamps shall be Dialight, General Electric, North American Philips (Norelco), Sylvania, Venture Lighting International, or approved equal.

B. GENERAL:

1. Lamps shall be as specified on the Luminaire Schedule in the drawings.

C. SPARES: Number of spares shall be equal to 5 percent of each rating type, with a minimum of one standard manufacturer's package.

2.3 EXTERIOR LIGHTING POLES ON STRUCTURE

A. GENERAL: Provide lighting poles with the necessary fixture mounting hardware.

B. TYPE: Poles shall be 2.5" diameter stainless steel with hand holes.

C. Where Shown on the drawings, provide 1" X 10' Rigid Galvanized Steel Conduit to serve as mounting pole for fixtures attached to structure. Attached Conduit to Structure in a minimum of two places with approved anchorage method for wind load of the project area.

D. Where shown on the drawings, poles to be provided with GFI, weatherproof receptacles located 24" above the base.

2.4 PHOTOELECTRIC CELL UNITS

A. Where required, Photoelectric cell units shall consist of a cadmium sulfide cell housed in a plug receptacle assembly. The plug receptacle assembly shall be three-prong polarized locking type. Assembly shall be suitable for outdoor mounting and shall be rated for 1800 VA at 120V maximum capacity.

2.5 EMERGENCY LIGHTING

A. In areas that show or require emergency lighting fixture in room that is also used for normal lighting, shall include LED luminaires as specified in this Section but with integrated 90 minute backup battery and test switch.

2.6 LED LUMINAIRES (LED)

A. LED luminaires shall be a complete functioning unit with all components including light source, lamps, power supply, control interface and any additional components needed for operation shall be assembled by the luminaire manufacturer.

B. Luminaires shall comply with ANSI chromaticity standard for classifications of color temperature. See the Luminare Schedule in the drawings for specified LED lamp color and color temperature. Luminaire shall be UL or ETL listed and labeled.

C. Luminaire testing shall be per IESNA LM-79 AND LM-80 procedures.

D. Useful Life Requirements: The useful life of the luminaire in terms of lumen output must be specified by one of the following two methods:

1. Simplified L70 threshold: A minimum of 50,000 operating hours before reaching the L70 lumen output degradation point, accounting for individual LED lumen depreciation and catastrophic failures. Fifty percent of the sample population must reach the 50,000 hour point—this is known as B50. Only 10 percent of the LED lamps can have failed in a conventional sense— this is known as F10.

E. Provide shop drawings showing illumination levels with LED systems based on lumen output at 70 percent lumen depreciation for white LEDs and 50 percent for colored LEDs. Initial lumen output for all LEDs shall be listed individually.

F. LED drivers shall have reversed polarity protection, open circuit protection and require no minimum load. Drivers shall operate at a minimum 80 percent efficiency and have a class-A noise rating.

G. Where LED systems are required to be dimmable, the LED system shall be capable of full and continuous dimming.

PART 3 EXECUTION

3.1 GENERAL

A. The location and type of fixtures are shown on the drawings. Lighting circuit raceways and conductors shall be sized by the contractor. Raceways and wire shall be provided from the fixtures and switches to the lighting panel in accordance with the NEC. Raceways shall be provided in accordance with Section 26 05 33. Wire shall be provided in accordance with Section 26 05 19.

B. Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture

shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

C. Photoelectric cells, where specified, shall be oriented toward the north.

D. Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

E. Where recessed fixtures are required, the fixture shall be provided with mounting hardware for the ceiling system specified. Catalog numbers given on the Luminaire Schedule in the drawings shall not be used for selection of mounting hardware, but only as a reference to the type of fixture required. A concealed latch and hinge mechanism shall be provided to permit access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels. Fixtures recessed in concrete shall have protective coating of bituminous paint.

F. Fixtures shall be aligned and directed to illuminate an area as specified. Fixtures shall be directly and rigidly mounted on their supporting structures. Unless otherwise specified, conduit system shall not be used to support fixtures. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

G. Underground and outdoor wire splices shall be in accordance with Section 26 05 19.

END OF SECTION

SECTION 31 05 13

SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes range of soil and subsoil materials intended to be referenced by other sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other sections and on Drawing notes.

B. Section includes:

1. Subsoil materials.
2. Topsoil materials.

1.2 RELATED SECTIONS

A. Section 31 05 16 - Aggregates for Earthwork.
B. Section 31 10 00 – Site Clearing.
C. Section 31 22 13 - Rough Grading.
D. Section 31 23 16 – Excavation.
E. Section 31 23 17 - Trenching.
F. Section 31 23 18 – Rock Removal.
G. Section 31 23 23 - Fill.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International:

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials source.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Furnish materials of each type from same source throughout the Work.

B. Soil Testing:

1. Soil sampling and testing to be completed by an independent laboratory approved by the Engineer.

2. Frequency of testing shall be determined by the Engineer.

3. All soil testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTMD698(AASHTO T99).

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Soil Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1, Select Native Material:

1. Select earth obtained from on-site excavations approved for use by Engineer.

2. Graded.

3. Free of peat, humus, vegetative matter, organic matter and rocks larger than 6 inches in diameter.

4. Processed as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.

B. Subsoil Type S2, Imported Fill Material:

1. Imported earth approved for use by Engineer.
2. Meeting the requirements of Subsoil Type S1.

2.2 TOPSOIL MATERIALS

A. Topsoil Type TS1, Select Native Topsoil Material:

1. Top 6 - 12 inches of existing soil containing organic matter.

2. Engineer decision shall be final as to determination of what material is topsoil quality.

3. Graded.

4. Free of roots, rocks larger than 1/2 inch subsoil, debris, large weeds and foreign matter.

   a. Screening: Single screened.

B. Topsoil Type TS2, Imported Topsoil Material:

1. Imported borrow.

2. Friable loam.

3. Reasonably free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, and foreign matter.

   a. Screening: Single screened.

4. Acidity range (pH) of 5.5 to 7.5.

5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

C. Topsoil Type TS3, Water Quality Swale Growing Medium:

1. Growing medium shall consist of a blended mix of Topsoil Type TS2 and 40 percent Compost.

2. Compost shall be derived from plant material and provided by a member of the US composting Council Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.

3. The compost shall be the result of the biological degradation and transformation of plant derived materials under conditions designed to promote aerobic

decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have no visible free water and produce no dust when handled. It shall meet the following criteria, as reported by the US composting Council STA Compost Technical Data Sheet provided by the vendor. It shall meet the following criteria, as reported by the US Composting Council STA Compost Technical Data Sheet provided by the vendor.

a. 100 % of material shall pass through a ½ inch screen.

b. The pH of the material shall be between 5.5 min. and 8.5 max.

c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight.

d. Organic matter content shall be between 30 and 70% (dry weight basis)

e. Soluble salt content shall be less than 6.0mmhos/cm.

f. Carbon/Nitrogen (C/N) ration shall be less than 25:1.

g. Trace metals test result = "Pass"

2.3 SPOILS

A. All excess material not suitable or not required for backfill and grading shall be hauled off site and disposed of at a location provided by the Contractor and approved by the Engineer.

B. Make arrangements for disposal of the material at no additional cost to the Owner.

C. Landfill permit to be obtained by the Contractor and provided to Engineer prior to commencement of disposal.

2.4 SOURCE QUALITY CONTROL

A. Testing and Analysis of Subsoil Material: Perform in accordance with ASTMD698(AASHTO T99).

B. When tests indicate materials do not meet specified requirements, change material or vary compaction methods and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

C. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate material of every nature and description to the lines and grades as indicated on the Drawings and/or as required for construction of facilities.

B. Site within clearing limits shall be stripped of topsoil as required to obtain additional topsoil necessary to complete Work indicated in the Drawings or as specified.

C. When practical, do not excavate wet top soil.

D. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

E. Remove excess excavated subsoil and topsoil not intended for reuse from Site.

F. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from Site.

3.2 STOCKPILING

A. Stockpile soils at locations shown in the Drawings or at locations as approved by Engineer for redistribution as specified.

1. Site may not have sufficient area to stockpile excavated material that will be required for fill later in the project. If additional stockpile area is required to complete the Project on schedule, arrange off-site stockpile areas.

2. No additional payments will be made for stockpiling excavated materials off-site.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

F. Stockpile unsuitable and/or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes a range of coarse and fine aggregate materials intended to be referenced by other Sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other Sections and in Drawing notes.

B. Section Includes:

1. Coarse aggregate materials
2. Fine aggregate materials

1.2 RELATED SECTIONS

A. Section 31 05 13 - Soils for Earthwork
B. Section 31 22 13 - Rough Grading
C. Section 31 23 17 - Trenching
D. Section 31 23 19 - Dewatering
E. Section 31 23 23 - Fill
F. Section 32 11 23 - Aggregate Base Courses
G. Section 33 11 10 – Water Utility Distribution and Transmission Piping
H. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses

2. AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates

3. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

4. AASHTO TP61 - Standard Method of Test for Determining the Percentage of Fracture in Coarse Aggregate

B. ASTM International (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

5. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

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

B. Materials Source: Submit name of imported materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Aggregate Testing:

1. Aggregate sampling and testing to be completed by an independent laboratory approved by the Engineer.

2. The frequency of testing shall be determined by the Engineer.

3. All aggregate testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTM D698.

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Aggregate Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate Type A1, Dense-Graded Aggregate: Crushed rock with ¾-inch-0, 1-inch-0, 1-1/2-inch-0, 2-inch-0 and 2-1/2-inch-0 gradation as shown in the Drawings and meeting the requirements provided below.

1. Grading - Dense-graded base aggregate shall be crushed rock, including sand. Uniformly grade the aggregates from coarse to fine.

2. Sieve analysis shall be determined according to AASHTO T27.

3. The aggregates shall conform to one of the grading requirements Table 31 05 16-A below.

Table 31 05 16-A
Grading Requirements for Dense-Graded Aggregate
Separated Sizes
Percent Passing (by weight)

Sieve Size	2-1/2" - 0	2" - 0	1-1/2" - 0	1" - 0	3/4" - 0
3”	100				
2-1/2”	95 - 100	100			
2”	-	95 - 100	100		
1-1/2"	-	-	95 - 100	100	
1-1/4”	55 - 75	-	-	-	
1”	-	55 - 75	-	90 - 100	100
3/4"	-	-	55 - 75	-	90 - 100
1/2"	-	-	-	55 - 75	-
3/8”	-	-	-	-	55 - 75
1/4"	30 - 45	30 - 45	35 - 50	40 - 55	40 - 60
No. 4*	-	-	-	-	-
No. 10	[1]	[1]	[1]	[1]	[1]

[1] Of the fraction passing the 1/4-inch sieve, 40 percent to 60 percent shall pass the No. 10 sieve.
* Report percent passing sieve when no grading requirements are listed.

B. Coarse Aggregate Type A2, Granular Drain Backfill Material: Crushed or uncrushed rock or gravel as shown in the Drawings.

1. Material shall be clean and free draining.
2. Sieve analysis shall be according to AASHTO T27.
3. Grading: Meeting the gradation requirements provided in Table 31 05 16-B below.

Table 31 05 16-B
Grading Requirements for Granular Drain Backfill Material
Separated Sizes
Percent Passing (by weight)

Sieve Size	Separated Sizes 1-1/2-inch – 3/4-inch	Separated Sizes 3/4-inch – 1/2-inch
2-inch	100	
1-1/2-inch	90 - 100	
1-inch	20 - 55	100
3/4-inch	0 - 15	85 - 100
1/2-inch	-	0 - 15
3/8-inch	0 - 5	-

2.2 SAND

A. Sand: Sand material shall consist of granular material, naturally produced or produced from crushed gravel, or dredge sand that is reasonably free of organic material, mica, clay, fly ash, and other deleterious material, meeting the gradations of Table 31 05 16-C below.

Table 31 05 16-C
Grading Requirements for Sand
Separated Sizes
Percent Passing (by weight)

Sieve Size	Coarse Sand	Medium Sand	Fine Sand
1-inch	100	100	100
3/8-inch	95 - 100	95 - 100	-
#4	80 - 100	70 - 95	90 - 100
#30	10 - 30	10 - 45	-
#100	-	2 - 10	2 - 10
#200	0 - 8	0 - 7	0 - 4
Sand Equivalent	50 min.	50 min.	50 in.

2.3 SOURCE QUALITY CONTROL

A. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D698.

B. Sand - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D698.

C. When tests indicate materials do not meet specified requirements, change material and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials imported to site as shown in the Drawings or at locations as approved by Engineer for redistribution as specified.

B. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

C. Prevent intermixing of aggregate types or contamination.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes clearing site of incidental paving and curbs, debris, grass, trees, and other plant life in preparation for site or building excavation work.

1.2 RELATED SECTIONS:

A. Section 01 56 39 – Temporary Tree and Plant Protection
B. Section 02 41 00 - Demolition
C. Section 31 22 13 - Rough Grading

1.3 DEFINITIONS

A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

B. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 12 inches below subgrade.

C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

D. Limits of Disturbance: Work area boundary as shown on the Plans.

E. Root Wad: Tree stump and root mass including all roots greater than 1-inch diameter.

F. Stripping: Removal of topsoil remaining after applicable scalping is completed.

1.4 SUBMITTALS

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

B. Clearing, Grubbing, and Stripping Plan: Drawings clearly showing proposed limits to clearing, grubbing, and stripping activities at Site.

C. Certification or disposal permit for landfill and/or waste disposal site.

D. 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.

1.5 QUALITY ASSURANCE

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

B. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits prior to commencing clearing, grubbing, and stripping.

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

1. Burning on project site will not be permitted.
2. Use of herbicides will not be permitted.

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

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

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.

B. Wound Paint: Emulsified asphalt formulated for use on damaged plant tissues.

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements within limits shown in approved Clearing, Grubbing, and Stripping Plan.

B. Remain within the property lines at all times.

C. Do not injure or deface vegetation or structures that are not designated for removal.

3.2 EXAMINATION

A. Verify existing plant life designated to remain is tagged or identified.
B. Identify waste and salvage areas for placing removed materials.

3.3 PREPARATION

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

B. Call Local Utility Line Information service at 1-800-332-2344, not less than three working days before performing Work.

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

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

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

D. Prepare Site only after:

1. Erosion and sediment controls are in place.

a. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls and in compliance with COP Erosion and Sediment Control Manual and ESC Permits.

2. Tree and vegetation protection is installed.

a. Protect existing site improvements, trees, and shrubs to remain to preclude damage during construction.

b. Follow the provisions set forth in 01 56 39, Temporary Tree and Plant Protection for all temporary tree and plant protection measures.

3. Temporary fencing is installed along the Limits of Disturbance.

4. Notification of utility agencies; disconnect or arrange for disconnection of utilities (if any) affected by required work. Keep all active utilities intact and in continuous operation.

3.4 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:

1. Avoid injury to trees, shrubs, vines, plants, grasses, and other vegetation growing outside of the areas to be cleared and grubbed and those trees and shrubs designated to be preserved.

2. Protect existing trees and shrubs against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of roots by stockpiling construction materials, excavated materials, excess foot or vehicular traffic, and parking of vehicles within drip line.

3. Provide temporary guards, as necessary, to protect trees and vegetation to be left standing.

4. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

5. Provide protection for roots and limbs over 1-1/2-inch diameter cut during construction operations. Coat cut faces with emulsified asphalt.

6. Repairable damage to trees and shrubs designated to remain shall be made by a professional tree surgeon approved by the Engineer. Cost shall be borne by the Contractor.

D. Landscaped Areas:

1. When any portion of the Work crosses private property or landscaped areas, excavate topsoil separately and pile it on the opposite side of the trench from the subsoil.

2. Conduct Work in a manner that will restore original conditions as nearly as practicable.

3. Remove and replace any trees, shrubs, plants, sod, or other vegetative material as needed to complete Work.

4. All shrubs or plants shall be balled by experienced workers, carefully handled and watered, and replaced in their original positions without damage. Sod shall be handled in a similar manner.

5. Wherever sod cannot be saved and restored, the ground must be reseeded and cared for until a stand of grass is reestablished.

6. Plants or shrubs killed or destroyed shall be replaced and paid for by the Contractor.

7. It is the intent of this paragraph that the Contractor shall leave the surface and plantings in substantially the same conditions as before the Work is undertaken.

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, 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.

3.5 LIMITS

A. As follows, but not to extend beyond Limits of Disturbance and within the approved disturbance limits in the Environmental Zones:

1. Excavation: 5 feet beyond top of cut slopes.

2. Trench Excavation: 6 feet from trench centerline, regardless of actual trench width.

3. Fill:

a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
b. Stripping: 2 feet beyond toe of permanent fill.

4. Structures: 15 feet outside of new structures.

5. Roadways: Clearing, grubbing, scalping, and stripping 5 feet from roadway shoulders.

6. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within the Limits of Disturbance as material is generated. Stockpiling shall not be permitted without written approval of Owner.

3.6 CLEARING AND GRUBBING

A. Clear and grub areas within limits shown in approved Clearing, Grubbing, and Stripping Plan.

B. Except in areas to be excavated, all holes resulting from the clearing and grubbing operations shall be backfilled and compacted in accordance with the applicable sections of these Specifications.

C. Clearing:

1. Remove trees, saplings, snags, stumps, shrubs, brush, vines, grasses, weeds, and other vegetative growth within the clearing limits shown in the Drawings, except those trees and shrubs noted to remain in the Drawings or as directed by the Engineer.

2. Clearing shall be performed in such a manner as to remove all evidence of the presence of vegetative growth from the surface of the project site and shall be inclusive of sticks and branches of thickness or diameter greater than 3/8-inch and of grasses, weeds, exceeding 12 inches in height except as otherwise indicated.

3. Clear undergrowth and deadwood, without disturbing subsoil.

D. Grubbing: Clear areas required for access to site and execution of Work and remove all stumps, root wads, and roots over 1-inch diameter to the following depths:

1. Future Structures and Building Areas	24 Inches
2. Roads and Parking Areas	18 Inches
3. All other Areas	12 Inches

3.7 TREE REMOVAL

A. Exercise care in cutting, felling, trimming, and handling of those trees shown for removal to prevent damage to neighboring trees and structures to remain.

B. Tree Salvage: As shown on the Plans.

C. No trees may be removed unless approved and permitted by the Engineer.

D. Do not top trees unless otherwise specified or approved by Owner in writing.

E. Refer to Section 01 56 39, Temporary Tree and Plant Protection for tree protection requirements.

3.8 REMOVAL AND DISPOSAL

A. Native vegetation may be mulched and used on Site.

B. Asphalt and Gravel Surfaces:

1. Asphalt, concrete, and gravel surfaces designated for removal shall be done to full depth.

2. Asphalt, concrete, and gravel removed at Site may be reused at Site where shown in the Drawings or following approval of the Engineer.

3. Haul removed asphalt, concrete, and gravel which is unsuitable for reuse or that exceeds quantity required.

C. Remove debris, rock, abandoned piping, and extracted plant life from Site.

D. Remove from the Site all debris, materials, equipment, and items found thereon and materials and debris resulting from the Work, except as otherwise indicated.

1. All existing improvements designated on 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 Work.

2. Unless otherwise specified, any resulting voids shall be thoroughly cracked out for drainage and backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.

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

F. Do not burn or bury materials on site. Leave site in clean condition.

G. Removal: All material resulting from demolition, clearing and grubbing, and trimming operations shall be removed from the Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.

H. Cleanup: During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, and debris.

I. Adjacent areas shall be returned to their existing condition prior to the start of Work.

3.9 CLEANUP

A. During the time Work is in progress, make every effort to maintain the Site in a neat and orderly condition.

B. All refuse, broken pipe, excess fill material, cribbing, and debris shall be removed as soon as practicable.

C. Should the Work not be maintained in a satisfactory condition, the Owner may cause the work to stop until the cleanup of the Work has been done to the satisfaction of the Engineer.

D. The Work will not be considered complete or the final payment certificate issued until all rubbish, unused material, or equipment shall have been removed and the premises left in a condition satisfactory to the Owner and the Engineer.

END OF SECTION

SECTION 31 22 13 - ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes rough grading and filling associated with contouring of Site in preparation for building excavation and subsequent site work.

B. Section Includes:

1. Excavating topsoil
2. Excavating subsoil
3. Cutting, grading, filling, and rough contouring of Site

1.2 RELATED SECTIONS:

A. Section 01 45 00 - Quality Control
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 10 00 - Site Clearing
E. Section 31 23 16 - Excavation
F. Section 31 23 17 - Trenching
G. Section 31 23 23 - Fill

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

4. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)

5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

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

B. Soils for Earthwork: As specified in Section 31 05 13, Soils for Earthwork.

C. Aggregates for Earthwork: As specified in Section 31 05 16, Aggregates for Earthwork.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

PART 2 PRODUCTS

2.1 MATERIALS

A. Subsoil Fill: Type S1 and S2 as specified in Section 31 05 13, Soils for Earthwork.

B. Topsoil: As specified in Section 31 05 13, Soils for Earthwork.

1. Type TS1, Select Native Topsoil Material, as may be available.
2. TS2, Imported Topsoil Material, as may be required.

C. Structural Fill: Type A1, Dense-Graded Aggregate as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

D. Granular Fill: Type A2, Granular Drain Backfill Material as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 not less than 3 working days before performing Work.

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

2. Notify Engineer of any potential conflicts resulting from utility locations and the Drawings.

3. Notify utility company to remove and relocate utilities, as may be necessary.

B. Identify required lines, levels, contours, and datum.

C. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with the Work of this Section.

3.3 TOPSOIL EXCAVATION

A. Excavate and stockpile topsoil as specified in Section 31 05 13, Soils for Earthwork.

3.4 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded as shown in the Drawings.

B. When practical, do not excavate wet subsoil. When wet subsoil must be excavated and is to be reused on site for the Work, process wet material to obtain optimum moisture content.

C. Stockpile excavated material in area designated onsite in accordance with Section 31 05 13, Soils for Earthwork.

D. When excavating through roots, perform Work by hand and cut roots with sharp axe.

E. Benching Slopes: Horizontally bench existing slopes greater than 1:2 to key placed fill material to slope to provide firm bearing.

F. Stability: Replace damaged or displaced subsoil as specified for fill.

3.5 FILLING

A. General:

1. Grading and filling operations shall not take place when weather conditions and moisture content of fill materials prevent the attainment of specified density.

2. Vertical curves or roundings at abrupt changes in slope shall be established as approved by Engineer.

3. Bring all graded areas to a relatively smooth, even grade and slope by blading or dragging. Remove high spots and fill depressions.

B. Fill areas to contours and elevations shown in the Drawings with unfrozen materials.

C. Topsoil Fill:

1. Scarify prepared subgrade to depth of 4 inches immediately prior to placing topsoil.

2. Place topsoil in areas to be seeded to depths indicated in the Drawings, minimum depth of 6 inches.

3. Place topsoil material loose; do not compact, do not place in wet or muddy conditions.

D. Place material in continuous layers as follows:

1. Subsoil Fill: Maximum 8 inches compacted depth.
2. Structural Fill: Maximum 12 inches compacted depth.
3. Granular Fill: Maximum 12 inches compacted depth.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet, unless noted otherwise.

G. Make grade changes gradual. Blend slope into level areas.

H. Repair or replace items indicated in the Drawings to remain which are damaged by excavation or filling. All costs shall be borne by the Contractor.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 of a foot from required elevation.

3.7 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D698.

B. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922
2. Moisture Tests: ASTM D3017

C. Frequency and location of testing is dependent upon type of material placed. See Section 01 45 00, Quality Control for testing requirements.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest at the sole expense of the Contractor.

END OF SECTION

SECTION 31 23 16

EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes excavation required for building foundations, site structures, or under slabs-on-grade or paving. Excavating for utilities outside building is included in Section 31 23 17, Trenching.

B. Section Includes:

1. Excavating for building foundations.
2. Excavating for paving, roads, and parking areas.
3. Excavating for slabs-on-grade.
4. Excavating for site structures.
5. Excavating for landscaping.

1.2 RELATED SECTIONS

1. Section 01 45 00 - Quality Control.
2. Section 31 05 13 - Soils for Earthwork.
3. Section 31 05 16 - Aggregates for Earthwork.
4. Section 31 10 00 - Site Clearing.
5. Section 31 22 13 - Rough Grading.
6. Section 31 23 17 - Trenching.
7. Section 31 23 23 - Fill.
8. Section 33 11 10 - Water Utility Distribution Piping.

1.3 DEFINITIONS

A. Common Excavation: All excavation required for Work, regardless of the type, character, composition or condition of the material encountered. Common Excavation shall further include all debris, junk, broken concrete, and all other material. All excavation shall be classified as Common Excavation, unless provided as Rock for under Section 31 23 18, Rock Removal below.

B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, excluding rock as defined below.

C. Concrete Excavation: The removal of pieces of concrete larger than 1 cubic yard in volume that requires drilling, splitting and breaking methods, or a necessitating a

trench width increase of 18 inches or more than the width of the preceding 10 feet of trench. Concrete excavation includes materials composed of Portland cement that are not identified other than manholes, structures, sewer pipe, or other appurtenances.

D. Exploratory Excavation: The removal and replacement of material from locations shown on the Drawings, or as directed for the purpose of investigating underground conditions and identifying potential utility conflict between existing and proposed utilities.

E. Overbreak: Material beyond and outside of the slope limits established by the Owner's Representative, which becomes displaced or loosened during excavation and is excavated.

F. Pothole Excavation: Pothole excavation is the removal and replacement of all materials via coring, vacuum extraction, or similar method, not classified as exploratory excavation, for the purposes of locating an underground utility and to investigate underground conditions.

G. Rock Removal: As defined in Section 31 23 18, Rock Removal.

H. Spoils: Excavated materials from Site unsuitable for use as fill or not required for backfill and grading.

I. Unsuitable Materials: See Spoils.

1.4 REFERENCES

A. Local utility standards when working within 24 inches of utility lines.

1.5 SUBMITTALS

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

B. Excavation support plan and utility protection plan as specified in Section 31 50 10, Excavation Support Systems.

1.6 QUALITY ASSURANCE

A. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

B. Provide adequate survey control to avoid unauthorized over excavation.

C. Weather Limitations:

1. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to commencing work in this Section, become familiar with site conditions. In the event discrepancies are found, notify the Engineer as to the nature and extent of the differing conditions.

B. Call Local Utility Line Information service at 1-800-332-2344 not less than three working days before performing Work.

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

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

C. Identify required lines, levels, contours, and datum.

D. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life and landscaped areas in coordination with Work in this Section.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.3 EXISTING UNDERGROUND UTILITIES

A. Protect active utilities encountered, located or otherwise, and notify persons or agencies owning same.

B. Remove inactive or abandoned utilities from within the project grading limits in accordance with Section 33 11 50, Existing Pipe Abandonment.

C. For sewer and other miscellaneous drainage facilities, fill and plug pipes as follows:

1. General:

   a. Remove all structures to a minimum of 3 feet below subgrade, unless otherwise noted.

   b. Cover top surface of all abandoned structures with two sheets of nonwoven geotextile, extended at least 1 foot beyond the outside walls of the abandoned manhole, sump, or basin.

   c. Plug all abandoned pipes with permanent plugs as specified in Section 33 11 50, Existing Pipe Abandonment.

2. Sumps:

   a. Remove existing sediment, soil, and water. Properly dispose of these materials in accordance with the requirements of these specifications.

   b. Remove top cone and first solid concrete section to a depth of approximately 8 to 10 feet below ground.

   c. Fill sump with CLSM.

   d. Backfill remaining voids for facilities within existing or proposed roadways with approved materials meeting the requirements of Section 32 11 23, Aggregate Base Courses.

3. Salvaging Manhole Frames, Covers, and Grates:

   a. Remove manhole frames, covers, and grates scheduled for salvage and store in approved location.

   b. Frames, grates, and covers meeting Specifications may be salvaged from structures to be adjusted and may be reused in the Work if of suitable size and condition.

c. Replace, at no additional cost to the Owner, all items damaged or lost by the Contractor with similar items that are comparable in all respects with those they are to replace, and which are adequate for the intended purpose.

d. Clean salvaged components to be reused of foreign material by methods that will not harm the components.

4. Existing Manhole Frames and Covers: Manhole frames and covers removed by the Contractor are the property of the Owner. Notify the Engineer a minimum of 48 hours before removal to arrange for pickup of the removed frames and covers, if not reused.

3.4 PRESERVATION OF EXISTING IMPROVEMENTS

A. Protect adjacent existing structures which may be damaged by excavation work.

1. Conduct operations in such a manner that existing street facilities, utilities, railroad tracks, structures, and other improvements, which are to remain in place, will not be damaged. Furnish and install cribbing and shoring or whatever means necessary to support material around existing facilities, or to support the facilities themselves, and maintain such supports until no longer needed.

2. Open slopes shall not be cut within 5 feet of any existing spread footings unless approved by the Engineer.

3. Do not interfere with 45 degree bearing splay of foundations unless approved by the Engineer

4. Excavated material shall not be placed adjacent to existing or proposed structures.

3.5 EXCAVATION

A. General:

1. Method of excavation shall be the Contractor's option, but care shall be exercised as final grade is approached to leave it in undisturbed condition.

2. If the final grade for supporting structures is disturbed, it shall be restored to requirements of these Specifications and satisfaction of the Engineer at no additional cost to Owner.

3. The Contractor is advised that footings should be poured as soon as possible to minimize unfavorable final grade conditions from developing.

4. Provide all measures to ensure public safety.

B. Control of Water:

1. Provide and maintain equipment to remove and dispose of water during the course of the work of this Section and keep excavations dry and free of frost or ice.

2. Bearing surfaces that become softened by water or frost must be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.

3. Grade top perimeter of excavation to prevent surface water from draining into excavation.

4. See additional requirements in Section 31 23 19, Dewatering.

C. Frozen Ground: Frost protection shall be provided for all structural excavation work. Foundation work shall not be placed on frozen ground.

D. Excavate material of every nature and description to the lines and grades as indicated in the Drawings and/or as required for construction of the facility.

1. Allow for forms, shoring, working space, granular base, topsoil and similar items, wherever applicable.

2. Trim excavations to neat lines. Remove loose matter and lumped subsoil.

E. Excavated Materials: Soils excavated at Site will be treated and used as one of two general categories of material as provided below.

1. Fill:

a. Subsoil Type S1, Select Native Fill, as approved for use by Engineer.

2. Spoils:

a. Ensure there is sufficient suitable material available to complete embankments and other required fillings prior to disposing of any excavated materials.

b. Make arrangements for disposal of spoils and include as part of contract work in preparing of project bids.

c. Landfill permit or written permission from private property owner to be obtained by the Contractor and provided to the Engineer.

F. Shoring:

1. The Contractor shall be solely responsible for excavation protection and worker safety and shall provide sheeting and shoring wherever required, all in accordance with current local, state and federal laws, codes and ordinances.

2. Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it shall be the responsibility of the Contractor to design, furnish, place, maintain and remove such supports in accordance with applicable ordinances and safety requirements.

3. The design, planning, installation and removal of all sheeting, accomplished in such a manner as to maintain the undisturbed state of the soil below and adjacent to the excavation.

G. Slope existing banks with machine to angle of repose or less until shored.

1. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

2. Protection of excavation side slopes:

a. Use excavation methods that will not shatter or loosen excavation slopes.

b. Where practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line.

c. Avoid overbreaks. Overbreak is incidental to the Work, except in cases where the Owner's Representative determines that such overbreak was unavoidable.

d. Excavation in rock or rocky cuts:

1) Once completed, thoroughly test the slopes with bars or other approved means to remove all loose, detached, broken, or otherwise unstable material.

2) Remove jutting points. Scale slopes using mine scaling rods or other approved methods to remove loose or overhanging materials and provide a safe, trim, neat, and stable condition.

3) Dispose of the materials removed under this subparagraph in the same manner as other excavated material.

e. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.

3. Construct slopes free of all exposed roots.

4. Construct slopes free of unstable rock and loose stones exceeding 3 inches in diameter.

5. Round tops of cut slopes in soil to not less than a 6 foot radius, provided such rounding does not extend off-site, outside of easements, outside of rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

6. Trim all surfaces neatly and smoothly.

H. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 17, Trenching and Section 31 23 23, Fill.

I. Notify Engineer of unexpected subsurface conditions.

J. Overexcavation for Unsuitable Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered and loose material or other objectionable materials.

2. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2 inch – 0 gradation, as specified in Table 310516-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

3. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.

K. Rock Removal:

1. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.

2. Remove larger boulders and rock material as specified in Section 31 23 18, Rock Removal.

3. Concrete removal, as defined herein, shall be treated as Rock Removal.

L. Stockpile excavated material in area(s) designated on or off site in accordance with Section 31 05 13, Soils for Earthwork.

3.6 FIELD QUALITY CONTROL

A. Perform excavation and controlled fill operations in accordance with the requirements of this Section.

B. Coordinate the visual inspection and approval of all bearing surfaces by Engineer before installing subsequent work.

3.7 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability and store excavated materials at a distance from top of excavation.

B. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17

TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for excavation and backfill of all utilities, including installation of pipe bedding, pipe zone backfill, and trench backfill and related Work as shown on the Drawings and as specified.

B. Section includes:

1. Excavating trenches for pipe, utility vaults and other utilities.
2. Compacted fill from top of utility bedding to final grades.
3. Trench and utility vault backfilling and compaction.

C. Related Sections

1. Section 01 45 00 - Quality Control.
2. Section 03 30 00 - Cast-In-Place Concrete.
3. Section 31 05 13 - Soils for Earthwork.
4. Section 31 05 16 - Aggregates for Earthwork.
5. Section 31 10 00 - Site Clearing.
6. Section 31 22 13 - Rough Grading.
7. Section 31 23 16 - Excavation.
8. Section 31 23 18 - Rock Removal.
9. Section 31 23 23 - Fill.
10. Section 33 11 13 - Water Utility Distribution & Transmission Piping.
11. Section 33 41 10 - Storm Utility Drainage Piping.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International:

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

C. City of Woodburn Standard Drawings, Sections 3800 and 5000.

D. ATTENTION: Oregon law requires adherence to the rules adopted by the Oregon Utility Notification Center. Those rules are set forth in OAR 952-001-0001 through 952-001-0100. Copies of the rules can be obtained by calling the center at 800-332-2344.

1.3 DEFINITIONS

A. Flexible Pipe: For the purposes of these Specifications, tubing between ½-inch and 4-inch diameter constructed of polyvinyl chloride (PVC) and high density polyethylene (HDPE) are considered flexible pipes. HDPE piping 4 inches in diameter and larger is also considered flexible pipe.

B. Geosynthetics: Geotextiles, geogrids, geomembranes, and drainage composite materials.

C. Imported Material: Materials obtained from sources offsite, suitable for specified use.

D. Lift: Loose (uncompacted) layer of material.

E. Obstructions: Items which may be encountered during utility and vault trenching which do not require replacement.

F. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

G. Pipe Bedding: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 6 inches below the bottom outside surface of pipe, conduit, cable or duct bank to the trench foundation so as to uniformly support the barrel of the pipe.

H. Pipe Zone: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 12 inches above the top outside surface of pipe, conduit, cable or duct bank.

I. Pipe Bedding, Pipe Zone and Trench Backfill Classifications:

1. Class A: Backfill with suitable native or imported material that is approved to meet the characteristics required for the specific surface loading or other criteria of the backfill zone.

2. Class B: Backfill with imported granular material consisting of gravel or crushed rock meeting the requirements of this Section and Coarse Aggregate Type A1 as specified in Section 31 05 16, Aggregates for Earthwork; typical designated size shall be 1”-0 or ¾”-0.

3. Class C: Backfill with Fine Sand, as specified in Section 31 05 16, Aggregates for Earthwork.

4. Class D: Backfill with approved pit run or bar run material, well-graded from coarse to fine; maximum dimension shall be 3 inches.

J. Pothole Excavations: Removal and replacement of all materials via coring, vacuum extraction, or similar method for the purposes of locating an underground utility and to investigate underground conditions.

K. Prepared Trench Bottom: The bottom of the trench on which the pipe bedding is to lie and which provides support for the pipe.

L. Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM Standards.

M. Rigid Pipe: For the purposes of these Specifications, pipe constructed of PVC, ductile iron, steel, concrete and clay pipes are considered rigid pipes.

N. Sewer, Pipes, and Mains: Conduits of circular or other geometric shapes, used to convey liquids or gases, or other material.

O. Trench Backfill: Trench backfill zone for full trench width extending from the top of the pipe zone to pavement base rock, ground surface or other surface material.

P. Trench Stabilization: Removal of unsuitable material in the bottom of a trench and replacement with specified material for support of a pipe, main, conduit, structure, or appurtenances.

Q. Utility: Any buried pipe, duct, conduit, or cable.

R. Well-Graded: A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.4 SUBMITTALS

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

B. Excavation Protection Plan: At a minimum, to include the following:

1. Methods and sequencing of mass excavation.

2. Proposed on-site and off-site spoil disposal locations.

3. Anticipated difficulties and proposed resolutions.

4. Proposed routes for Owner's access to Owner's facilities impacted by excavation Work.

5. Proposed haul routes.

C. Product Data:

1. Geotextile fabric, indicating fabric and construction.
2. Marking tapes;
3. Tracer wire;
4. Connectors for tracer wire and/or marking tapes;
5. Tracer wire locate boxes;
6. Marker balls;
7. Locator stations;
8. Ground wires;
9. Plastic or copper markers for service laterals.

D. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

E. Concrete: Mix designs in accordance with Submittal requirements of Section 03 30 00, Cast-in-Place Concrete.

1.5 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

1.6 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

B. Coordinate trenching and utility installation work with other work at utility construction location occurring near or adjacent to specified herein.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S1, Select Native Material as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete with compressive strength of 3,000 psi.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Sand: As specified in Section 31 05 16, Aggregates for Earthwork.

F. Trench Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2” - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

2.2 MARKING TAPE

A. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.

2. Foil Thickness: Minimum 0.35 mils.

3. Laminate Thickness: Minimum 5 mils.

4. Width: 6 inches.

5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.

6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.

7. Manufacturers and Products:

a. Reef Industries; Terra Tape, Sentry Line Detectable.
b. Mutual Industries; Detectable Tape.
c. Presco; Detectable Tape.

B. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities and as specified in NEMA Z535.1, Safety Color Code.

Color	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines

2.3 ELECTRONIC LOCATING MATERIALS

A. Marker Balls:

1. Exterior Material: High-density polyethylene.

2. Size: Maximum 4.5 inches in diameter.

3. Range: Locatable with standard electronic marker locating devices at depths up to 5 feet.

4. Field Type: Spherical RF field regardless of orientation.

5. Contain no floating or movable parts, and no batteries or active components.

6. Color: Provide colored marker balls per Article 2.03 B above.

7. Manufacturer and Product: Omni Marker Model 162 (green), Omni Marker Model 161 (blue), or approved equal.

B. Tracer Wire:

1. Direct burial No. 12 AWG solid, annealed copper-clad steel (CCS) high strength tracer wire.

2. Tensile Breaking Load: 380-pound average.

3. Jacket:

a. High molecular weight high-density polyethylene complying with ASTM D1248, 30-volt rating.

b. Color: Provide in colors per Article 2.03 B above.

4. Manufacturer and Product: Copperhead Industries; LLC, 12 CCS high strength reinforced tracer wire, or approved equal.

C. Tracer Wire Connectors:

1. Waterproof, corrosion proof and suitable for No. 12 AWG solid core wire.

2. Prefilled with silicone and suitable for use with low-voltage tracer lines of less than 50 volts.

3. Lug Connectors:

a. Waterproof plastic housing that encases the silicone prefilled lug terminals.

b. Manufacturer and Product: King Innovations; DryConnTM Direct Bury Lug, or approved equal.

4. Twist Connectors:

a. Waterproof epoxy-filled packaging that encases the silicone prefilled twist connectors.

b. Manufacturer and Product: 3M Division; DBY Direct Bury Splice Kit 09053 connectors, or approved equal.

D. Ground Wire: No. 12 AWG bare solid copper wire.

E. Locator Station:

1. Test Station:

a. Lexan® polycarbonate.
b. Color: Provide in colors per Article 2.03 B above.

2. Terminals suitable for No. 12 AWG leads.

3. Use single (two lead) locator stations with two terminals, one for ground wire and one for tracer wire, when only one tracer wire is terminated in manhole.

4. Use multilead locator stations with the appropriate number of terminals when 2 or more tracer wire leads are terminated in manhole.

5. Manufacturer and Product: Cott Manufacturing Company; FlangeFink® Cathodic Protection Test Station.

2.4 VISUAL IDENTIFICATION MATERIALS

A. Tracer Wire Locate Boxes:

1. Material: Polyolefin.

2. Cover:

a. Color: Provide in colors per Article 2.03 B above.

b. Provide box cover identification marking for facility type such as “Sewer Locate Wire”, as approved by Owner.

c. Locking type with a nominal 6-inch opening.

B. Service Lateral 2-inch by 4-inch Markers:

1. S4S Douglas fir, pressure-treated 2-inch by 4-inch lumber, utility grade or better.
2. Grade stamped by an American Lumber Standards certified inspection agency.

PART 3 EXECUTION

3.1 PREPARATION

A. Call Utility Notification Center at 1-800-332-2344 not less than three working days before performing Work.

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

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

3. Maintain and protect above and below grade utilities indicated to remain.

B. Identify required lines, levels, contours, and datum locations.

C. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

D. The site of an open cut excavation shall be first cleared of all obstructions preparatory to excavation in accordance with Section 31 10 00, Site Clearing.

E. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life and landscaped areas in coordination with Work in this Section.

1. Intent of Drawings and Specifications is that all streets, structures, and utilities be left in condition equal to or better than original condition.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material, which is satisfactory to Owner.

F. Potholing / Exploratory Test Pits: Dig such exploratory test pits and perform potholing as may be necessary in advance of trenching to determine the exact location and elevation of subsurface structures, pipelines, duct banks, conduits, and other obstructions which are likely to be encountered or need to be connected to and shall make acceptable provision for their protection, support, and maintenance of their continued operation.

G. Paved or Surfaced Streets:

1. Wherever paved or surfaced streets are cut, saw wheel or approved cutting devices shall be used.

2. Width of pavement cut shall be as shown in the Drawings.

3. Any cut or broken pavement shall be removed from site during excavation.

H. Traffic:

1. Maintain street traffic at all times as required by the Drawings and as specified herein.

2. Erect and maintain barricades, warning signs, traffic cones, and other safety devices during construction in accordance with the latest edition of Manual of Uniform Traffic Control Devices (MUTCD), Part 6, to protect the traveling public in any area applicable.

3. Provide flaggers as required during active work in roadway areas.

I. Operations shall be confined to rights-of-way and easements provided. Avoid encroachment on, or damage to, private property or existing utilities unless prior arrangements have been made with copy of said arrangement submitted to Engineer.

3.2 EASEMENTS

A. Where portions of the Work are located on private property, easements and permits will be obtained by the Owner. Easements shall provide for the use of property for construction purposes to the extent indicated on the easements.

B. Copies of these easements and permits will be available from the Owner for inspection by the Contractor. It shall be the Contractor's responsibility to determine the adequacy of the easement obtained in every case.

C. Confine construction operations to within the easement limits or street right-of-way limits, or make special arrangements with the property owners for the additional area required and notify the Engineer with a copy of the written approval from property owners of any such conditions.

D. Any damage to private property, either inside or outside the limits of right-of-way or easements provided by the Owner, resulting from Work shall be the responsibility of the Contractor. Before the Engineer will authorize final payment, the Contractor will be required to furnish the Owner with written releases from property owners where the Contractor has obtained special agreements or easements or where the Contractor's operations, for any reason, have not been kept within the construction right-of-way obtained by the Owner.

3.3 PROTECTION

A. Existing Facilities:

1. It is the intent of these specifications that all streets, structure, and utilities be left in a condition equal to or better than original condition at the completion of the Project.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material to the satisfaction to the Engineer.

3. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

B. Removal of Water:

1. At all times during construction provide and maintain ample means and devices with which to remove promptly and dispose of properly all water entering the excavations or other parts of the Work.

2. Keep all excavations dry until the utilities or vaults to be placed therein are completed. In water bearing sand, well points and/or sheeting shall be supplied, together with pumps and other appurtenances of ample capacity to keep the excavation dry as specified.

3. Dispose of water from the Work in a suitable legal manner without damage to adjacent property or structures.

C. Trench Protection:

1. Provide the materials, labor and equipment necessary to protect trenches at all times.

2. Trench protection shall provide safe working conditions in the trench and protect the Work, existing property, utilities, pavement, etc.

3. The method of protection shall be according to the Contractor's design.

4. The Contractor may elect to use a combination of shoring, overbreak, tunneling, boring, sliding trench shields, or other methods of accomplishing the work provided the method meets the approval of all applicable local, state and federal safety codes.

5. Damages resulting from improper shoring, improper removal of shoring or from failure to shore shall be the sole responsibility of the Contractor.

3.4 LINES AND GRADES

A. Trench excavation for piping, utility vaults and other utilities shall be performed to the alignment and grade as indicated in the Drawings.

B. Where grades are not shown in the Drawings, utilities shall be laid to grade between control elevations shown.

C. Water mains shall be installed with a minimum cover of 36 inches.

D. The Engineer reserves right to make changes in lines, grades and depths of utilities when changes are required for Project conditions.

E. Changes in the grade and horizontal alignment of the pipeline as shown in the Drawings or as provided elsewhere in the Specifications may be necessary due to unanticipated interferences or other reasons.

1. No additional compensation will be allowed the Contractor for changes in horizontal alignment.

2. No additional compensation will be allowed for changes in grade which require additional depth of trench excavation and backfill up to 2 feet from those shown in the Drawings.

F. Use laser-beam instrument with qualified operator to establish lines and grades.

3.5 OBSTRUCTIONS

A. Obstructions to the construction of the trench, such as tree roots, stumps, abandoned pilings, abandoned buildings and concrete structures, logs, rubbish, and debris of all types shall be removed without additional compensation from the Owner.

B. The Engineer may, if requested by the Contractor or Owner, make changes in the trench alignment to avoid major obstructions if such alignment changes can be made within the perpetual easement and right-of-way and without adversely affecting the intended function of the facility or increasing costs to the Owner.

3.6 INTERFERING ROADWAYS AND STRUCTURES

A. Remove, replace and/or repair any damage done during trenching activities to fences, buildings, cultivated fields, drainage crossings, and any other properties without additional compensation from the Owner.

1. Replace or repair these structures to a condition as good as or better than their pre-construction condition prior to commencing work in the area.

B. Paved Roadways:

1. Where paved roadways are cut as part of trenching activities, Class D trench backfill will be required to the bottom of pavement base.

2. New pavement shall be equal to or better than the existing paved surface.

3. New surface shall not deviate by more than 1/4-inch from the existing finish elevation.

C. Existing Structures:

1. If existing structures are encountered as part of trenching activities which will prevent construction and are not adequately shown in the Drawings, the Contractor shall notify the Engineer before continuing with the Work.

2. The Engineer may make such field revisions to the utility alignment as necessary to avoid conflict with the existing conditions.

3. The cost of waiting or “down time” during such field revisions shall be borne by the Contractor without additional cost to the Owner or liability to the Engineer.

4. If the Contactor fails to so notify the Engineer when a conflict of this nature is encountered, but proceeds with construction despite this interference, the Contractor shall do so at the Contractor’s own risk with no additional payment.

3.7 TRENCHING

A. Excavate subsoil as required for construction of utilities to elevations shown in the Drawings.

B. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section. Remove larger boulders and rock material as specified in Section 31 23 18, Rock Removal.

C. Open Trench Limit:

1. Do not advance open trench beyond the distance which will be backfilled and compacted the same day.

2. A maximum length of open trench shall not exceed 100 feet at any one time.

3. Temporary resurfacing shall be completed within 300 feet of the associated open trench limit for each main pipe laying operation.

4. Cover or backfill excavations at the end of each day.

5. If the trench is not backfilled at the end of each working day:

a. Provide means to prevent caving of excavation sides, as necessary, during non-working hours.

b. Cover the excavation with a system as needed to provide public safety and prevention of entry during non-working hours.

c. Provide signed and stamped submittal of caving prevention system and cover system.

6. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

D. Utility Crossings: Avoid horizontal and vertical conflicts with existing utilities.

1. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.

2. Vertical clearance between the new pipe and existing utilities shall be 12 inches minimum, unless otherwise noted on the Drawings.

3. Where existing utility lines are damaged or broken during trenching activities, the utility shall be repaired or replaced. For water or sewer

bearing lines, care being taken to insure a smooth flow line and absolutely no leakage at the new joints.

4. All expenses involved in the repair or replacement of leaking or broken utility lines that have occurred due to the Contractor's operations shall be borne by the Contractor, and the amount thereof shall be absorbed in the unit prices of its bid.

E. Water Lines Crossing Sewer Lines: Whenever water lines cross sewer lines, the Contractor shall comply with OAR 333-061-0050 and City of Woodburn Standard Detail 5000-6.

1. Wherever possible, the bottom of the water line shall be 18 inches or more above the top of sewer pipe. One full length of the water line pipe shall be centered at the crossing.

2. For clearances less than 1.5 feet, the Contractor shall replace the existing sewer pipe with ductile iron or PVC of equal size, centered at the utility crossing, or shall encase existing sewer pipe with concrete for a minimum of 10 feet on both sides of crossing, as directed by the Engineer, at no additional cost to the Owner.

F. Excavate trenches to width and depth as indicated on Drawings. No additional payment will be provided for trenching activities beyond dimensions shown in the Drawings.

1. Excavation for trenches in which pipelines are to be installed shall provide adequate space for workers to place and joint the pipe properly and safely, but in every case the trench shall be kept to a minimum width.

2. The width of the pipe trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall not exceed 12 inches on either side of the pipe.

3. Excavation for utility vaults and other structures shall be wide enough to provide 18 inches between the structure surface and the sides of the excavation.

4. For pipe or utility vaults to have bedding material, excavate to a depth of 6 inches below the bottom of the pipe or utility vault. Care shall be taken not to excavate below depths required.

5. If over digging occurs, the trench bottom shall be filled to grade with compacted bedding material.

G. Remove water or materials that interfere with Work.

1. The trench at all times shall be kept free from water to facilitate fine grading, the proper laying and joining of pipe, and prevention of damage to completed joints.

2. Adequate pumping equipment shall be provided to handle and dispose of the water without damage to adjacent property.

3. Water in the trench shall not be allowed to flow through the pipe while construction work is in progress unless special permission to do so has been given by the Engineer.

4. An adequate screen shall be provided to prevent the entrance of objectionable material into the pipe.

5. Remove and dispose of existing abandoned sewer pipe, structures, and other facilities as necessary to construct the improvements.

a. Where the excavation activities require the removal of portions of an abandoned pipeline, masonry plugs shall be installed in the open ends of the pipe, unless otherwise noted in the Drawings or by the Engineer.

b. Coordinate with Engineer prior to plugging.

c. For plugs less than 36 inches in diameter, 8-inch deep masonry units shall be used. For plugs in larger pipelines, 12-inch deep masonry units shall be used.

6. The costs associated with the removal of water and materials noted above will be considered incidental to trench excavation and backfill.

H. Do not interfere with 45 degree bearing splay of foundations.

I. Overexcavation for Unsuitable Trench Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered and loose material or other objectionable materials.

2. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.

3. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2 inch – 0 gradation, as specified in Table 310516-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

4. Install nonwoven geotextile under trench stabilization material, over the soft or yielding excavated surface.

a. Install the nonwoven geotextile ahead of placement of the trench stabilization material, continuously along the excavation bottom and centered on the pipe centerline.

b. Use nonwoven geotextile width equal to the pipe diameter plus 2 feet.

c. Place laps or splices in the geotextile in the direction of the pipe laying.

J. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

K. Excavated material shall be placed at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic, or interfere with the function of existing drainage facilities or system operation.

L. Remove excess subsoil not intended for reuse from site.

M. Stockpile excavated material in area designated on site in accordance with Section 31 05 13, Soils for Earthwork.

3.8 TUNNELING

A. In lieu of open cut trenching as specified above, the Contractor may utilize tunnel methods for installation of pipe where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks and other structures.

1. The Engineer must approve tunneling methods prior to utility installation.

2. Where tunneling is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks and other surface improvements whose replacement is avoided by the tunneling method.

3.9 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, new and existing structures, and adjacent and neighboring properties and to prevent caving, erosion, settlement, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

D. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

E. Design sheeting and shoring to be removed at completion of excavation work, unless shown otherwise in the Drawings.

F. Construction Sheeting Left in Place:

1. Furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.

2. Construction sheeting and bracing originally intended for temporary installation, placed by the Contractor to protect adjacent and neighboring structures, may be left in place if desired by the Contractor and approved by the Engineer. All such sheeting and bracing left in place shall be included in the cost for excavation.

3. Any construction sheeting and bracing which the Contractor has placed to facilitate its work may be ordered in writing by the Engineer to be left in place. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating an obligation on its part to issue such orders. Failure of the Engineer to order sheeting and bracing left in place shall not relieve the Contractor of its responsibility under the contract.

4. For sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade.

3.10 COMPACTION

A. Testing will be required to show specified densities of compacted backfill are being achieved by the Contractor's compaction methods.

B. Moisture Control:

1. Moisture condition backfill material to within 2 percent of optimum moisture content required for compaction throughout each lift of the fill.

2. Add moisture to granular backfill by sprinkling during compaction operation.

3. Compaction by ponding or jetting is not permitted.

C. Compact all materials and areas that are not accessible for in-place density testing, as determined by the Engineer, in place by whatever equipment and method is practicable or specified, and as approved by the Engineer.

1. Perform compaction at such moisture content as is required to produce well-filled, dense, and firm material in place that will show no appreciable deflection or reaction under the compacting equipment.

3.11 BEDDING

A. All utility vaults, potable water pipe 4-inch nominal diameter and over, all steel pipe, all concrete sewer pipe, all plastic pipe, all pipe under existing or future structures or roadways, and any and all utilities at a depth greater than 6 feet shall be laid in pipe bedding material.

B. Unless otherwise noted in the Drawings, pipe or conduit of less than 4-inch diameter, outside structure lines and at a depth of less than 6 feet shall be bedded in native material properly shaped as specified below, all as detailed on the Drawings.

C. Compacted bedding material shall be placed the full width of the excavated trench to a depth as shown on the trench detail included in the Drawings.

    1. In lieu of a detail, the depth shall be 6 inches.

D. Spread the bedding smoothly over entire width of trench to the proper grade so that the pipe is uniformly supported along the barrel.

E. Hand grade and compact each lift to provide a firm, unyielding surface along the entire pipe length. For rigid pipe, compact to at least 90 percent relative compaction.

F. Excavate bell holes at each joint to permit proper assembly and inspection of the joint.

G. Check grade and correct irregularities in bedding material.

H. Center pipes horizontally in trench width.

3.12 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Maintain optimum moisture content of fill materials to attain required compaction density.

D. Place fill material in continuous layers and compact in 6 to 8-inch lifts.

    1. Prevent pipe from moving either horizontally or vertically during placement and compaction of pipe zone material.

    2. Where trenches are under existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on the Drawings or specified elsewhere in these specifications, the trench backfill shall be Class

B and pipe zone backfill shall be Class B. Class B backfill shall be compacted to 95 percent of maximum density at optimum moisture content.

3. Where trenches are outside existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on plans or specified elsewhere, the trench backfill shall be Class A and pipe zone backfill in these areas shall be Class B. For these locations, compaction of Class B backfill shall be to not less than 90 percent of maximum density at optimum moisture content. Class B backfill shall be compacted to not less than 95 percent of maximum density at optimum moisture content.

E. Employ placement method that does not disturb or damage nearby or adjacent foundation perimeter drainage or utilities in trench.

F. Do not use power-driven impact compactors to compact pipe zone material.

G. Backfill Immediately: All trenches and excavations shall be backfilled immediately after pipe or conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible, unless otherwise directed by the Engineer.

H. Under no circumstances shall water be permitted to rise in open trenches after pipe has been placed.

I. Do not allow backfill material to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.

J. Use hand compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

K. Placement of Sand:

1. Place medium sand in lifts not exceeding 8 inches in uncompacted thickness.

2. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

L. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

M. Do not leave trench open at end of working day.

3.13 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, install 24 inches below finished grade. Coordinate with piping installation drawings.

3.14 ELECTRONIC LOCATING FACILITY INSTALLATION

A. Marker Balls:

1. Install according to manufacturer's recommendations and as shown or directed and according to the following requirements:

a. Install marker balls directly above the pipe alignment at a depth no less than 3 feet and no more than 4.5 feet below final surface grade.

b. Install marker balls during trench backfill operations by placing the marker ball in compacted backfill.

c. Cover marker ball with a minimum of 6 inches of backfill and compact backfill before continuing trench backfill operations.

d. Install markers balls with trenchless pipe installations by core-drilling hole of a minimal diameter needed to allow clearance for placement of marker ball. Backfill with approved trench backfill, pavement base and pavement, as applicable.

2. Water Marker Ball Locations: Install at locations as required by Sewer Marker Ball Locations specified herein.

3. Sewer Marker Ball Locations:

a. Install marker balls directly above connection points, termination points and all fitting locations, and at a minimum spacing of 50 linear feet on sewers with a straight horizontal alignment.

b. Install marker balls at a minimum spacing of 25 lineal feet directly above sewer mains installed on a radius.

c. Install marker balls on new or reconstructed sewer service laterals, directly above the centerline of the end of the lateral at the curb, property line or other end of lateral location, as directed.

d. Install marker balls directly above every alignment change along sewer mains and service laterals.

e. Install marker balls directly above manholes for manholes with buried covers.

B. Tracer Wire and Terminal Appurtenances:

1. Tracer Wire:

a. Install as shown or directed directly over the pipe centerline and on top of the pipe zone in all sewer trenches, including mainline sewers, service laterals and storm sewer inlet leads.

b. Connect mainline and service lateral tracer wires using either an approved direct-bury lug connector or direct-bury twist connector.

c. Extend tracer wire to locator stations in manholes, locator boxes, storm inlets, or other visually identifiable terminal appurtenances, allowing for access with electronic locating equipment, as shown or directed and according to the following requirements:

2. Locator Stations:

a. Install locator stations as shown within manholes.

b. Mount locator station to manhole wall within 18 inches of manhole rim with two stainless steel expansion anchors.

c. Drill a minimum 3/8-inch diameter hole through the manhole wall within 18 inches of the finish grade of the manhole rim.

d. Extend the tracer wire from the pipe trench in one continuous piece up the outside of the manhole and through the hole and into a locator station, and attach to one of the lugs in the locator station.

e. When multiple tracer wires are terminated in manhole install a multilead locator station.

f. Extend a ground wire from the locator station through a minimum 3/8-inch diameter hole in the manhole wall.

g. Install ground wire approximately 3 feet deep, and extend from the outside manhole wall a minimum of 3 feet horizontally in any direction.

h. Seal all holes drilled in manhole walls with silicone sealant.

3. Storm Inlet Tracer Wire Termination: Terminate tracer wire inside inlet and directly over storm outlet pipe by placing tracer wire as follows:

a. Drill a minimum 3/8-inch diameter hole through inlet wall to pass tracer wire through to inside inlet wall.

b. Seal hole with silicon sealer or material approved by Engineer.

c. Leave 6 inches of coiled tracer wire along inside of inlet wall approximately 3 inches below the inlet frame and grate or as directed by Engineer.

4. Service Lateral Tracer Wire Termination: Terminate tracer wire at ends of service laterals as shown or directed, as follows:

a. Termination in Tracer Wire Locate Boxes: Extend the tracer wire in one continuous piece up vertically from the pipe trench and into the bottom of the locate box. Leave 18 inches of coiled tracer wire inside locate box.

b. Termination at 2-inch by 4-inch Markers: Extend tracer wire in one continuous piece directly up service lateral 2-inch by 4-inch markers and leave 18 inches of tracer wire wrapped around the exposed top end of 2-inch by 4-inch marker.

3.15 VISUAL IDENTIFICATION FACILITIES

A. Tracer Wire Locate Boxes: Install tracer wire locate boxes directly over service laterals at property line, service boundary, or other location as shown or directed by the Engineer.

B. Service Lateral Plastic or Copper Markers:

1. Install plastic or copper markers in the concrete curb directly over the centerline of the service lateral, as shown or directed by the Engineer.

2. Either plastic or copper markers may be used.

3. If there is not suitable concrete curb for marker placement, then install a lateral cleanout as close to property line as practical at location approved by Engineer.

C. Service Lateral 2-inch by 4-inch Markers:

1. Place a 2-inch by 4-inch marker at the end of each new service lateral not connected to a building sewer.

2. Omit markers only as approved.

3. Block the capped or plugged service lateral end with a wood block against undisturbed earth and install the marker.

4. Extend the marker from the blocked service lateral invert to at least 12 inches above the existing or proposed finish ground surface.

5. Install marker in one piece. No splicing will be accepted.

6. Paint the exposed portion of the marker after its installation with quality quick drying enamel white paint for a storm only sewer and green paint for a sanitary or combined sewer.

7. After the paint has dried, use black, quick drying enamel, and neatly indicate the distance from the ground surface to the top of the service lateral in feet and inches.

8. Do not disturb the position and location of the marker during the backfilling operation.

9. If the marker is broken, moved out of location, or vertical alignment is changed during the backfilling operation, reopen the trench and replace the marker.

3.16 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the Owner. Initial testing will be paid for by the Owner. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99)

C. In-place compaction testing of pipeline backfill materials shall be performed at 2-foot elevation increments, one test per 200 lineal feet of pipeline trench as measured along pipe centerline.

1. The Engineer may reduce the frequency when satisfied with method of compaction.

2. The Engineer may direct testing at a higher frequency at no additional cost to the Owner upon failure to obtain specified densities or if the Contractor changes compaction equipment or methods of compaction.

3. The Engineer shall determine all test locations.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

3.17 SURFACE RESTORATION AND CLEANUP

A. Open Trenches: At the end of each work day, all open trenches shall be backfilled and all trenches within streets shall be temporarily paved or covered to the satisfaction of the Engineer and the local permitting agency.

1. Temporary paving shall be replaced with permanent street paving at the completion of construction within street rights-of-way, or sooner, if deemed necessary by the ENGINEER.

2. No gravel-filled trenches shall be left open within the street right-of-way at the end of the workday.

B. Topsoil:

1. Where trenches cross lawns, garden areas, pastures, cultivated fields, or other areas on which reasonable topsoil conditions exist, remove the topsoil to the specified depth and place the material in a stockpile.

2. Topsoil shall not be mixed with other excavated material.

3. After the trench has been backfilled, the topsoil shall be replaced.

C. Clean up and remove all excess materials, construction materials, debris from construction, etc. Replace or repair any fences, mailboxes, signs, landscaping, or other facilities removed or damaged during construction. Replace all lawns, topsoil, shrubbery, flowers, etc., damaged or removed during construction. The Contractor shall be responsible for seeing that lawns, shrubs, etc. remain alive and leave premises in condition equal to original condition before construction.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes backfilling required at building perimeter and site structures to subgrade elevations, fill under interior and exterior slabs-on-grade or pavement, and fill under landscaped areas. Backfilling for utilities within building proper is included within this section; backfilling for utilities outside building is included in Section 31 23 17, Trenching.

B. Section includes:

1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete

B. Section 31 05 13 - Soils for Earthwork

C. Section 31 05 16 - Aggregates for Earthwork

D. Section 31 22 13 - Rough Grading

E. Section 31 23 16 - Excavation

F. Section 31 23 17 - Trenching

G. Section 33 11 10 - Water Utility Distribution and Transmission Piping

H. Section 33 41 10 - Storm Utility Drainage Piping

I. Supplemental Information: Geotechnical report; bore hole locations and findings of subsurface materials.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

5. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.4 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill elsewhere in these Specifications. A self-compacted, cementitious material.

B. Imported Material: Materials obtained from sources offsite, suitable for specified use.

C. Lift: Loose (uncompacted) layer of material.

D. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

1.5 SUBMITTALS

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

B. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

C. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.6 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S2, Imported Fill Material, as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete. Compressive strength as required by the application or as noted in the Drawings.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Foundation Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to Work in this Section, become familiar with Site conditions. In the event discrepancies are found, notify Engineer as to the nature and extent of the differing conditions.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

D. See provisions for Work in Section 31 25 00, Erosion and Sediment Controls.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Control of Water:

1. Excavated areas shall be kept free of water and frost.

2. Bearing surfaces which become softened by water or frost shall be re-excavated to solid bearing at Contractor’s expense and backfilled with compacted crushed rock at Contractor’s expense.

C. Compact subgrade to density requirements for subsequent backfill materials.

D. Cut out soft areas of subgrade not capable of compaction in place and replace with specified granular fill material. See Article 3.5, Over-excavation for Unsuitable Foundation Conditions in Section 31 23 16, Excavation for additional details.

E. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

F. Subgrade to be approved by Engineer prior to placement of structures and commencement of backfill activities.

G. Do not allow or cause any work performed or installed to be covered up or enclosed prior to required tests and approvals. Should any Work be enclosed or covered up, uncover at Contractor's expense.

3.4 BACKFILLING

A. Backfill areas to contours and elevations shown in the Drawings with unfrozen materials.

B. Do not place materials when weather conditions and/or moisture content prevent attainment of specified density.

C. Maintain optimum moisture content of backfill materials to attain required compaction density.

D. Employ placement method that does not disturb or damage other work.

E. Mechanical tampers permitted in confined areas.

F. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

G. Foundation Base for Structures:

1. Bring excavation to required subgrade elevation shown in the Drawings.

2. Place foundation base material to required grade shown in the Drawings.

3. Place foundation base material in 6-inch lifts and compact to 95 percent maximum dry density.

4. Well Building:

a. Concrete Footings: Place a 6-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation to required grade under all concrete footings.

b. Concrete Slabs: Place an 8-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation under all concrete slabs.

c. Place a 3-inch thick layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in the bottom of footing excavations to minimize disturbance of silty foundation soils during wet weather.

H. Backfill for Structures:

1. Prior to placing backfill, remove forms, temporary construction, and debris below grade.

2. Backfill shall not be placed against poured concrete until 28 days have passed from completion of original concrete pour, unless otherwise approved by Engineer.

3. Heavy compactors and large pieces of construction equipment shall be kept away from any embedded wall a distance of a least 5 feet in order to avoid the build-up of excessive lateral pressures.

    a. Over-compaction of fill near walls should be avoided.

4. Compaction within 5 feet of the walls shall be accomplished using hand-operated vibratory plate compactors or tamping units.

5. The maximum particle size of granular material placed against buried structures shall be limited to no greater than 1-1/2-inch diameter.

6. Structural fill backfill material shall be brought up on all sides of the walls and footings in such a manner as to avoid adverse differential lateral earth pressures on the vertical surfaces.

7. Appropriate lift thickness will depend on the type of compaction equipment used and the type of material being placed. All material shall be compacted to at least 95 percent of the standard maximum dry density.

    a. For moderate- to heavy-weight compactors, a maximum loose lift thickness of 12 inches shall be used.

    b. For hand-operated or small compactors, a maximum loose lift thickness of 8 inches shall be used.

8. Particular care must be taken to avoid damage to the pipe connections to the structure.

9. Utility trench backfill within 10 feet of all structural perimeters shall meet the requirements for structural fill.

I. For areas receiving surface structures or existing paved areas to be constructed or replaced, such as roadways, driveways, parking lots, and sidewalks:

1. Place Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in 6-inch lifts.

2. Compact with vibratory equipment to 95 percent maximum density, unless otherwise specified or shown in the Drawings.

J. Permanent Embankment Fill:

1. Fill slopes shall be slightly overbuilt and then trimmed back to final grade using a track hoe with a smooth-edged bucket.

2. The Engineer shall review the proposed placement of any fill and evaluate the subgrade prior to fill placement.

3. The proposed compaction equipment shall be approved by the Engineer prior to fill placement to evaluate loads on embedded walls.

4. Permanent embankment fill placed beyond 5 feet of the embedded walls and beneath buildings, pavement, and other structures should be compacted to at least 95 percent of the maximum dry density.

5. Landscape fill shall be compacted to at least 90 percent of the maximum dry density as determined by ASTM D 698. Landscape fill should be no steeper then 3H:1V, unless shown otherwise.

K. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet, unless noted otherwise in the Drawings.

L. Make gradual grade changes. Blend slope into level areas.

M. Remove surplus backfill materials from Site in accordance with Section 31 23 16, Excavation.

3.5 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the Owner. Initial testing will be paid for by the Owner. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698.

C. In-place compaction testing for structural fill material shall be performed at 2-foot elevation increments in the fill material with at a minimum of one test per each 2,500 square feet of material placed. The Engineer shall be provided with the results of each compaction test at the time of testing.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

F. When testing of subgrade is not possible or feasible as detailed above, proof roll compacted fill surfaces under slabs-on-grade, pavers, paving, and as may be otherwise required by the Engineer.

3.6 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION

SECTION 32 11 23 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes construction of an aggregate subbase and base course for placement under asphalt or concrete paving, unit paving, or placed and left exposed.

B. Section Includes:

1. Aggregate subbase
2. Aggregate base course

1.2 RELATED REQUIREMENTS:

A. Section 31 22 13 - Rough Grading
B. Section 31 23 17 - Trenching
C. Section 31 23 23 - Fill
D. Section 31 05 16 - Aggregates for Earthwork
E. Section 32 12 16 - Asphalt Paving

1.3 REFERENCE STANDARDS

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

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications

2. T11, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing

3. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

4. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

4. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports

5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities and standing water, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Keystone: Fine aggregate used to aid in binding of loose surface stone.

1.5 SUBMITTALS

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

B. Product Data:

1. Submit data for geotextile fabric and herbicide.

C. Materials Source: Submit name of aggregate materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

PART 2 PRODUCTS

2.1 SHOULDER AGGREGATE

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.2 DENSE-GRADED BASE AGGREGATES

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.3 OPEN-GRADED BASE AGGREGATES

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A2, Granular Drain Backfill Material as specified in Section 32 05 16, Aggregates for Earthwork.

2.4 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

2.5 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

2.6 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Obtain Engineer’s acceptance of subgrade before placing base course or surfacing material.

B. Verify compacted substrate is dry and ready to support paving and imposed loads.

1. Proof roll substrate with equipment approved by the Engineer in minimum two perpendicular passes to identify soft spots.

2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.3 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.

2. Loads: Of uniform capacity.

3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.

2. Produce even distribution of material on prepared surface without segregation.

3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

4. Maintain consistent gradation of material. Widely varying gradation will be cause for rejection.

3.4 CONSTRUCTION OF COURSES

A. Untreated Aggregate Base Course:

1. If the required compacted depth of the base course exceeds 6 inches, construct it in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.

2. Completed Course Total Thickness: As shown on the Plans, 8-inch minimum.

3. Spread lift on preceding course to required cross-section. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.

4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:

    a. Use 3/4-inch leveling course or surfacing material as keystone.

    b. Spread evenly on top of base course, using spreader boxes or chip spreaders.

    c. Roll surface until keystone is worked into interstices of base course without excessive displacement.

    d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.

6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing and Leveling Course:

1. Place shoulder aggregates in a single layer, or two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 9 inches.

2. Spread on preceding course in accordance with cross-section shown.

3. Blade lightly and roll surface until material is thoroughly compacted.

4. Complete Total Thickness: As shown on the Plans, 8-inch minimum.

3.5 ROLLING AND COMPACTION

A. Commence compaction of each layer of base immediately after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by AASHTO T99.

B. Roll each layer of material until there is no appreciable reaction or yielding under the compactor before succeeding layer is applied.

C. Shape and maintain the surface of each layer during compaction operations. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to the required density before succeeding lift is placed.

F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate: Within plus or minus 0.04-foot of grade shown at any individual point.

C. Overall Average: Within plus or minus 0.04-foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

A. Quality control testing shall be performed by an independent testing laboratory provided by the Owner.

B. Refer to table below for minimum sampling and testing requirements for aggregate base course and surfacing. The OWNER reserves the right to complete additional testing.

Property	Test Method	Frequency	Sampling Point
Gradation	AASHTO T11 and AASHTO T27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T99	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	AASHTO T310	One for each 500 ton but at least every 10,000 square feet of area	In-place completed, compacted area

3.8 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate. Restore per Specifications as applicable.

END OF SECTION

SECTION 32 12 16

ASPHALT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SCOPE

A. This Section includes the construction of asphalt concrete pavement.

B. Section Includes:

1. Aggregate materials.
2. Asphalt concrete pavement.
3. Tack coat.
4. Seal and cover coat.

1.2 RELATED SECTIONS

A. Section 31 05 16 - Aggregates for Earthwork.
B. Section 32 01 16.69 - Asphalt Concrete Pavement Repair.
C. Section 32 01 16.71 - Cold Plane Pavement Removal.
D. Section 32 11 23 - Aggregate Base Courses.

1.3 REFERENCE STANDARDS

A. Standard Specifications:

1. Where the term “Standard Specifications” is used, such reference shall mean the 2021 edition of the Oregon Department of Transportation (ODOT) Standard Specifications for Highway Construction.

2. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications.

3. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

B. ASTM International (ASTM):

1. ASTM D2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.

2. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Maximum Density Test (MDT): Theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041 (Rice), by 62.4 pounds per cubic foot.

1.5 SUBMITTALS

A. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00640 for aggregate used in aggregate base.

B. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00744 for aggregate used in asphalt concrete.

C. Job Mix Formula (JMF):

1. ODOT-verified JMF within the past year. Provide formula, supplier, and product identification to the Engineer 30 days prior to start.

2. Provide Mix Design Verification (MDV) data from previous projects over the past 12 months indicating that the MDV and JMF specifications were met.

3. Definite percentage for:

a. Each sieve fraction.
b. New asphalt cement.
c. Recycled asphalt pavement.

4. Temperature of completed mix when discharged from mixer.

5. Character and quantity of anti-strip and recycling agents.

D. Tack Coating: Product information in accordance with Standard Specifications.

E. Liquid Asphalt: Product information in accordance with Standard Specifications.

1.6 QUALITY ASSURANCE

A. All testing to determine compliance with the specifications shall be performed by an independent testing laboratory contracted by the Contractor and approved by the Engineer. All testing costs shall be borne by the Contractor.

B. Density Testing:

1. A minimum of five (5) nuclear densometer readings shall be taken in random locations within every test area.

2. Each test area shall not exceed 200 tons of asphalt; however, smaller areas may be designated by the Engineer.

C. Plant Testing: In accordance with Section 00744.16 of the Standard Specifications.

D. Surface Smoothness:

1. Surface smoothness of the new asphalt concrete pavement shall be such that when a 12-foot straightedge is laid longitudinally across the paved area in any direction, the new pavement shall not deviate from the straightedge more than 1/4-inch.

2. Surface drainage shall be maintained.

3. Paving shall conform to the design grade and crown and contain no abrupt edges, low or high areas or any other imperfections as determined by the Engineer.

4. Pavement construction not meeting these requirements will be repaired by grinding the existing pavement to a 2-inch depth and replacing with the HMAC type indicated on the Typical Sections of the Drawings at the full roadway width at no cost to Owner.

1.7 PRE-PAVING CONFERENCE

A. Any supervisory personnel of the Contractor and any subcontractors who are to be involved in the paving work shall meet with the Engineer and Owner, at a time mutually agreed upon, to discuss methods of accomplishing all phases of the paving work.

B. The Contractor shall be prepared to review the size and type of equipment to be used and the anticipated rate of placement to determine equipment needs.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIAL

A. Aggregate Base for Dense Graded Asphalt Concrete:

1. The aggregate material shall be a clean, well-graded crushed base aggregate conforming to the Standard Specifications as specified in Section 32 11 23, Aggregate Base Courses.

2.2 ASPHALT CONCRETE PAVEMENT

A. Dense Graded Hot Mix Asphalt Concrete (HMAC)

1. Trench patch/resurfacing:

a. Level 3, ½-inch dense graded, PG 70-22 HMAC.

2. Roadway resurfacing:

a. Level 2, ½-inch dense graded, PG 70-22 HMAC.

3. Conform to the requirements as specified in Section 00744 of the Standard Specifications.

4. Asphaltic concrete pavement delivered to the site shall be accompanied by a ticket with the approved "job mix formula" number shown. Loads without tickets identifying the job mix formula will not be accepted.

5. Percent of recycled asphalt pavement used in new asphalt pavement shall not exceed 30 percent. Recycled asphalt pavement may not be used in top wearing course unless otherwise approved by the Engineer.

B. Tack Coat

1. In accordance with Standard Specifications. Use AR 4000, AC-20 asphalt or CSS-1 emulsified asphalt C.

C. Seal and Cover Coat

1. Asphalt material shall be CRS-2 cationic emulsified asphalt.

2. Cover stone shall conform to size ¼ -inch -#10 aggregate in the Standard Specifications.

D. Subgrade Geotextile

1. Certification Level B, as specified in Section 02320 of the Standard Specifications.

PART 3 EXECUTION

3.1 AGGREGATE PAVEMENT BASE

A. In accordance with Section 32 11 23, Aggregate Base Courses.

3.2 ASPHALT CONCRETE PAVEMENT

A. Construct asphalt concrete pavement in accordance with Section 00744 of the Standard Specifications.

B. Conform to the requirements for prime coat and tack coat in the Standard Specifications. Tack coat all edges of existing pavement, manhole and clean out frames, inlet boxes and like items. When rate is not specified, asphalt will be applied at the rate of 0.1 gallon per square yard.

C. Obtain the Engineer's acceptance of the aggregate base course before beginning construction of the asphalt concrete wearing course.

D. Hot mix asphalt shall be placed on dry, prepared surfaces, when air temperature in the shade of 40^{o} F or warmer, unless otherwise authorized by the Engineer.

E. Placing asphalt pavement during rain or other adverse weather conditions will not be permitted unless otherwise authorized by the Engineer, except that asphalt mix in transit at the time these adverse conditions occur may be placed provided it is of proper temperature, the mix has been covered during transit, and it is placed on a foundation free from mud or free-standing water.

F. Correct any defects in material and workmanship, as directed, when determined detrimental by the Engineer. These include segregation of materials, non-uniform texture, and fouled surfaces preventing full bond between successive spreads of mixture. The corrections or replacement of defective material or workmanship shall be at the Contractor's expense.

G. Compact the bituminous mixture to at least 92 percent of the Theoretical Maximum Density.

H. The finished surface of each course of layer of mixture shall be of uniform texture, smooth, and free of defects and shall closely parallel that specified for the top surface finished grade. Remove and replace boils and slicks immediately with suitable materials.

I. The surface of each layer shall meet the surface smoothness requirements herein.

J. Lift thickness shall be as shown on the Drawings or specified, but not to exceed 3 inches.

K. Do not place asphalt concrete pavement on emulsified asphalt (tack coat) until the asphalt separates from the water (breaks) but before it loses its tackiness.

L. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

3.3 ASPHALT CONCRETE PAVEMENT SPEED BUMPS

A. Install in accordance to details shown in the Drawings using the same asphalt concrete pavement mix as adjacent roadway surface.

3.4 PAVEMENT MARKINGS

A. The replacement of existing pavement markings removed as part of this work shall be incidental the work specified in this Section.

3.5 FIELD QUALITY CONTROL

A. Job mix will be sampled immediately behind the paving machine.

B. Temperature of the mix will be measured immediately behind the paver.

C. The theoretical maximum specific gravity of the bituminous mixture will be determined in accordance with ASTM D2041.

D. Properties of the job mix will be measured using ASTM D2041.

E. Density of the compacted job mix will be measured in accordance with ASTM D6938.

3.6 ADJUSTMENT OF EXISTING MANHOLE COVERS AND VALVE BOXES

A. Prior to placing asphalt concrete pavement, make all necessary adjustments to existing manhole frames and covers and valve box covers to ensure that the tops of the manhole covers or valve box lids are flush with the finished grade of the adjoining pavement or ground surface, and that valve boxes and PVC pipes are centered and plumb over operating nut valve.

END OF SECTION

SECTION 32 16 13.16

CAST-IN-PLACE CONCRETE CURBS

PART 1 GENERAL

1.1 SCOPE

A. This Section includes removing existing concrete curbs and constructing new Portland cement concrete curbs.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 03 21 00 - Reinforcing Steel.
C. Section 31 05 16 - Aggregates for Earthwork.
D. Section 32 11 23 - Aggregate Base Courses.

1.3 REFERENCE STANDARDS

A. Standard Specifications:

1. Where the term “Standard Specifications” is used, such reference shall mean the 2015 edition of the Oregon Department of Transportation Standard Specifications for Highway Construction.

2. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications.

3. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.4 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Aggregates:

1. Materials Source: Submit name of aggregate materials suppliers.

2. Gradation: Meeting the requirements of Coarse Aggregate Type A1, Dense-Graded Aggregate provided in Section 31 05 16, Aggregates for Earthwork, for the sizes of materials shown in the Drawings.

C. Concrete: In accordance with Section 03 30 00, Cast-in-Place Concrete.

PART 2 MATERIALS

2.1 MATERIALS

A. Provide materials in accordance with Section 00759, Miscellaneous Portland Cement Concrete Structures, of the Standard Specifications.

2.2 EQUIPMENT

A. Provide equipment in accordance with Section 00759, Miscellaneous Portland Cement Concrete Structures, of the Standard Specifications.

PART 3 EXECUTION

3.1 REMOVAL OF EXISTING CURB

A. Comply with the requirements of Section 00310, Removal of Structures and Obstructions, of the Standard Specifications.

B. Saw cut existing asphaltic concrete pavement 12 inches from the face of existing curb to a maximum depth of 6 inches. Remove material to a maximum depth of 12 inches to facilitate construction of replacement curb.

3.2 CONSTRUCTION

A. Comply with the requirements of Section 00759, Miscellaneous Portland Cement Concrete Structures, of the Standard Specifications.

B. Where existing curbside drains are present, provide connections for existing curbside drains to and through new curb for the outlet of flows on to the adjacent roadway.

END OF SECTION

SECTION 32 31 13

CHAIN LINK FENCING AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes chain link steel fencing and gates as shown on the Drawings or specified elsewhere. All fences and gates shall be furnished with top rails and knuckled periphery edges.

B. Section includes:

1. Chain link fabric.
2. Posts.
3. Rails.
4. Tension wires.
5. Braces.
6. Fittings.
7. Gates.
8. Lock assemblies and gate stops.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Chain Link Fence Manufacturer's Institute:

1. Galvanized Steel Chain Link Fence Fabric.
2. Industrial Steel Specifications for Fence-Posts, Gates and Accessories.

B. ASTM International (ASTM):

1. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.

2. A313, Standard Specification for Stainless Steel Spring Wire.

3. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

4. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.

5. A497, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

6. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

7. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.

8. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.

9. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

10. C94, Standard Specification for Ready-Mixed Concrete.

11. C150, Standard Specification for Portland Cement.

12. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.

13. F552, Standard Terminology Relating to Chain Link Fencing.

14. F567, Standard Practice for Installation of Chain-Link Fence.

15. F626, Standard Specification for Fence Fittings.

16. F900, Standard Specification for Industrial and Commercial Swing Gates.

17. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.

18. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

19. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.

20. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.

21. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

C. Conflicts in requirements shall use this Section to take precedence.

1.3 SUBMITTALS

A. Section 01 30 00, Submittal Procedures: Requirements for submittals.

B. Shop Drawings:

1. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.

2. Fence, gate posts, rails, and fittings.

3. Chain link fabric.

4. Gates and hardware.

C. Manufacturer's recommended installation instructions.

D. Evidence of Supplier and installer qualifications.

1.4 QUALITY ASSURANCE

A. Use skilled workers thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Provide each type of steel fence and gate as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition.

B. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fabric

1. Continuous chain link fence with 2 13/16-inch slats.

2. Height: As shown on the Drawings.

3. Mesh: 2-inch. All mesh shall have knuckled periphery to eliminate sharp appendages.

4. #9 gauge steel core wire.

5. Top and bottom selvage: Knuckled finish.

6. Galvanized after weaving.

7. Zinc coating shall not be less than 1.2 ounces per square foot.

8. Fabric shall be provided minimum 15 mils of PVC coating, colored to match existing green fencing.

B. Line Posts

Line posts shall be hot dipped galvanized 2.375" O.D. hot dipped galvanized pipe, weighing 3.12 pounds per lineal foot.

C. Terminal Posts

End, corner and pull posts shall be hot dipped galvanized pipe 2.875 inches O.D. and weighing not less than 4.64 pounds per lineal foot.

D. Top Rail

1. Top rail shall be hot dipped galvanized 1.660 inch O.D. pipe, weighing 1.83 pounds per lineal foot.

2. Furnish in random lengths of approximately 20 feet.

3. Jointed using a pressed steel or malleable sleeve, not only allowing for expansion and contraction, but also providing a continuous brace from end to end of each stretch of fence.

E. Tension Wire

Bottom tension wire shall be #6 gauge heavy galvanized high carbon steel coil spring wire, securely fixed to the fabric, line posts and terminal posts.

F. Braces

1. All terminal posts shall be braced with 1.660 inch O.D. horizontal pipe bracing of the same material as the top rail, securely attached to the terminal and first line post with malleable iron fittings.

2. Braces shall be truss-braced from the first line post to the bottom of the terminal post, with a 3/8-inch galvanized truss rod assembly.

3. Corner posts shall be braced in both directions.

G. Fittings

1. Malleable, cast iron or pressed steel.

2. Hot dip galvanized.

H. Fabric Ties

1. #11 gauge galvanized wire ties shall be used to tie the fabric to the line posts and rails.

I. Chain Link Gates

1. Frames:

   a. Made of heavy galvanized 1.90 inch O.D. pipe, weighing 2.28 pounds per lineal foot.

   b. Welded or assembled with corner fittings.

2. Corner fittings, ball and socket hinges, catch stops and center rest to be heavy galvanized malleable iron.

3. Hinges as required.

4. Provide diagonal cross-bracing.

J. Gate Posts

Posts shall be hot dipped galvanized pipe 2.875-inch O.D. weighing 4.64 pounds per lineal foot.

K. Framework Material

All posts, rails and braces to be heavy galvanized.

L. Lock Assembly and Gate Stop

1. Provide for each gate one (1) double-hasp drive gate drop rod lock assembly set in concrete and one (1) gate stop set in concrete.

2. All lock assemblies and gate stops shall be fabricated from heavy galvanized malleable iron.

3. Provide one vandal-proof keyed lock and 3 keys for each gate assembly.

M. Privacy Slats

1. Provide privacy slats to match existing site fencing.

2. Match existing privacy slates.

PART 3 EXECUTION

3.1 INSTALLATION

A. All materials and workmanship shall be first class in all respects and shall be done in a neat and workmanlike manner.

B. Installation shall be conducted in accordance with the requirements of the Chain Link Fence Manufacturers Institute and these Drawings & Specifications.

C. All line, terminal, gate stops, gate drop, and gate posts shall be fixed with a minimum of 3-foot embedment in concrete poured into a 1-foot diameter hole and plumb upon curing of the concrete.

D. Line posts shall be spaced not further than 10-foot on-center.

E. Gates shall have 3-inch clearance above ground surface and sized for the application shown.

F. Space ties at 14 inches on-center (O.C.).

END OF SECTION

SECTION 32 80 00

TEMPORARY IRRIGATION SYSTEM

PART 1 GENERAL

1.1 SCOPE

A. This Section includes furnishing and delivery of labor, materials and equipment to install a complete, automatic, above and below grade, temporary irrigation system in the areas shown on Drawings.

B. Temporary irrigation system shall be used by the Contractor to water and establish plants during the warranty period and be left in place for the Owner to use after the warranty/establishment period.

C. Temporary irrigation system design consists of connection to water source, protection of water source with a backflow preventer, buried mainline to buried control valves, buried lateral zone lines to plant beds, exposed lateral lines stake to the ground surface within the plant beds, and irrigation nozzles mounted on a wood stake riser within the plant beds. The control valves are operated by battery powered controllers located in valve boxes. The head layout on the Drawings may be adjusted by the Contractor to provide better coverage as required. The exposed lateral line layout is diagrammatic and may be adjusted as necessary. The lateral zone lines shall be sized according to the pipe sizing chart found on the Drawings.

D. Contractor shall provide record drawings, operating instructions and adjust the programming for the following year prior to the end of the warranty/establishment period.

1.2 RELATED SECTIONS

A. Section 32 90 00, Planting.
B. Section 32 91 21 Finish Grading and Seeding

1.3 STANDARDS AND REGULATIONS:

A. All irrigation work shall be performed by those licensed to conduct required work in accordance with applicable Federal and State Laws.

B. The Owner shall be responsible for providing water source. The Owner shall be responsible for cost of water during specified irrigation operations.

C. Provide at least one person who shall be present at all times during execution of this portion of the work, who shall be thoroughly familiar with the types of materials being installed and the manufacturers recommended methods of installation, and who shall direct all work performed under this section.

D. Except where more stringent requirements are specified, conform to the "Uniform Plumbing Code" as adopted and modified by the State of Oregon and all legally constituted authorities having jurisdiction.

E. All materials and equipment in the irrigation system shall be new and shall be brands and types as specified on the submitted drawing, or as specified herein, or as approved by the Owner's Representative.

1.4 SUBMITTALS

A. Submit three copies of the manufacturer's product information ('cut') sheets for all components and materials specified

B. Upon completion of the irrigation system installation and as a condition of its acceptance, deliver to the Owner's Representative the following:

1. As-Built Record Drawings: Clearly differentiate between the buried components such as valves, backflow preventer, and main and lateral lines, and the above-ground portions of lateral lines and irrigation nozzles that are intended to be removed after plant establishment by the Owner. Submit electronic file of as-built drawings.

C. System Programming

1. Calculate three irrigation programs: Spring / Early Summer, Summer, Late Summer/ Fall as directed by the Project Manager.

2. Submit seasonal controller(s) operation programs with as-built record drawings. Include total application quantities in inches per week for all zones, for establishment period and continual system operation. Revise the programs as directed by the Project Manager and as necessary for each year of plant establishment.

1.5 PROTECTION OF THE PUBLIC

A. Protect existing pavements, reference points, monuments, and markers on this site. Verify utility location prior to commencement of construction. Verify, identify, and protect all utilities. Protect adjacent property. Protect work and materials of other trades. Protect irrigation system materials before, during, and after installation. In the event of damage, repair or replace items as necessary to the approval of the Owner's Representative and at no additional cost to the Owner. Use all means necessary to protect the public from injury during the construction process.

1.6 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

1.7 ORDINANCES AND REGULATIONS

A. All local, municipal and state laws and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications and the Contractor shall carry out their provisions. Anything contained in these specifications shall not be construed to conflict with any of the above rules, regulations or requirements.

1.8 GUARANTEE

A. The Contractor guarantees that the irrigation system installed under this section of the specifications shall be free from defects in materials, design and workmanship for a period of one year coinciding with the plant establishment period.

B. The Contractor shall maintain the system in working order to water and establish plants, winterize the system during the Fall, and start up the system in Spring during the plant establishment period.

C. The Contractor shall be responsible for grade settlement, and/or erosion of soil surfaces resulting from irrigation construction and operation throughout specified warranty period.

PART 2 MATERIALS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Materials and equipment shall be new and sufficient to afford complete and full irrigation performance and coverage as specified in this section.

2.2 PLASTIC PIPE

A. Plastic pipe shall be polyvinyl chloride (PVC) continuously bearing the seal of the National Sanitation Foundation, or UV resistant Polyvinyl chloride with the exception of polyethylene pipe specified as follows.

B. Polyvinyl Chloride (PVC) pipe

1. Lateral Lines: PVC Class 200 solvent weld pipe meeting the requirements of ASTM D2241-00.

2. Main Lines: PVC Sch, 40 solvent weld pipe, meeting the requirements of ASTM D2855-96.

3. Sleeves: PVC Class 200.

4. Nipples: PVC Schedule 80 standard weight with molded threads.

2.3 PLASTIC FITTINGS

A. For Polyethylene Pipe: Same manufacturer or as recommended by manufacturer of polyethylene pipe.

B. For PVC Pipe: PVC Schedule 40 meeting the requirements of ASTM D2466-01.

C. For PVC Schedule 80 Pipe: PVC Schedule 80 standard weight.

2.4 PIPE JOINING COMPOUNDS

A. Cement and Primer for Solvent Weld Joints: Weld-On 725 cement and Weld-On P-75 primer or approved equal.

B. Teflon Tape for Threaded Joints (PVC or galvanized): Dupont or equal.

2.5 ELECTRIC CONTROL WIRE AND CONNECTORS

A. Wire: Single strand insulated copper designed for 24 volts or greater, Type UF, UL approved for direct burial in NEC Class II circuits, 14 gauge. Control wires shall be red and common wire shall be white.

B. Wire Connectors and Sealant: 3M DBY or approved equal for direct burial.

2.6 AUTOMATIC CONTROLLER

A. One to four station battery operated controller(s) as required, suitable for installing in valve boxes with zone valves, Hunter Node, Rainbird TBOSII, Hunter WVC, or approved equal.

B. Provide one control unit/programmer to match controller(s) provided which shall be turned over to the Owner at the end of the one year establishment period.

2.7 VALVES

A. Manual Isolation Valves: Brass or bronze ball type valves same size as pipe.

B. Automatic Control Valves: Rainbird PEB, Hunter ICV valves or approved equal.

C. Manual Drain Valve: 3/4-inch size bronze angle valve with rising stem and cross-type handle.

D. Quick Coupling Valve and Accessories: RainBird 44LRC quick coupling valve, RainBird 44K key, or approved equal. Quick Coupler Stabilizer; Leemco LS-100 by Leemco, Inc., 1525 E. 6th Street, Corona, CA 91718, (909) 735-3330, or approved equal.

2.8 VALVE BOXES

A. Plastic valve box with locking lid, sized to facilitate access to valve(s) for maintenance, repair or removal. Ametek, Carson, or approved.

2.9 BACKFLOW PREVENTION ASSEMBLIES

A. Brass or bronze construction, double check valve type, see Irrigation Legend Drawings for manufacturer, model and size.

2.10 IRRIGATION SPRINKLERS

A. Hunter/Nelson MP Rotator nozzles mounted on shrub adaptor fixed on top of PVC riser,and attached to wood stake as detailed on Drawings. See Irrigation Legend Drawings for models and performance information.

2.11 WATER SOURCE

A. Owner provided, see Drawings for location.

2.12 OTHER MATERIALS:

A. Locator Wire; Mainline to be marked with continuous #14 gauge, single strand locator wire, with light blue color coating. Ends of locator wire to be exposed at valve boxes.

B. All other materials, not specifically described, but required for a complete and proper temporary irrigation system, shall be high quality of their respective kinds and subject to acceptance by Owner’s Representative.

PART 3 EXECUTION

3.1 PERFORMANCE

A. System Preparation:

1. Prior to all work of this section, carefully inspect previous work and verify that all such work is complete to the point where this installation may properly commence.

2. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the proposed design, the referenced standards, and the manufacturer's specifications.

3. Verify that the static water pressure at the water sources are sufficient to operate system within component manufacturer's tolerances.

4. In the event of a source and volume discrepancy in field at the time of construction, immediately notify Owner’s Representative. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved. Start of work denotes acceptance and responsibility for discrepancy.

5. Protect paving, structures and other improvements from soil and debris from excavation and other installation procedures. See Drawings for other requirements.

B. Connection to Water Sources:

1. Verify location of water sources. Connect system as detailed on Drawings.

C. PVC Pipe Layout and Connections:

1. Bury mainline 18 inches deep from top of pipe to finish grade.

2. Lateral pipe within plant beds shall be placed on finish grade and staked in place as detailed on Drawings. Connect lateral line to valve in valve box and bring line to surface within 5 feet of valve box using elbow fittings and pipe sections as necessary. Lateral pipe between plant beds that cross routes that could be driven on by vehicles or mowers shall be buried the same as mainline.

3. Do not use solvent cement on threaded joints. Wrap threads with Teflon tape in accordance with manufacturer's specifications.

4. Follow manufacturer's instructions for solvent welding of PVC pipe and fittings to achieve tight and inseparable joints.

5. Solvent weld PVC pipes only during nonfreezing weather. Solvent weld PVC pipes only under cover in rainy weather.

6. Remove any solvent completely from soil if spillage occurs. Remove all debris and dispose legally off-site.

7. Cementing plastic pipe:

a. Cut all ends squarely with approved pipe cutting tool. Bevel ends with a deburring tool.

b. Clean all pipe ends prior to assembly.

c. Clear all pipe lengths of dirt and debris. Protect from contamination.

d. Do not use excess primer and solvent when joining pipe ends.

e. Insert pipe ends to full depth of fitting, hold tightly as necessary to insure full depth bonding.

f. Allow 15 minutes curing time following joint assembly prior to moving or handling jointed pipe.

D. Drain Valve Installation: Install one manual drain valve at discharge side of each remote control valve and at all low points in main line pipe to allow for complete drainage of main lines.

E. Valve Installation: Install plumb and below grade in valve boxes, in accordance with manufacturer's specifications and tolerances.

F. Quick Coupling Valves: Install in specified box at point of connection, and as shown on the Drawings.

G. Controller Installation: Install battery operated controller(s) in valve boxes.

H. Electrical Wiring: Connect controller to valves with control wire following manufacturer's requirements. Do not exceed the maximum length for control wire if tying valves in a different valve box to the location of the controller. Provide another battery operated controller if the distance is too far.

1. Lay control wires in trench under mainline. Place control wires in sleeves under paving and when not in common trench with mainline.

2. Wire splices to be moisture proof using specified electrical connectors. Make splices only in valve boxes. Provide minimum of 1' of coiled slack between wire splices.

3. Clearly mark both ends of wiring, on a permanent tag, with number of corresponding valve and controller station. Locate 1 tag at each control valve and 1 tag per wire in controller.

4. Sharp bends or kinks in wiring not permitted.

I. Irrigation Sprinkler Installation

1. Install all sprinklers as detailed on Drawings with nozzle fitted to a shrub adaptor and attached to a threaded nipple which is fixed to a wood stake in a vertical position.

2. Connect threaded nipple to lateral line with polyethylene pipe and appropriate fittings. Secure lateral pipe and polyethylene pipe to ground with appropriate plastic or metal wire stakes.

J. Flushing:

1. After piping, risers, and valves are installed, but prior to installing sprinkler nozzles, thoroughly flush piping system under full water head.

2. Maintain flushing for five minutes.

3. Cap risers immediately after flushing unless they are fixed to stake above grade.

K. Pressure Testing:

1. Conduct test in presence of Owner's Representative prior to backfilling trenches.

2. Test shall be conducted with quick couplers, control valves and manual drains, in place, prior to backfilling. Test all mainlines only.

3. Piping shall not lose more than 4-psi water pressure while holding 125-psi for 60 minutes.

4. The Contractor shall correct defects and retest until Owner's Representative acceptance.

L. Operational testing shall be performed for approval of Owner's Representative after hydrostatic testing is completed, backfill is in place, and sprinkler nozzles are adjusted to provide the best coverage of the plant bed.

1. Demonstrate that system meets coverage requirements and that automatic controls function properly.

2. Coverage requirements are based on operation of one circuit zone at a time.

3.2 COMPLETION

A. Final Inspection:

1. Thoroughly clean, adjust and balance the installed irrigation system. Adjust spray pattern of nozzles to minimize throw of water onto roads and sidewalks. Monitor system until all components operate as specified. Adjust pattern or add heads to zones to cover dry spots as necessary at no cost to the Owner.

2. Upon 48 hours notice, demonstrate irrigation system performance to the Owner's Representative. Demonstration shall prove that the installed system is functioning properly.

3. Even though the Contractor will manage the system during the maintenance period, the Contractor is required to demonstrate operation of the system, including control valves to Owner's Representative. Submit irrigation plan and record drawings to Owner's Representative.

4. Explain and demonstrate start-up and winterizing procedures to Owner's Representative.

END OF SECTION

SECTION 32 90 00

PLANTING

PART 1 GENERAL

1.1 SCOPE

A. This Section includes the planting and establishment of plant materials, complete, including furnishing, delivery, planting, and maintenance of all trees, shrubs, and ground covers.

B. Section Includes:

1. Topsoil.
2. Imported topsoil.
3. Soil conditioners.
4. Fertilizer.
5. Mulch.
6. Anti-desiccant.
7. Fungi.
8. Tree staking and guying.
9. Standpipes.
10. Plant materials.
11. Plant guards.
12. Guarantee, maintenance, and warranty.

1.2 RELATED SECTIONS

A. Section 31 05 13, Soils for Earthwork.
B. Section 32 91 21, Finish Grading and Seeding.

1.3 SUBMITTALS

A. The following submittals are required as part of this work:

1. Proof of procurement and contract for delivery of plant material.

2. Schedule for delivery of plant material for inspection prior to planting.

3. Sources of plant materials, and identification tags visible for each plant.

4. Color-coded tagging system for all plant material species. (Flag all plant materials prior to installation.)

B. Plant Establishment and Maintenance Plan: Provide a proposed method and schedule for watering and maintaining plant material and seeded areas for the duration of the two-year guarantee and maintenance period, or through two growing seasons. The plan shall provide for the following:

1. During dry weather and generally between the months of May through October, water newly planted trees and shrubs with more frequency to maintain a healthy growing condition. Maintain an average of 1 inch of water per week during the one-year period. Increase watering when weather temperatures are above 90 degrees for more than 3 consecutive days. Program the irrigation system to provide 1 inch of water every 18 days during the dry months of the second year.

2. Water sufficiently to maintain soil moisture depth between 6"-8" of the finish grade.

3. Watering operations shall not cause erosion or surface runoff onto paved areas.

PART 2 MATERIALS

2.1 TOPSOIL

A. See Section 32 91 21, Finish Grading and Seeding.

2.2 IMPORTED TOPSOIL

A. See Section 32 91 21, Finish Grading and Seeding. Provide imported topsoil if native topsoil is not available or rendered useless by unauthorized construction activity.

2.3 SOIL CONDITIONERS

A. Organic Material

1. Garden Compost: Commercially manufactured material, made from dead plant material such as grass clippings, weeds, green and dead dry leaves, garden and vegetable material, and ground branches of trees and shrubs. Furnish a product that is composted under controlled aerobic decomposition, with the internal temperature reaching 135 °F for 15 days, without exceeding 155 °F. Ensure that it contains a maximum of 10% bacteria and 10% fungus. Additional certification may be required in areas having a certification program.

B. Sand

Clean, coarse, ungraded sand, meeting the requirements of ASTM C 33 for fine aggregate.

2.4 FERTILIZER

A. Commercial Fertilizer: A complete plant food containing 22% nitrogen, 16% phosphorous, 8% soluble potash, and a minimum 2% sulfur, conforming to applicable State fertilizer laws. Fertilizer shall be uniform in composition, dry, free-flowing, and delivered in original, unopened containers bearing manufacturer's guaranteed analysis.

2.5 MULCH

A. Arbor Chips: Mulch that is chipped from cleared site vegetation. Ensure that chipped material is free of any noxious weeds or invasive vegetation. Additional material can be sourced from arborists.

B. Organic Mulch: use same material as specified for Garden Compost, see 2.3, A, 1 this Section.

C. Rock Mulch: ¼-inch to ¾-inch graded crushed rock

2.6 ANTI-DESICCANT

A transpiration retarding material to be used where any plant material is moved during the normal growing season. Anti-desiccant may be composed of an acrylic polymer or vinyl latex compound, Wiltpruf or approved equal.

2.7 FUNGI

Commercially produced ectomycorrhizal and endomycorrhizal fungi that improve plant root absorption of soil nutrients.

A. Furnish mycorrhizae inoculum in granular or concentrated powder form for areas to be seeded. The product shall have an OMRI Listed™ seal from the Organic Materials Review Institute.

B. The product shall contain a minimum of the following four (4) species of Endomycorrhizae fungi: *Glomus intraradices, G. mosseae, G. aggregatum,* and *G. etunicatum*. The product shall contain a minimum of the following seven (7) species of Ectomycorrhizae fungi: *Rhizopogon villosullus, R. luteolus, R. amylopogon, R. fulvigleba, Pisolithus tinctorius, Scleroderma Cepa*, and *S. citrinum*.

C. The product shall be MycoApply® Endo/Endo Plus by Mycorrhizal Applications, Inc., or EcoLive™ Organics by Sunmark Environmental Services, LLC, or an approved equivalent.

2.8 TREE STAKING AND GUYING

A. Staking Materials

1. Vertical stakes shall be 2" x 2" x 8' (minimum) or 2" round X 8' sound new fir, or hemlock, free of knots and other defects.

2. Tree ties shall be placed on the tree to allow natural movement in the wind. Tree ties shall be placed to allow for two years growth of the trunk.

B. Guying Material

1. Anchors shall be 2" x 4" x 3' sound new heart cedar, fir or hemlock, free of knots or other defects.

2. Wires and tree ties shall be same as for staking with additional galvanized turnbuckle, centered in wire line with white industrial rubber hose, or manufactured product specific for this use.

2.9 PLANT MATERIALS

A. The Plant List is shown on the Drawings. Names of some species and varieties not included therein conform to names generally accepted in the native grown nursery trade. Information on sources for native plant material species can be obtained through the publication titled “Hortus Northwest.”

B. Nursery grown plant material shall be grown with a quality and habit of growth that is sound, healthy, vigorous, and free from insects, diseases, and injuries. Size shall be equal to or exceeding measurements indicated in the Plant List and measured before pruning with branches in normal position. Sizes and methods for handling shall be according to the American Standard for Nursery Stock recommended by the AAN.

C. Trees: Balled and burlapped trees shall be of height and caliper shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Single stem trees shall be provided except where special forms are shown or listed. Container grown trees are subject to AAN specifications for container grown stock.

D. Shrubs: Shrubs shall be of the height shown or listed and with not less than minimum number of canes required by ANSI Z60.1 for type and height of shrubs and vines required. Shrubs are balled and burlapped (B&B) or container grown.

E. Ground cover shall be plants established and well rooted in removable containers, and with not less than a minimum number of and length of runners required by ANSI Z60.1 for the pot size indicated on the drawings.

PART 3 EXECUTION

3.1 INSPECTIONS AND REPORTS

All plant materials shall be inspected prior to installation. Notify the ENGINEER 10 days prior to delivery date for inspection at the site. Each individual species shall bear a tag indicating species and source. Material not inspected prior to planting will be rejected at the ENGINEER's sole discretion.

3.2 TIME OF PLANTING

Conduct planting operations under favorable weather conditions during seasons which are normal for such work, generally during the periods of April 1 to June 1, and from September 1 to November 1. Planting operations outside these time periods may be conducted with approval of the Landscape Architect.

3.3 EXAMINATION

A. Examine the site for conditions that might adversely affect execution, performance, quality of the Work, and survival of plantings.

B. Take field measurements of landscape areas to determine if differences exist between plans and actual ground dimensions. Notify ENGINEER prior to proceeding with Work.

C. Verify that grades and slopes of landscaped areas insure positive drainage and that they are acceptable to ENGINEER prior to commencing Work.

3.4 DELIVERY

Supply plants designated B&B (balled and burlapped) in the Plant List with firm, natural balls of earth, or diameter and depth sufficient to encompass the fibrous and feeding root system necessary for vital plant growth. Rootball shall be firmly wrapped with burlap and bound with twine, cord or wire mesh. Manufactured rootballs or rootballs less than the diameter indicated for the caliper or size of plant material (American Standard for Nursery Stock) will be rejected.

Furnish plants designated CG or "gallon" (container grown) in the Plant List with self-established root systems sufficient to hold earth together after removal from the container but not root-bound, in a container of specified size.

3.5 PROTECTION DURING DELIVERY

A. Small Plant Material

1. If plants are not in a dormant state, spray with anti-desiccant to cover foliage as recommended by manufacturer. During shipment, protect plants with a tarpaulin or other covering to prevent excessive drying from sun and wind.

2. Cover balls of B&B plants and containers of CG plants which cannot be planted immediately upon delivery with moist mulch to protect from drying.

B. Trees

Spray trees with anti-desiccant immediately prior to digging. Protect the top of the tree by wrapping with burlap. Pad all parts of the tree to be cabled or roped. Keep soil balls and exposed roots moist during all digging and transporting operations.

Transport trees during favorable weather conditions. Trees damaged by exposure during transport will be rejected at the site. Damaged trees, as a result of improper or haphazard moving or planting techniques, will be rejected. Right of rejection shall be at the sole discretion of the ENGINEER.

3.6 LOCATION OF PLANTS

A. Locate new planting where shown on the Drawings except where obstructions below ground are encountered or where changes have been made in the construction. Review necessary adjustments with the ENGINEER and begin planting only after approval from the ENGINEER.

B. All plant material species to be flagged prior to planting, (see Part 1, paragraph 1.03, item 4.)

C. Plant trees in locations shown. Plant shrubs and ground cover plants in random patterns within designated areas with the quantities indicated in the plant list.

3.7 PLANTING PROCEDURES

A. Planting Soil Mix: Prepare planting soil mix for plant pits and beds using stockpiled or imported topsoil, soil conditioners, and fertilizer. Thoroughly mix in the following proportions with rotary mixer or other method. Store and protect mixture from excessive leaching by covering with tarpaulin.

Material	Parts by Volume
Topsoil	80 – 90%
Organic Material	10 – 20%

B. Plant Pits: Excavate circular pits with vertical sides for all plants as shown in the details. Scraify sides of plant pits. Dispose of excavated subsoil. The diameter of the pits shall be a minimum of 2.5 times the diameter of the rootball. Compact planting soil mix at the bottom of plant pit.

C. Setting Small Plants

Remove the top 2/3 of burlap and all twine or cord from the top and sides of balled and burlapped plant material. Cut containers or water and lift plant material out of containers. Set base of all plants 2 inches above finish grade and backfill with planting soil mix and water to fill voids. Form a shallow saucer around plant at the edge of the pit.

D. Setting Evergreen Trees

1. Prepare pits to receive trees prior to digging trees in situ. Break up side surfaces of tree pits with a pick or spade and also scarify the bottom of pit to ensure that planting soil mix interfaces with native soil.

2. Lower tree into hole and stabilize in three locations before watering and backfilling with planting soil mix. All trees shall be properly aligned to be vertical after lowering rootball into hole. Take care when moving soil ball to avoid cracking and damaging roots.

3. Use hand spades and work soil into the hole, watering to ensure all air pockets are eliminated. Tamp backfill after the tree pit is 1/2 full to stabilize the lower half of the rootball.

4. Do not plant trees deeper than the level at which they originally grew. Do not plant in frozen ground or in freezing weather. All trees shall be planted in an upright, vertical position. Lopsided trees will be rejected.

E. Install tree staking and guying as shown in the details. Submit alternative staking and guying products for review prior to installation.

F. Mulching:

1. Mulch all tree pits and shrub layer areas with a 4-inch layer of arbor chip mulch within 2 days of planting. Mulch to entirely cover area around saucer of trees as specified on planting details.

2. Where rock mulch is shown on the Drawings, place a 4 to 6 inch depth and a 1 to 2 inch depth in planting areas. Rake to a smooth finish grade.

3.8 GUARANTEE

A. Guarantee all trees, shrubs, and seeded areas for a minimum of 1 year from substantial completion to be alive and in vigorous growing condition at the end of the guarantee period or through one growing season.

B. Plant Establishment and Field Reports: Visit the site as necessary, minimum twice a month between March to October and once a month between November to February, to control weeds, monitor the irrigation system, and inventory plant health. Provide a field report of activities complete every 3 months minimum documenting weed control activities, plants identified to be replaced, and replacement plantings complete. Payment will be made upon acceptance of field report in the following amounts:

1. Substantial Completion: 50% contract amount

2. Field Report 1: 12.5% contract amount. Must include completion of all punchlist items from substantial completion

3. Field Report 2: 12.5% contract amount.

4. Field Report 3: 12.5% contract amount.

5. Field Report 4 (Final): 12.5% contract amount. Must include 100% plants in vigorous growing condition, Irrigation Record drawing with programming/ operations instructions.

C. Perform plant replacements and reseeding operations at the first opportunity during a season favorable for planting as defined herein and in Section 32 91 21, Finish Grading and Seeding.

D. Plant Materials:

1. Remove and replace any unsatisfactory plants and replace with plants of the same kind, quality and size as specified in the Plant List.

2. Furnish and plant replacements as specified herein.

3. Replacements shall be at the Contractor's sole expense.

E. Seeded Areas:

1. Repair any damage to seeded areas by filling with topsoil, fertilizing, and seeding as specified. Reseed as specified under Section 32 91 21, Finish Grading and Seeding.

2. Reseeding shall be at the Contractor's sole expense.

3.9 MAINTENANCE

A. The Contractor is responsible for watering all plant material and seeded areas for one year. Watering may be accomplished by installation of a temporary irrigation system.

1. Note water service provided for Contractor's use in developing a temporary irrigation system.

B. Perform the following maintenance operations during the one year guarantee period:

1. Water as often as required to meet the requirements of the watering contract as stated above.

2. Remove all noxious weeds from plant beds and saucers by hand.

3. Mulch to maintain 4-inch arbor chip mulch depth.

4. Reset plants to finish grade and restoration of plant saucers, as necessary

5. Repair damaged or washed out erosion control seeding.

C. Report any problems that may be a hindrance to completing and fulfilling the conditions of the plant guarantee within 7 days to the Owner.

3.10 INSPECTIONS

A. Start of the Maintenance and Guarantee Period:

1. Notify the Engineer two weeks in advance of anticipated substantial completion of planting and seeding operations.

2. Observations will be performed prior to the start of the formal guarantee and maintenance period.

B. Quarterly Inspections:

1. The Owner will make quarterly inspections of the site for compliance with the maintenance requirements.

2. Unsatisfactory conditions will be noted and forwarded in writing to the Contractor for correction. Respond and/or provide remedy for unsatisfactory conditions within two weeks of Owner notification.

C. Final Acceptance:

1. Notify the Owner within 15 days of the date for final inspection.

2. Before final acceptance, the terms of the plant/seeding guarantee must be met.

3. If the Contractor is negligent in performing ongoing watering, maintenance and plant replacement during the guarantee period and only replaces dead and unacceptable plants at the end of the one year period, the duration of the guarantee and maintenance periods may be extended in order that the Contractor may fulfill obligations to establish plant material through a growing season, as required under the guarantee at no additional cost to the Owner.

END OF SECTION

SECTION 32 91 21

FINISH GRADING AND SEEDING

PART 1 GENERAL

1.1 SCOPE

A. This Section includes finish grading, erosion control, and establishment of seeding, complete, including furnishing and delivery of labor, materials and equipment.

B. Section Includes:

1. Topsoil.
2. Imported topsoil.
3. Soil conditioners.
4. Erosion control matting.
5. Fertilizer.
6. Seed mixes.
7. Tackifier.
8. Guarantee, maintenance and warranty.

1.2 RELATED SECTIONS

A. Section 31 05 13, Soils for Earthwork.
B. Section 32 90 00, Planting.

1.3 SUBMITTALS

A. The following submittals are required as part of this work:

1. Proof of procurement and contract for delivery of plant material.

2. Schedule for delivery of plant material for inspection prior to planting.

3. Sources of plant materials, and identification tags visible for each plant.

4. Color-coded tagging system for all plant material species. (Flag all plant materials prior to installation.)

5. Compost certifications: Copies of STA lab analysis and copy of DEQ permit or registration of the compost producer.

B. Maintenance Plan: Per the requirements of Section 32 90 00, Planting.

PART 2 MATERIALS

2.1 TOPSOIL

A. Topsoil Type TS1, Select Native Topsoil Material, in accordance with Section 31 05 13, Soils for Earthwork.

2.2 IMPORTED TOPSOIL

A. Topsoil Type TS2, Imported Topsoil Material, in accordance with Section 31 05 13, Soils for Earthwork. Provide imported topsoil if native topsoil is not available or rendered useless by unauthorized construction activity.

2.3 EROSION CONTROL MATTING

A. Jute Matting:

1. Jute matting shall consist of a uniform, open, plain weave of single jute yarn.

2. The yarn shall be of loosely-twisted construction and shall not vary in thickness by more than one-half of its normal diameter.

3. The weave shall provide openings of about 1 square inch.

4. Furnish the matting in widths of 45 inches or more, continuous lengths of not less than 150 feet, and weigh not less than 0.9 pounds per square yard.

B. Staples: 12 gauge or heavier steel wire which is bent to a U-shape 2 inches wide.

2.4 FERTILIZER

A. Slow Release Fertilizer:

1. Slow release fertilizer for use in erosion control seeding containing 22% nitrogen, 16% available phosphoric acid, and 8% potash, including a minimum of 2% sulfur.

2. The fertilizer shall contain not less than 30% available water-insoluble nitrogen derived by incorporating urea formaldehyde.

B. Soil Amendment: Soil amendment is defined as any material that can improve the physical qualities of the soil to provide better growing media for plants. There are two types of soil amendments:

1. Organic soil amendments that made of remains of living beings like plants, animals, and microorganisms.

2. Inorganic soil amendments that made of sand, clay, lime, gravel, and other soil materials.

2.5 SEED MIX

A. As shown in the Plant Schedule in the Drawings.

2.6 SOIL CONDITIONERS

A. Compost: Commercially manufactured medium (coarseness) compost material. Meeting the following requirements:

1. Processed through thermophilic composting meeting the EPA's definition of “Process to Further Reduce Pathogens".

2. Is from a commercial compost facility that holds a current DEQ composting permit or is registered with DEQ as a composting facility.

3. Meets the requirements of the US Composting Council (USCC) and its Seal of Testing Assurance (STA) program.

4. Contains a minimum 65 percent by volume of the following recycled plant waste:

a. Source-separated yard and garden wastes

b. Wood wastes

c. Agricultural crop residues

d. Wax-coated cardboard

e. Pre-consumer vegetative food wastes

f. Other similar source-separated materials that the DEQ has determined to have a comparable low level of risk in hazardous substances, human pathogens, and physical contaminants.

g. · Manure or biosolids based composts when approved.

5. Meets the following compost particle size and media parameters:

a. Sieve Size Fine* Medium* Coarse**

b. Percent Passing (By Dry Weight)

3" 100 100 100
1" 99-100 95-100 90-100

3/4" 99-100 95-100 70-100
5/8" 95-100 90-100 70-100
1/2" 80-100 70-100 60-100
1/4" 75-100 70-90 30-60
* maximum 3 inch particle length
** maximum 6 inch particle length

6. Media Parameters and Test Method Requirements:

   a. Physical Contaminants* TMECC** 03.08-A Less than 1.0%
   b. Organic Matter TMECC** 05.07-A 35% (Minimum)
   c. pH TMECC** 04.11-A 6.0 to 8.5
   d. Soluble Salt Concentration TMECC** 04.10-A 5 dS/m (Maximum)
   e. Carbon/Nitrogen Ratio Total Carbon, Total Nitrogen TMECC** 04.02-D <30:1
   f. Stability TMECC** 05.08-B ≤8
   g. Maturity TMECC** 05.05-A 80% or Greater
   h. Moisture Content TMECC** 03.09-A 35-60% (Wet Weight)
      * Man-made Inert
      ** Test Methods for Evaluation of Compost and Composting

B. Soil Conditioners added per manufacturer's recommendation

C. Tackifier, see Section 2.8 below

D. Bonded Fiber Matrix (BFM)

   1. Include when installing during wet weather

   2. Material shall be composed of long strand, thermally processed wood fibers, crimped, interlocking fibers and performance enhancing additives.

   3. Product shall require cure time less than 2 hours and should be able to be applied during wet weather.

   4. Product shall be applied at a rate of 4000lb/ac.

   5. Product shall meet the following additional criteria:

      a. Flexural rigidity when wet, shall be equal to or greater than 5 oz-yd.
      b. Permissible Shear Stress 1.0 lbs/sqft
      c. Thermally Processed Wood Fibers – 73%
      d. Crosslinked Hydro-Colloid Tackifiers and Activators – 10% + 1%
      e. Crimped, Interlocking Fibers – 5% +1%
      f. Moisture Content – 12% + 3%

E. Blend compost with tackifier, Seed Mix per plans, Mycorrhizal inoculate, bio-char, and BFM (if required) per manufacturer's recommendation. Apply with equipment that propels the material directly at the soil surface and achieves direct contact with the soil. Apply mixture to a uniform depth of 2 inches to all exposed soil surfaces.

F. The processed mulch shall have the ability to hold seed mix in contact with soil.

2.7 TACKIFIER

A. Emulsion designed to retain moisture and heat in the soil.
B. Mulch shall be chemically inert, nontoxic to plants, humans, and animals.
C. Tackifier shall be J-Tac, Sentinnel Tackifier additive, or equal.

PART 3 EXECUTION

3.1 FINISH GRADING PROCEDURES

A. Remove all vegetation, rocks larger than 2 inch diameter, clods, roots, sticks, debris, and other matter detrimental to the growth of sod.

B. Cultivate existing ground to a depth of 6 inches, achieving a loose and friable condition suitable for fine grading.

C. Uniformly spread and mix soil conditioners, soil amendments, soil bio-amendments, and fertilizer evenly over the area and thoroughly rototill into the soil to a depth of 4 inches. Apply at rates recommended by soil testing, or as follows:

Material	Rate (per 100 square yards)
Soil conditioner	1/2 cubic yard
Fertilizer	10 pounds

D. Fine-grade and roll planting areas with a water-filled roller to provide a fine-textured, smooth, firm surface, free of undulations, irregularities or low areas that could create standing water. Finish Grading: Spread fill/topsoil and rake the area to a uniform grade so that all areas drain, as indicated on the Drawings.

E. Preparation of Seedbed: Remove all trash and stones exceeding 2 inches prior to seeding.

3.2 TIME OF SEEDING

A. Conduct seeding operations under favorable weather conditions during seasons which are normal for such work generally from April 1 to June 1, and Sept. 1 to November 1.

B. Guarantee germination of erosion control seeding by November 1 at the latest.

C. Seed all native plant species in fall only.

3.3 SEEDING

A. Seeding operations shall occur in two applications.

1. The first application shall include seed, fertilizer, and mulch. 2. The second application shall consist of tackifier and mulch only and be applied immediately after the first seeding. A second application of fertilizer shall be made two months after initial seeding at the rate indicated below.

B. See drawings or this section for specified seed mixes. Apply seed mixes per supplier's recommendations.

C. FOR AREAS WITH SLOPE GREATER THAN 3H:1V track soil perpendicular to the slope, as the tracks will help reduce erosion, retain seed, and seed moisture.

3.4 GUARANTEE

A. See Section 32 90 00, Planting.

3.5 MAINTENANCE

A. See Section 32 90 00, Planting.

3.6 INSPECTIONS

A. See Section 32 90 00, Planting.

END OF SECTION

SECTION 33 01 30.13 - SEWER AND MANHOLE TESTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes methods for testing of pressure sewer piping, and manholes.

B. Section includes:

1. Testing of pressure piping

2. Deflection testing of plastic sewer piping

3. Testing of Manholes:

a. Vacuum testing

1.2 RELATED SECTIONS

A. Section 33 05 13 - Manholes
B. Section 33 13 00 - Testing and Disinfection of Water Utility Piping
C. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

2. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

B. American Water Works Association (AWWA):

1. AWWA C600 - Installation of Ductile Iron Mains and Their Appurtenances

2. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

1.4 SUBMITTALS

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

B. Submit following items prior to start of testing:

1. Testing procedures

2. List of test equipment
3. Testing sequence schedule
4. Provisions for disposal of flushing and test water
5. Certification of test gage calibration
6. Deflection mandrel drawings and calculations

C. Test and Evaluation Reports: Indicate results of manhole and piping tests.

PART 2 PRODUCTS

2.1 VACUUM TESTING

A. Equipment:

1. Vacuum pump

2. Vacuum line

3. Vacuum Tester Base:

a. Compression band seal
b. Outlet port

4. Shutoff valve

5. Stopwatch

6. Plugs

7. Vacuum Gage: Calibrated to 0.1-inch hectogram (Hg) (0.34 kilopascal (kPa)).

2.2 AIR TESTING

A. Equipment:

1. Air compressor
2. Air supply line
3. Shutoff valves
4. Pressure regulator
5. Pressure relief valve
6. Stopwatch
7. Plugs
8. Pressure Gage: Calibrated to 0.1 pounds per square inch (psi)

2.3 HYDROSTATIC TESTING

A. Equipment:

1. Hydro pump
2. Pressure hose
3. Water meter
4. Test connections
5. Pressure relief valve
6. Pressure Gage: Calibrated to 0.1 psi

2.4 DEFLECTION TESTING

A. Equipment:

1. "Go, no go" mandrels
2. Pull/retrieval ropes

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify manholes and piping are ready for testing.
B. Verify trenches are backfilled.
C. Verify pressure piping thrust restraint system is installed, as may be required.

3.2 PREPARATION

A. Obstructions:

1. After backfilling and restoration of surfaces, gravity pipelines shall be inspected for obstructions and shall be cleaned.

2. Pipes less than 24 inches in diameter shall be cleaned using the sewer ball method.

B. Lamping:

1. Lamp gravity piping after flushing and cleaning of lines, checking manholes for unfinished work.

2. Perform lamping operation by shining light at one end of each pipe section between manholes.

3. Observe light at the other end.

4. Pipe not installed with uniform line and grade will be rejected.

5. Remove and reinstall rejected pipe sections.

6. Reclean and lamp until pipe section is installed to uniform line and grade.

C. Plugs:

1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Testing of Gravity Sewer Piping:

1. Low Pressure Air Testing:

a. Test each reach of gravity sewer piping between manholes.

b. Introduce air pressure slowly to approximately 4 pound-force per square inch gauge (psig).

1) Determine ground water elevation above spring line of piping.

2) For every foot of ground water above spring line of piping, increase starting air test pressure by approximately 0.4 psi.

3) Do not increase pressure above 10 psig.

c. Allow pressure to stabilize for at least 5 minutes.

d. Adjust pressure to 3-1/2 psig or to increased test pressure as determined above when ground water is present.

e. Testing:

1) Determine test duration for reach of sewer with single pipe size from following table; do not make allowance for laterals.

Table 33 01 30.13 -1
Air Testing Duration for Gravity Sewer Piping

NOMINAL PIPE SIZE, INCHES	MINIMUM TESTING TIME, MIN/100 FEET
6	0.7
8	1.2
10	1.5
12	1.8

15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

2) Record drop in pressure during testing period.

3) If air pressure drops more than 1.0 psi during testing period, piping has failed.

4) If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.

5) If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

B. Testing of Pressure Piping:

1. Test system according to AWWA C600 and the requirements of Section 33 13 00, Testing and Disinfection of Water Utility Piping.

END OF SECTION

SECTION 33 05 13

MANHOLES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes cast-in-place and precast concrete manholes and covers for access to subsurface drainage piping or utilities.

B. Section Includes:

1. Cast-in-place concrete manholes with transition to cover frame, covers, anchorage, and accessories.

2. Modular precast concrete manhole with tongue-and-groove joints with precast transition to cover frame, covers, anchorage, and accessories.

3. Bedding and cover materials.

C. Related Requirements:

1. Furnish and install all storm utility structures shown and specified in accordance with the requirements of the Contract Documents.

2. All piping, fittings, structures, and trench requirements in the Public Right-of-way shall comply with the City of Woodburn Standard Specifications and Drawings.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 03 21 00 - Reinforcing Steel.
C. Section 31 05 13 - Soils for Earthwork.
D. Section 31 05 16 - Aggregates for Earthwork.
E. Section 31 23 16 - Excavation.
F. Section 31 23 23 - Fill.
G. Section 33 01 30.13 - Sewer and Manhole Testing.
H. Section 33 41 10 - Storm Utility Drainage Piping.

1.3 REFERENCE STANDARDS

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

1. AASHTO M-198B – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. American Concrete Institute (ACI):

1. ACI 301 – Building Code Requirements for Structural Concrete.
2. ACI 315 – Details and Detailing of Concrete Reinforcement.
3. ACI 318 – Building Code Requirements for Structural Concrete.

C. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
4. ASTM C55 - Standard Specification for Concrete Building Brick.
5. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
6. ASTM C150 - Specifications for Portland Cement.
7. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar.
8. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
12. ASTM C913 - Standard Specification for Precast Concrete Stormwater and Wastewater Structures.
13. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
14. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

D. Federal Specifications:

1. SS-S-00210 (210-A) – Specification for Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

E. US Army Corp of Engineers:

1. CRD-C 621 – Specifications for Non-Shrink Grout.

1.4 SUBMITTALS

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

B. Product Data:

1. Pre-cast concrete manholes:

a. Design criteria and calculations.
b. Details of reinforcement.

2. Steps.

3. Cover and frame construction, features, configuration, dimensions and material specifications.

4. Rubber gaskets.

5. Grout and mortar.

C. Shop Drawings:

1. Indicate manhole by location.

2. Provide dimensions, elevations, joints, location and type of lifting inserts.

3. Indicate connecting piping material, piping size, piping connection angles and offsets, and sizes of penetrations.

D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

B. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

C. Storage:

1. Store precast concrete manholes as to prevent damage to Owner's property or other public or private property.

2. Repair property damaged from materials storage.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA FOR MANHOLES

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: According to ASTM C913.

C. Design of Joints for Precast Components:

1. According to ASTM C913.
2. Lipped male/female joints.
3. Maximum Leakage: 0.025 gal. per hour per foot of joint at 3 feet of head.

D. Shaft Construction:

1. Reinforced concrete.
2. Concentric with eccentric cone top section.
3. Sleeved to receive pipe connections.

E. Wall Thickness:

1. Minimum wall thickness shall be 5 inches.
2. Cones shall have the same wall thickness and reinforcement as riser sections.

F. Shape: Cylindrical.

G. Clear Inside Dimensions:

1. As indicated on Drawings.

2. Sections shall consist of circular sections in standard nominal inside diameters of 48, 54, 60, 72, 84, 96, 108, 120, 132, or 144 inches.

H. Design Depth:

1. As indicated on Drawings.

I. Clear Cover Opening: As indicated on Drawings, minimum of 30 inches.

J. Pipe Entry: Furnish openings as required and as indicated on the Drawings.

K. Steps:

1. Rungs:

a. Materials may be:

1) Structural steel galvanized

2) Reinforcing steel galvanized

3) Plastic with reinforcing steel

2. Formed integral with manhole sections.

3. Width: Minimum 12 inches.

4. Spacing: 12 inches o.c. vertically.

2.2 MANHOLES

A. Precast Concrete Manholes:

1. Sections:

a. Description: Reinforced precast concrete according to ASTM C478.
b. Gaskets: According to ASTM C923.
c. Heights: Multiples of 6 inches.

2. Bases:

a. Base slab integral with sidewalls.
b. Monolithic construction, conforming to ASTM C478.

B. Cast-in-Place Concrete Manholes:

1. Sections: Reinforced cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.

C. Joint Materials:

1. Mortar:

   a. Conform to ASTM C387.

   b. Admixtures

      1) Allowable, not exceeding the following percentages of weight of cement:

         a) Hydrated lime, 10 percent;
         b) Diatomaceous earth or other inert materials, five (5) percent;

   c. Consistency: Shall be such that it will readily adhere to the precast concrete if using the standard tongue and groove type joint.

   d. Mortar not used within 30 minutes of initial mixing shall be discarded and not be used.

2. Non-Shrink Grout:

   a. Description: Non-metallic, cementitious, commercial grout exhibiting zero shrinkage per ASTM C827 and CRD-C-621.

   b. Manufacturers:

      1) Preco-Patch;
      2) Sika 212;
      3) Euco N-S;
      4) Five-Star;
      5) Approved equal

3. Grout shall not be amended with water after initial mixing.

4. Grout not used within 20 minutes of initial mixing shall be discarded and not be used.

5. Commercial Concrete Bonding Agent:

   a. Non-shrink grout shall be placed or packed only with the use of an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted.

   b. Bonding agent shall be compatible with the brand of grout used.

   c. Water shall not be used as a substitute for the commercial bonding agent.

D. Preformed mastic gaskets for manhole joints shall meet Federal Specifications SS-S-00210 (210-A), AASHTO M-198B and ASTM C990.

E. Reinforcement:

1. Formed steel wire.

F. Manholes shall comply with COB Standard Drawing Nos. 330 and 331 and CWS Standard Drawing Nos. 100, 140, and 150, as applicable.

2.3 FRAMES AND COVERS

A. Description:

1. Construction: ASTM A48, Class 30B cast iron.

2. Lid:

a. Machined flat bearing surface.
b. Removable.
c. Boltable at locations shown on the Drawings.

3. Cover Design: Closed.

4. Live Load Rating: AASHTO H20 loading.

5. Cover: Molded with “S” cast in.

6. Coefficient of Friction on Outside Face: Minimum of 0.60.

B. Manholes shall comply with City of Woodburn Standard Drawing Nos. 7500-1.

2.4 RISER RINGS

A. Description:

1. 4 Inches to 6 Inches Thick:

a. Material: Precast concrete.
b. Comply with ASTM C478.

2. Less than 4 Inches Thick:

a. Material: Cast iron.
b. Comply with AASHTO M306.

3. Rubber Seal Wraps:

a. Wraps and Band Widths: Conform to ASTM C877, Type III.
b. Cone/Riser Ring Joint: Minimum 3 inches overlap.
c. Frame/Riser Ring Joint: 2 inches overlap.
d. Additional Bands: Overlap upper band by 2 inches.

2.5 MATERIALS

A. Bedding and Cover:

1. Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Backfill Around Structure: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Soil Backfill from Above Pipe to Finish Grade:

a. In existing or future roadways, right-of-way:

1) Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

b. In non-paved areas outside of footprint of existing or future structures, outside of right-of-way:

1) Soil Type S1, as specified in Section 31 05 13, Soils for Earthwork.
2) Subsoil: No rocks over 6 inches in diameter, frozen earth, or foreign matter.

2.6 FINISHES

A. Steel:

1. Galvanizing:

a. ASTM A123.
b. Hot dip galvanize after fabrication.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items provided by other Sections of Work are properly sized and located.
B. Verify built-in items are in proper location and ready for roughing into Work.
C. Verify correct size of manhole excavation.

3.2 PREPARATION

A. Design the method of placement for all precast items and add all reinforcing steel, embeds, bracing and other items necessary for placement. All portions of embeds which remain embedded in the concrete shall be made of stainless steel.

B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

D. Do not install manholes where site conditions induce loads exceeding structural capacity of manhole components.

E. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage; remove and replace damaged units.

F. Subgrade

1. Subgrade shall be compacted to 95 percent of maximum density.

2. Compacted subgrade shall be covered with a minimum of six (6) inches of aggregate base compacted to 95 percent of maximum density, extending a minimum of six (6) inches beyond the outside limits of the manhole, unless otherwise indicated on Drawings.

3. Grade the aggregate base to a uniform, level surface which will fully support the structure and to an elevation that will ensure proper positioning of the top slab or lid.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate manholes as specified in Section 31 23 16, Excavation in location and to indicated depth.

2. Provide 12 inches of clearance around sidewalls of structure for construction operations.

3. When groundwater is encountered, prevent accumulation of water in excavations; place manholes in dry trench.

B. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation as approved by Engineer.

C. Base Pad:

1. Place base pad.
2. Trowel top surface level.

D. Backfill excavations for manholes as specified in Section 31 23 23, Fill.

E. Form and place manhole cylinder plumb and level and to correct dimensions and elevations.

F. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.

G. Set cover frames and covers level without tipping and to correct elevations.

H. Coordinate with other Sections of Work to provide correct size, shape, and location.

I. Precast Concrete Manholes:

1. Assembly:

a. Install precast structures in accordance with the manufacturer's recommendations unless otherwise required by the Contract Documents.

b. Verify installed manholes meet required alignment and grade.

c. Lift precast components at lifting points designated by manufacturer.

d. When lowering manholes into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.

e. Set precast structures bearing firmly and fully on crushed stone bedding, compacted as specified in Section 31 23 23, Fill or on other support system as indicated on Drawings.

f. Assemble multi-section structures by lowering each section into excavation; set level and firmly position base section before placing additional sections.

g. Place manhole sections plumb and level, trim to correct elevations, and anchor to base pad.

h. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.

i. Maintain alignment between sections by using guide devices affixed to lower section.

2. Joints:

   a. Sealing materials may be installed onsite or at manufacturers plant.

   b. All joints shall be sealed watertight by the use of rubber gaskets or other approved preformed sealant.

   c. All joints shall then be filled with non-shrink grout on both the inside and outside surfaces to produce smooth interior and exterior surfaces.

3. Concrete Base Installation:

   a. Bases shall be set at the proper grade to allow pipe openings to match the grades for connecting pipes.

   b. Invert shall be constructed to a section identical with that of the sewer pipe.

   c. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces.

   d. Prevent sewage or water from contacting the new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

   e. Manhole bases shall be set level so base gravel fully and uniformly supports them in true alignment with uniform bearing throughout full circumference.

   f. Do not level the base sections by wedging gravel, or other material, under the edges.

   g. Flexible connectors shall be installed in the base section to form a permanently watertight seal.

4. Manhole Riser Sections:

   a. Precast manhole components may be used to construct standard, drop and carry-through manholes. Manholes less than four (4) feet in depth measured from the spring line of the pipe to the bottom of the lower riser ring shall be flat-top manholes.

   b. Install manhole riser sections at the location shown on the plans. All sanitary sewer and pollution control manholes joints shall be watertight and shall use

rubber gaskets or a preformed sealant. All joints shall then be filled with non-shrink grout inside and out so as to produce smooth interior and exterior surfaces. All manhole penetrations shall be watertight. Complete manholes shall be rigid. Compact backfill in accordance with the provisions stated elsewhere in this document.

c. All lift holes shall be thoroughly wetted, completely filled with mortar, and smoothed and pointed both inside and out to ensure watertightness.

d. The shortest length of riser section to be incorporated into the manhole shall be installed immediately below the flat slab top or cone.

e. Properly locate and plumb each manhole riser section.

f. Install manhole extensions and top slabs in accordance with manufacturer's specifications and as shown on the plans. Lay section risers with the sides plumb and the tops level. Make joints and penetrations watertight.

g. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.

5. Entrances / Exits:

a. Cut pipe flush with interior of structure.

b. Shape inverts through manhole as indicated on Drawings.

c. All rigid non-reinforced pipe entering or leaving the manhole (new or existing manhole) shall be provided with flexible joints within one (1) foot of the structure and shall be placed on compacted bedding.

d. Ribbed HDPE pipe connections shall be grouted watertight with non-shrink grout.

e. PVC pipe shall be connected to manholes using an approved adapter specifically manufactured for the intended service.

1) Adapters shall be Fernco, Kor-N-Seal, or approved equal.

6. Grates, Frames, and Covers:

a. Manhole frames, grates and covers shall be installed in such a manner as to prevent infiltration of surface or groundwater between the frame and the concrete of the manhole section. Use preformed rubber ring to form a watertight seal.

b. Manhole frames and covers shall be installed to grades shown on the drawings or as directed.

c. Adjustment of manhole castings shall be made using specified precast grade rings and approved rubber ring joints.

d. The maximum depth of adjustment below any manhole casting shall be 16 inches, and a minimum depth of adjustment shall be four (4) inches.

J. Cast-in-Place Concrete Manholes:

1. Prepare crushed stone bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.

2. Erect and brace forms against movement as specified in Section 03 30 00, Cast-in-Place Concrete.

3. Install reinforcing steel as indicated on Drawings and as specified in Section 03 10 00, Concrete Work.

4. Place and cure concrete as specified in Section 03 30 00, Cast-in-Place Concrete.

5. Frames and Covers:

a. Set frames using mortar and masonry.

b. Install radially-laid concrete brick with 1/4-inch thick vertical joints at inside perimeter.

c. Lay concrete brick in full bed of mortar and completely fill joints.

d. If more than one course of concrete brick is required, stagger vertical joints.

e. Set frame and cover as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

A. Test concrete manhole and structure sections according to ASTM C497.

B. Perform manhole testing according to Section 33 01 30.13, Sewer and Manhole Testing.

C. Test cast-in-place concrete as specified in Section 03 30 00, Cast-in-Place Concrete.

D. Vertical Adjustment of Existing Manholes:

1. If required, adjust top elevation of existing manholes to finished grades as indicated on Drawings.

2. Reset existing frames, grates, and covers that were carefully removed and cleaned of mortar fragments to required elevation according to requirements specified for installation of castings.

3. When removal of existing concrete wall is required, remove concrete without damaging existing vertical reinforcing bars, clean concrete from vertical bars, and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 03 30 00, Cast-in-Place Concrete.

END OF SECTION

SECTION 33 05 17 - PRECAST CONCRETE VALVE VAULTS AND METER BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete valve vaults.
2. Precast concrete meter boxes.

1.2 RELATED SECTIONS

A. Section 05 50 00, Metal Fabrications
B. Section 31 05 16, Aggregates for Earthwork
C. Section 31 23 16, Excavation
D. Section 31 23 23, Fill.
E. Section 33 11 10, Water Utility Distribution and Transmission Piping

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
6. ASTM C33 - Standard Specification for Concrete Aggregates.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

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

12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.

13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

15. ASTM D4104 - Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests).

16. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 COORDINATION

A. Coordinate Work with utilities within construction area.

B. The drawings identify precast vaults and meter boxes by manufacturer and model number. This information is provided for dimensional information only. Provide precast items in accordance with the requirements of this Section.

1.5 SUBMITTALS

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

B. Product Data: Submit data on valve vaults and meter boxes.

C. Shop Drawings for Precast Concrete Valve Vaults:

1. Indicate plan, location, and inverts of connecting piping.
2. All interior and exterior dimensions.
3. Location and type of lifting inserts, connection embeds, and joints.
4. Details of reinforcement.
5. Covers or hatches.
6. Ladders and grating.

D. Manufacturer's Certificate: Certify that precast concrete valve vaults and meter boxes meet or exceed ASTM standards and specified requirements.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and inverts of buried pipe, components, and connections.

1.7 QUALITY ASSURANCE

A. Perform Work according to standards identified in Article 1.2 herein.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Transport and handle precast concrete units with equipment designed to protect units from damage.

C. Storage:

1. Store precast concrete valve vaults and meter boxes according to manufacturer instructions.

2. Do not place concrete units in position to cause overstress, warping, or twisting.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Performance and Design Criteria:

1. Watertight, Precast, Reinforced, Air-Entrained Concrete Structures:

a. Manufactured to conform to ASTM C913.

2. Loading:

a. Design to ASTM C890-A16 / AASHTO HS20 live loading and installation conditions.

b. Where vaults are below grade, a dead load of 125 pounds per cubic foot shall be added for the soil.

c. Lateral loads:

1) Static: 105 x Depth of fill per square foot (psf) triangular equivalent fluid pressure plus a surcharge of an additional 3 feet of soil depth in areas subject to vehicular traffic (assume traffic load in all areas, unless indicated otherwise by the Contract Documents).

2) Seismic acceleration: UBC Zone 3 requirements (I = 1.25) where I = importance factor, I = 1.25, but not less than 0.20 grams (g) acting on structure mass. Seismic loading need not be considered simultaneously with traffic surcharge.

3. Minimum 28-Day Compressive Strength: 3,000 pounds per square inch (psi).

4. Honeycombed or re-tempered concrete is not permitted.

5. No knockouts shall be cast into vault walls. All pipe penetrations shall be pre-formed or core-drilled at the required locations.

6. Accessories: Accessories such as ladders, floor grates at sumps, and other features shall be provided as shown on the Drawings.

7. Size: Vault dimensions shall be as required by the Drawings.

2.2 PRECAST CONCRETE VALVES AND METER BOXES

A. Manufacturers:

1. Furnish materials according to Owner standards as shown in the details of the Drawings.

B. Valve Vault and Meter Box Frames and Covers:

1. Cast Iron Castings:

a. ASTM A48, Class 30 or better.
b. Free of bubbles, sand, air holes, and other imperfections.

C. Access Steps:

1. Steel reinforced formed polypropylene:

a. ASTM C478
b. Reinforced rod: ASTM A615, Grade 60, 1/2-inch diameter

2. Aluminum: ASTM B221, Alloy 6061-T6

3. Width: Minimum 12 inches

4. Spacing: 12 inches on center vertically.

2.3 ACCESS HATCHES AND LIDS

A. Unless noted otherwise elsewhere in the Contract Documents, vaults shall have concrete top slabs with access openings as shown on the Drawings.

B. Vault manufacturer shall provide the access hatches per the requirements of Section 05 50 00, Metal Fabrications.

C. Lids shall have lifting holes.

D. When leveling bolts are used to set the vault top sections, ensure the load from the top slab is transferred through grout to the vault walls so that the load is not carried by the leveling bolts.

2.4 MATERIALS

A. Portland Cement:

1. ASTM C150, Type II

B. Coarse Aggregates:

1. ASTM C33
2. Graded 1 inch to No. 4 sieve

C. Sand:

1. ASTM C33
2. Fineness Modulus: 2.35

D. Water:

1. Potable.

2. Clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.

E. Air-Entraining Admixtures: ASTM C260

F. Reinforcing Steel:

1. Deformed Bars: ASTM A615, Grade 40 minimum
2. Welded Wire Fabric: ASTM A185

G. Gaskets:

1. Rubber gaskets: ASTM C443

H. Joint Sealant:

1. ASTM C990

I. Bedding:

1. Aggregate Bedding Material: Fill Type A1 as specified in Section 31 05 16, Aggregates for Earthwork. Size as shown in the Drawings.

2.5 FABRICATION

A. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.

B. Vaults may be formed with separate top and bottom slabs.

C. Walls shall be cast so that all sides are continuous at corners and their full length with no block-outs or knockouts.

D. Horizontal joints may be provided so that walls can be placed in horizontal segments.

E. All horizontal joints shall be keyed to prevent offsets and shall be provided with a watertight gasket.

F. Finish:

1. Formed surfaces shall be smooth and uniform with no fins, bulges, or other irregularities.

2. Any void greater in width than 1/2-inch or deeper than 3/8-inch shall be repaired.

3. Unformed interior slab surfaces shall have a smooth steel trowel finish.

4. Unformed exterior slab surfaces shall have a light broom finish applied to a steel trowel finish.

2.6 MIXES

A. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping connections, sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

A. Ream pipe ends and remove burrs.

B. Remove scale and dirt from components before assembly.

C. Establish invert elevations for each component in system.

D. Hand trim excavation to suit valve vaults and meter boxes; remove stones, roots, and other obstructions.

3.3 INSTALLATION

A. Vaults/Meter and Bedding:

1. Excavate as specified in Section 31 23 16, Excavation for Work of this Section.

2. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.

3. Place bedding material level in one continuous layer to a minimum compacted depth of 12 inches.

4. Compact bedding material to 95 percent maximum density.

5. Bases for precast concrete structures shall be set level so that bedding material fully and uniformly supports them in true alignment with uniform bearing throughout full perimeter. Do not level bases by wedging gravel under the edges.

6. Backfill around sides of vaults and meter boxes as required by the Drawings.

B. Connect piping.

3.4 FIELD QUALITY CONTROL

A. Request examination of subgrade by Engineer prior to placing aggregate base under precast materials.

B. Compaction Testing: In accordance with Field Quality Control requirements of Section 31 23 23, Fill.

C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

D. Frequency of Compaction Tests: In accordance with Section 01 45 00, Quality Control.

END OF SECTION

SECTION 33 11 10

WATER UTILITY DISTRIBUTION & TRANSMISSION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Work under this Section applies to furnishing and installation of pipe materials, fittings and appurtenances normally encountered with water distribution and transmission systems, including potable water and fire water systems.

B. Section includes:

1. Pipe and fittings.
2. Flexible couplings.
3. Flanged coupling adapters.
4. Insulating flanged joints.
5. Tapping sleeves and valves.
6. Flexible expansion joints.
7. Bedding and cover materials.

C. Related Requirements:

1. General

a. Furnish and install all piping systems shown and specified in accordance with the requirements of the Contract Documents.

b. Each buried piping system shall be complete, with all necessary fittings, valves, accessories, lining and coating, testing, excavation, backfill and encasement, to provide a functional installation.

c. Piping layouts shown in the Drawings are intended to define the general layout, configuration, and routing for pipe, as well as the size and type of piping to be installed. The piping plans are not pipe construction or fabrication drawings.

d. The Contractor shall cause the Supplier of pipes, valves, fittings and appurtenances to coordinate piping installation such that all equipment is compatible and is capable of achieving the performance requirements specified in the Contract Documents.

e. It is the Contractor's responsibility to develop the details necessary to construct all piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, valves, gaskets, fittings, appurtenances etc., for a complete and functional system.

1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Work.
B. Section 31 05 13 - Soils for Earthwork.
C. Section 31 05 16 - Aggregates for Earthwork.
D. Section 31 23 16 - Excavation.
E. Section 31 23 17 - Trenching.
F. Section 31 23 23 - Fill.
G. Section 31 23 24 – Flowable Fill
H. Section 33 05 17 - Precast Concrete Valve Vaults and Meter Boxes.
I. Section 33 12 13 - Water Service Connections.
J. Section 33 12 16 - Water Utility Distribution Valves.
K. Section 33 12 19 - Fire Hydrants.
L. Section 33 13 00 - Testing & Disinfecting of Water Utility Piping.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys.

3. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.

4. ASME B31.10 - Standards of Pressure Piping.

5. ASME B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300

C. ASTM International:

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

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

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

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

5. ASTM A536, Standard Specification for Ductile Iron Castings.

6. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

7. ASTM D1598 - Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.

8. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

9. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

10. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

13. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

D. American Water Works Association:

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.

4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

5. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

7. AWWA C153 - Ductile-Iron Compact Fittings.

8. AWWA C207 – Carbon Steel Flange Classes

9. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe

10. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

11. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

12. AWWA C606 – Standard for Grooved and Shouldered Joints.

13. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

14. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm) for Water Transmission and Distribution.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joints between Tapping Sleeves and Tapping Valves.

F. National Sanitation Foundation:

1. NSF Standard 61 - Drinking Water System Components – Health Effects.
2. NSF Standard 372 - Drinking Water System Components – Lead Content.

G. SUBMITTALS

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

I. Product Data: Submit data on pipe materials, pipe fittings, restrained joint systems, and accessories.

J. Shop Drawings: Indicate piping layout, including piping specialties.

1. Layout Schedule for applicable segments of proposed transmission main alignment. Schedule shall include layout plan and dimensions, schedule of pipe fittings and specials, materials and class for each size and type of pipe, joint details, pipe supports and any special provisions required for assembly.

K. Lining and coating data.

L. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

M. Manufacturer’s handling, delivery, storage and installation requirements.

N. Field Quality-Control Submittals:

1. Pipeline hydrostatic testing plan.
2. Indicate results of Contractor-furnished tests and inspections.

O. Preconstruction Photographs:

1. Submit digital files of colored photographs of Work areas and material storage areas.

1.4 CLOSEOUT SUBMITTALS

A. As-Built Drawings:

1. Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Materials:

1. Unless otherwise noted, all water works materials provided for the project shall be new, of first class quality and shall be made by reputable manufacturers.

2. All material of a like kind shall be provided from a single manufacturer unless otherwise approved by the Owner's Representative.

3. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage and handling.

B. Markings:

1. Pipes and Fittings: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, inside diameter of pipe, dimension ratio as applicable, pipe class as applicable, pipe number for laying purposes as applicable, and other information required for type of pipe.

2. Bolting materials (washers, nuts and bolts) shall be marked with material type.

C. Testing:

1. Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards.

1.6 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer's written recommendations and as specified in these Contract Documents.

B. Pipe, specials, and fittings delivered to Project Site in damaged condition will not be accepted.

C. Storage:

1. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

2. Pipe and fittings shall not be stored on rocks, gravel or other hard material that might damage pipe. This includes storage area and along pipe trench.

3. Do not store materials in direct sunlight.

4. Gaskets: Do not allow contact with oils, fuels, petroleum, or solvents.

D. Handling:

1. Pipe and appurtenances shall be handled in accordance with manufacturer's recommendations or requirements contained in this section or subsequent sections dealing with the specific pipe material, whichever is more stringent.

2. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.

3. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.

4. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.

PART 2 PRODUCTS

2.1 WATER PIPING

A. General

1. All piping materials and specials shall meet the specifications of this Section and of the appropriate AWWA Standard Specifications. In the case of conflict, the more stringent specifications shall apply.

2. All coatings and materials specified herein which may come in contact with potable water shall conform to National Sanitation Foundation (NSF) Standard 61 and 372.

3. Minimum Pressure Ratings: Unless otherwise specified herein or shown in the Drawings, the minimum working pressure rating of all water works materials specified herein shall be 1.5 times the operating pressure or 150 psi minimum.

4. Push-On Pipe Gaskets:

    a. Material: Styrene Butadiene Rubber (SBR).

B. Ductile Iron Pipe:

1. Centrifugally cast, conforming to AWWA Standard C151.

2. Coating: Asphaltic exterior coating in accordance with AWWA Standard C151.

3. Pipe Mortar Lining: Shop-applied NSF 61 cement mortar lining, smoothed finish, complying with AWWA C104.

4. Pipe Thickness Class:

    a. Comply with AWWA C151.

    b. Class 52, unless shown to be greater in the Plans.

        1) The Contractor shall be aware ductile iron piping with thickness class greater than Class 52 may have long fabrication and supplier lead times. The Contractor shall be responsible for coordinating product submittal and delivery times accordingly such as not to delay construction.

5. Polyethylene Encasement:

    a. Comply with AWWA C105.

    b. Polyethylene film shall be minimum 8-mil thick virgin linear low-density polyethylene (LLDPE).

6. Joints:

    a. Joint types shall be provided as identified in the Drawings and as required for the application.

    b. Mechanical Joints:

        1) Comply with AWWA C111.

    c. Push-on Joints:

        1) Comply with AWWA C111.

2) Manufacturers:

a) Tyton Joint by American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, McWane, and Pacific States Cast Iron Pipe.

b) Fastite Joint by American Cast Iron Pipe Company.

d. Restrained Joints:

1) Joint restraint for pipe shall be accomplished with an integral lock mechanism, except as may be otherwise specified.

a) Any such system shall be a manufacturer's standard proprietary design, shall be as recommended by the manufacturer for the application, and shall be performance proven.

2) Restraining components:

a) Ductile iron complying with AWWA C110 and/or C153, with the exception of a manufacturer's proprietary design dimensions.

b) Push-on joints for such fittings shall comply with AWWA C111.

3) Deflection:

a) The maximum pipe deflection shall not exceed one half of the manufacturer's stated joint deflection allowance.

4) Manufacturers:

a) "MEGALUG", EBAA Iron, Inc.

(1) Where any restrained joint system requires the use of a wedge-type mechanical restraint gland for restraint, the glands shall be provided in quantities as may be required and shall be considered incidental to the joint restraint system.

(2) Wedge-type mechanical restraining glands shall not be used to restrain the plain end of plain end ductile iron or cast iron fittings.

e. Flanged Joints:

1) Flat faced, complying with AWWA C115.

2) Bolt hole drilling according to ASME/ANSI B16.1, Class 125. Flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.

3) The Contractor shall coordinate with pipe, valve and fitting suppliers to make certain mating pipe, valve and fitting flanges match in bolt pattern.

4) Flange class:

   a) Where design pressure is 150 psi or less, flanges shall conform to either AWWA C207 Class D or ASME B16.5 150-pound class.

   b) Where design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either AWWA C207 Class E or ASME B16.5 150-pound class.

5) AWWA flanges shall not be exposed to test pressures greater than 125% of rated capacity.

6) Threaded flanges:

   a) Ductile iron pipe spools with threaded flanges shall conform to AWWA C115.

   b) Installed only on pipe with a minimum Class 53 wall thickness.

7) Buried flanges:

   a) Flanged connections shall not be buried unless shown as such on the Drawings.

   b) Buried flanges shall be wrapped with 2 layers of 10 mil tape along edges of flanges.

8) Gaskets:

   a) Full faced, composed of synthetic rubber and 1/8-inch thick conforming to ASME B21.1 and AWWA C111.

   b) Ring gaskets will be permitted only where specifically noted in the Drawings and Specifications.

   c) Gaskets for flanged joints shall be as follows:

      (1) Pipe sizes between 6-inch and 24-inch diameter, service pressures of 150 psi or greater shall be Garlock 3760-U or equal.

      (2) Pipe sizes 4-inch diameter and under, service pressures of 150 psi or greater shall be Garlock 3505 or equal.

(3) All pipe sizes with service pressures of 150 psi or less shall be Garlock 98206 or equal.

d) Insulating flanged joints:

(1) Full faced, conform to ANSI 16.21.

(2) Material: Non-asbestos.

(3) Suitable for operating and test pressures of the pipe system.

(4) Manufacturer:

(a) Garlock GYLON Style 3505 or equal.

C. NOT USED

2.2 FITTINGS:

A. Material: Ductile iron, complying with AWWA Standard C110.

1. Fittings conforming to AWWA C153 may be substituted in lieu of AWWA C110 fittings.

B. Fittings used for joining ductile iron and PVC pipe shall be of the type, size and strength designated on the Plans, elsewhere in the specifications.

1. Fittings shall be mechanical joint, push-on type, flanged or plain-end as required and shown on the Drawings.

2. All restraint systems and flanged fittings shall be provided with bolts and gaskets as specified herein.

C. Pressure ratings: As specified for joining pipe above and as shown on the Drawings.

D. Coating and Lining:

1. Asphaltic exterior coating in accordance with AWWA Standard C110.
2. Cement Mortar Lining: Comply with AWWA C104.

E. Following information cast upon fittings:

1. Manufacturer’s identification.
2. Country of manufacture.
3. Pressure rating.
4. For bends, number of degrees and/or fractions of a circle.

F. Owner may require additional metallurgical documentation or other certifications.

2.3 NUTS, BOLTS AND WASHERS:

A. All bolts shall have heavy hex head with heavy hex nuts.

B. For operating pressures greater than 150 psi:

1. Bolts: Steel alloy composition. Comply with ASTM A193.
2. Nuts: Comply with ASTM A194, Grade 2H.
3. Washers: Comply with ASTM F436.

C. For operation pressures of 150 psi or less:

1. Bolts: Low-carbon steel composition. Comply with ASTM A307, Grade B.
2. Nuts: Comply with ASTM A563A, Heavy Hex.
3. Washers: Comply with ASTM F844.

2.4 FLEXIBLE COUPLINGS

A. General

1. All flexible couplings shall be constructed to inside diameters that properly fit the connecting pipes.

2. The Contractor shall be responsible for selecting sleeve lengths appropriate to the application, subject to review and approval of the Engineer, recognizing that longer sleeves allow for larger deflections and may ease installation.

B. Flexible Couplings:

1. Description:

a. Comply with AWWA C219.

b. Type: Bolted, sleeved.

c. Configuration: Straight, transition or reducing as shown in the Drawings.

d. Center rings and end rings: Ductile iron. Comply with ASTM A536.

e. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

f. Bolts and nuts: High strength low alloy steel. Comply with AWWA C111.

g. Lining and coating: Factory-applied fusion bonded epoxy.

h. Working pressure: Up to 260 psi.

2. Manufacturers:

    a. For 2-inch to 24-inch diameter:

        1) Romac Industries, Inc. – Style 501 or equal.

    b. For 12-inch diameter and larger:

        1) Romac Industries, Inc. – 400 Series or equal.

C. Insulating Flexible Couplings:

1. The Contractor shall be responsible for selecting couplings appropriate to the application, subject to review and approval of the Engineer, recognizing that different pipe materials will require specific sizing and material selection for couplings.

2. Description:

    a. Comply with Flexible Coupling specifications above.

    b. Insulating Boot: Ethylene propylene diene monomer (EPDM) compounded for water service. Comply with ASTM D2000.

3. Manufacturers:

    a. For 4-inch to 14-inch diameter:

        1) Romac Industries, Inc. – Style IC501 or equal.

    b. For 12-inch to 96-inch diameter:

        1) Romac Industries, Inc. – Style IC400 or equal.

D. Restrained Flexible Couplings:

1. Description:

    a. Body: Steel. Comply with ASTM A36.

    b. Restrained gland: Ductile iron. Comply with ASTM A536, Grade 65-45-12.

    c. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

    d. Bolts and nuts: All-thread rod, at a minimum complying with ASTM A193 Grade B7. Nuts per ASTM A194 Grade 2H.

    e. Lining and coating: Factory-applied fusion bonded epoxy.

f. Working pressure: 250 psi. Test pressure: 500 psi.

2. Manufacturers:

a. Romac Industries, Inc. – Style 400RG
b. EBAA Iron – 3800 MEGA-COUPLING

2.5 FLANGED COUPLING ADAPTERS

A. Flanged Coupling Adapters:

1. All flanged coupling adapters shall be constructed to diameters that properly fit the connecting plain end pipe and the flanged fitting.

2. Description:

a. Comply with AWWA C219.

b. Flange: AWWA Class D Steel Ring Flange, compatible with ANSI Class 125 & 150 bolt circles.

c. End ring and body:

1) Steel. Comply with ASTM A36.
2) Ductile iron. Comply with ASTM A536, Grade 65-45-12.

d. Flange: Compatible with ANSI Class 125 & 150 bolt circles.

e. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

f. Bolts and nuts: High strength low alloy steel bolts and nuts. Comply with AWWA C111 composition requirements.

g. Lining and coating: Factory-applied fusion bonded epoxy.

h. Working pressure rating: Equal to the maximum rating of the flange.

3. Manufacturers:

a. Romac Industries, Inc.

1) Style FCA501

a) For 3-inch to 16-inch diameter.

2) Style FC400.

a) For 12-inch to 96-inch diameter.

B. Restrained Flanged Coupling Adapters:

1. Description:

a. Gland and flange body: Ductile iron. Comply with ASTM A536.

b. Flange: Compatible with ANSI Class 125 & 150 bolt circles.

c. Gaskets: Virgin styrene butadiene rubber (SBR) compounded for water service. Comply with ASTM D2000.

d. Restraining bolts and lugs: Ductile iron. Comply with ASTM A536.

e. T-bolts Bolts and nuts: High strength low alloy steel. Comply with AWWA C111 composition requirements.

f. Lining and coating: Factory-applied fusion bonded epoxy.

2. Manufacturers:

a. Romac Industries, Inc. – RFCA Restrained Flanged Coupling Adapters.
b. EBAA Iron – MEGAFLANGE Restrained Flange Adapter.

2.6 TAPPING SLEEVES AND VALVES

A. Tapping Sleeves:

1. Description:

a. Type: Dual compression.

b. Material:

1) Body: Stainless steel, Type 304.
2) Flanged outlet: Stainless steel, Type 304.

c. Outlet Flange Dimensions and Drilling: Comply with ASME B16.1, Class 150 and MSS SP-60.

d. Outlet Gasket:

e. Provide with Type 304 stainless steel test plug.

f. Nuts, bolts and washers: Stainless steel, Type 304.

2. Manufacturers:

a. Romac Industries, Inc. – Model STS 420
b. JMC Industries, Inc.

B. Tapping Valves:

1. Resilient wedge gate valves specified in Section 40 05 23.15, Gate Valves.

2.7 FLEXIBLE EXPANSION JOINTS

A. Description

1. Installed at locations indicated in the Drawings.

2. End connections: As shown in the Drawings.

3. Material: Ductile iron, AWWA C153.

4. Working pressure: 350 psi, minimum.

5. Construction:

a. An expansion joint designed and cast as an integral part of a double ball and socket type flexible joint.

b. Manufactured of ductile iron, conforming to requirements of AWWA C153 and ASTM A536.

c. Deflection: Minimum of 15 degrees deflection per ball.

d. Expansion:

1) 12-inch diameter and under: 8 inches.
2) Greater than 12-inch diameter: 16 inches.

e. The flexible expansion joint unit shall not impart a thrust force while under internal pressure.

f. Each flexible expansion joint shall be hydrostatically tested to the manufacturer's published pressure rating prior to shipment.

g. Lining: All interior "wetted" parts shall be shop-lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213 and shall be holiday tested with a 1500-volt spark test conforming to said specification.

h. Coating: Coal tar epoxy.

6. Quality Assurance: Hydrostatically tested to manufacturer's published pressure rating prior to shipment.

7. Appropriately sized polyethylene sleeves, meeting AWWA C105 requirements, shall be included for direct bury applications.

B. Manufacturers

1. EBAA Iron, Inc. – Flex-Tend or equal.

2.8 UNDERGROUND PIPE MARKERS

A. As specified in Section 31 23 17, Trenching.

2.9 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 30 00 - Cast-in-Place Concrete.
2. Type: reinforced, air entrained as shown in the Drawings.
3. Compressive Strength: Minimum 3,000 psi at 28 days.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 20 00 - Concrete Reinforcing.

2.10 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

c. Subsoil Type S1 and/or S2, as specified in Section 31 05 13, Soils for Earthwork.

2.11 ACCESSORIES

A. Concrete for Thrust Restraints: As specified in Section 03 30 00 - Cast-in-Place Concrete.

B. Manhole and Cover: As specified in Section 33 05 13- Manholes and Structures.

C. Miscellaneous Steel Rods, Bolt, Lugs, and Brackets:

1. Comply with ASTM A36 or ASTM A307.
2. Grade A carbon steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing utility water main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

A. Preconstruction Site Photos:

1. Take photographs along centerline of proposed pipe trench; minimum one photograph for each 50 feet of pipe trench.

2. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.

3. Include Project name, date taken, and sequential number of each photograph in physical log or CD.

B. Inspection:

1. All pipe sections, specials and jointing materials shall be carefully examined for defects.

2. No piping or related materials shall be laid that is known to be defective. Any defective piece installed shall be removed and replaced with a new pipe section in a manner satisfactory to the Engineer at the Contractor's expense.

3. Defective material shall be marked and removed from the job site before the end of the day.

C. Pipe Cutting:

1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.

3. Grind edges smooth with beveled end for push-on connections.

4. Prior to assembly of field cut pipe, the reference mark shall be re-established with a pencil or crayon. The location of the reference mark at the proper distance from the bevel end shall be in accordance with the manufacturer's recommendations.

D. Remove scale and dirt on inside and outside before assembly. Cleaning of each pipe or fitting shall be accomplished by swabbing out, brushing out, blowing out with compressed air, or washing to remove all foreign matter.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Bedding:

1. Excavation:

a. Excavate pipe trench as specified in Section 31 23 17, Trenching for Work of this Section.

b. All pipe trenches shall be excavated below the proposed pipe invert as required to accommodate the depths of pipe bedding material as scheduled on the Drawings.

c. Remove large stones or other hard matter which could damage pipe or impede consistent pipe bedding backfilling or compaction.

d. Trench base shall be inspected prior to placement of pipe.

e. Hand trim excavation for accurate placement of pipe to elevations as indicated on Drawings.

2. Dewater excavation as specified in Section 31 23 19, Dewatering to maintain dry conditions and to preserve final grades at bottom of excavation.

3. Provide sheeting and shoring as specified in Section 31 23 17, Trenching.

4. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth, and compact to 95 percent of maximum density.

B. Piping:

1. Install pipe according to AWWA C600

2. Handle and assemble pipe according to manufacturer instructions and as indicated on Drawings.

3. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

4. Steel Rods, Bolt, Lugs, and Brackets: Coat buried steel with one coat of coal tar coating before backfilling.

5. Sanitary Sewer Separation:

    a. Install new water lines and appurtenances in compliance with local and state regulations governing the horizontal and vertical separations between water and sewer facilities.

    b. Variance:

        1) If a variance is proposed due to requested design revisions or if an existing facility has been installed at a different location or elevation than indicated on the Plans, submit written proposal for review and approval by the Engineer.

        2) Include the reason for the variance, type of material and condition of the sewer line, location of the water and sewer facilities, horizontal and vertical skin-to-skin clearances and corrective measures proposed.

        3) Each variance will be considered on a case-by-case basis.

        4) Review Time: Allow a minimum of 5 working days review and response to each proposal.

6. Install ductile iron fittings according to AWWA C600.

7. Joints:

    a. Pipe jointing surfaces shall be clean and dry when preparing surfaces for joining.

    b. Lubricants, primers, adhesives, etc. shall be used as recommended by the pipe or joint manufacturer’s specifications.

    c. The jointing materials or factory-fabricated joints shall then be placed, fitted, joined, and adjusted in such a manner as to obtain a watertight joint.

d. Trenches shall be kept water-free and as dry as possible during bedding, laying and jointing.

e. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to prevent movement of the pipe from any cause.

8. Flanged Joints: Not to be used in underground installations except within structures, unless shown otherwise in the Drawings.

9. Install pipe and fittings to the line and grade specified on the Drawings, with joints centered, pipe properly supported and restrained against movement, and all valve stems plumb. Re-lay pipe that is out of alignment or grade.

10. High Points:

    a. Install pipe with no high points, unless otherwise shown in the Drawings.

    b. If unforeseen field conditions arise that necessitate high points, install air release valves as directed by Engineer.

11. Bearing:

    a. Install pipe to have bearing along entire length of pipe.

    b. Excavate bell holes to permit proper joint installation where necessary or as directed by Engineer.

    c. Do not lay pipe in wet or frozen trench.

12. Prevent foreign material from entering pipe during placement.

13. Install pipe to allow for expansion and contraction without stressing pipe or joints.

14. Close pipe openings with watertight plugs during Work stoppages.

15. All pipe ends which are to be permanently closed shall be plugged or capped and restrained against internal pressure.

16. Install access fittings to permit disinfection of water system performed under Section 33 13 00 - Disinfecting of Water Utility Distribution.

17. Cover:

    a. Establish elevations of buried piping with not less than 36 inches of cover.
    b. Measure depth of cover from final surface grade to top of pipe barrel.

C. Tapping Sleeves and Valves:

1. As indicated on Drawings and according to manufacturer instructions.

D. Polyethylene Encasement:

1. Encase all ductile iron piping in two layers of 8 mil polyethylene film to prevent contact with surrounding backfill material.

2. Comply with AWWA C105.

E. Thrust Restraints:

1. Provide valves, tees, bends, caps, and plugs with concrete thrust blocks at locations shown in the Drawings and as required to facilitate testing of lines.

2. Pour concrete thrust blocks against undisturbed earth.

3. Locate thrust blocks to ensure that pipe and fitting joints will be accessible for repair.

4. Provide thrust restraint bearing area on subsoil as shown in details within the Drawings.

5. Install tie rods, clamps, setscrew retainer glands, or restrained joints.

6. Protect metal-restrained joint components against corrosion with polyethylene film as specified herein.

7. Do not encase pipe and fitting joints to flanges.

F. Backfilling:

1. Backfill of piping systems shall be as specified in Section 31 23 17, Trenching.

G. Testing and Disinfection of Potable Water Piping System:

1. In accordance with AWWA C600, AWWA C65,1 and as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

2. All chlorinated water used in disinfection of the water main shall either be discharged through an approved connection to a public sanitary sewer system or shall be dechlorinated to limits acceptable by the Oregon State Department of Environmental Quality (DEQ) prior to discharge into any storm drainage system or open drainage way.

3. No chlorinated water shall be discharged into a storm drainage system or open drainage way without a dechlorination under a plan meeting DEQ's.

3.4 FIELD QUALITY CONTROL

A. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

END OF SECTION

SECTION 33 12 13

WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials, fittings, valves, meters and backflow preventers encountered with service connections 2 inches in diameter and smaller from the main to a water meter.

B. Section Includes:

1. Pipe and fittings for 2- inch diameter and smaller water service connections.
2. Corporation stop assemblies.
3. Curb stop assemblies.
4. Meter setting equipment.
5. Water meters.
6. Backflow preventers.
7. Sampling stations.
8. Underground pipe markers.
9. Bedding and cover materials.

1.2 RELATED SECTIONS

A. Section 31 05 13 - Soils for Earthwork.
B. Section 31 05 16 - Aggregates for Earthwork.
C. Section 31 23 17 - Trenching.
D. Section 31 23 23 - Fill.
E. Section 33 05 13 - Manholes.
F. Section 33 11 10 - Water Utility Distribution and Transmission Piping.
G. Section 33 13 00 - Testing and Disinfecting of Water Utility Piping.

1.3 REFERENCE STANDARDS

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

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. American Society of Mechanical Engineers (ASME):

1. ASME B16.15 - Cast Copper Threaded Fittings.

C. American Society of Sanitary Engineering (ASSE):

1. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.

2. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.

D. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.

2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

4. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.

5. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

6. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

7. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

8. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

9. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

10. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

E. American Welding Society (AWS):

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association (AWWA):

1. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

2. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.

3. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.

4. AWWA C800 - Underground Service Line Valves and Fittings.

5. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.

6. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

G. National Sanitation Foundation International (NSF):

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

1.4 SUBMITTALS

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

B. Product Data: Submit data on pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventer, and accessories.

C. Shop Drawings: Indicate details showing meter boxes, vaults and accessories.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping mains, connections, thrust restraints, and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Unless otherwise noted, all water works materials provided shall be new, of first class quality and shall be made by reputable manufacturers.

B. All material of like kind shall be provided from a single manufacturer unless otherwise approved by the Engineer.

C. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage and handling.

D. Where an item is to be used but does not have its quality specified herein, it shall be equal to that specified in the appropriate AWWA Standard Specification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store products and materials off ground and under protective coverings and away from walls.

C. Exercise care in handling precast concrete products to avoid chipping, cracking, and breakage.

PART 2 PRODUCTS

2.1 GENERAL

A. Service line material shall conform to the latest version of AWWA C800 and as follows:

1. Minimum working pressure rating of all service line material shall be 150 psi.

2. All water works materials provided shall be rated for the test pressures indicated for the water main and as specified in Section 33 13 00, Testing and Disinfection of Water Utility Piping.

B. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 WATER PIPING AND FITTINGS

A. Copper Tubing:

1. Comply with ASTM B88.

2. Type K.

a. 3/4-inch and 1-inch diameter service connections: Annealed, soft, seamless.
b. Greater than 1-inch diameter service connections: Hard drawn.

3. Fittings: Brass alloys, threaded. Conform to AWWA C800, meeting “lead free” requirements above, and ASME B16.15.

a. Mechanical surfaces shall have a 100% machine finish with no gaps or low spots due to insufficient parent material.

b. All fittings shall either be stamped or embossed with the manufacturer’s name.

c. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

d. Manufacturers:

1) Ford, refer to City Std Detail 5000-4.
2) Or approved equal

4. Joints: Compression. No quick joint style connections shall be permitted.

2.3 CORPORATION STOP ASSEMBLIES

A. Furnish materials according to the City of Woodburn Standard Drawing No. 5000-4, Water Service Connection; and details as shown in the Drawings.

2.4 CURB STOP ASSEMBLIES

A. Furnish materials according to the City of Woodburn Standard Drawing No. 5000-4, Water Service Connection; and details as shown in the Drawings.

2.5 WATER METERS

A. Furnished and installed by Owner.

2.6 BACKFLOW PREVENTERS

A. As specified in Section 40 05 13, Common Work Results for Process Piping.

2.7 SAMPLING STATIONS

A. Furnish materials according to the City of Woodburn Standard Drawing No. 5100-1, Sampling Tap Assembly; and details as shown in the Drawings.

2.8 UNDERGROUND PIPE MARKERS

A. As specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

2.9 METER BOXES

A. As specified in Section 33 05 17, Precast Concrete Valve Vaults and Meter Boxes.

2.10 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

c. Subsoil Type S1 and/or S2, as specified in Section 31 05 13, Soils for Earthwork.

PART 3 EXECUTION

3.1 GENERAL

A. All service lines shall be installed continuous, without joints or splices, complete from the new water main (insulating corporation stop) to the new meter location or as otherwise shown.

B. Install service pipelines perpendicular to the main, unless shown otherwise.

C. Install service runs parallel to existing services with a perpendicular distance of 2 feet, minimum to 5 feet, maximum from existing services and a minimum perpendicular distance of 18 inches from property line for new services.

D. For service renewals, terminate service run inside of existing meter box as described below.

3.2 INSTALLATION

A. Construct the depth of trench for service connection piping to provide a minimum of 30 inches of cover over the top of the pipe, unless otherwise shown.

B. Excavation, backfill and surface restoration shall be performed in accordance with provisions stated in Section 31 23 17, Trenching.

C. Do not damage the main in any way during the service installation.

D. Water Main Tap

1. All direct service taps shall be made with a drilling and tapping machine intended for use on ductile iron pipe as manufactured by Mueller or approved equal. Hand held equipment is not allowed. Coupons shall be removed from pipe.

    a. The drilling and tapping machine shall have alignment tool guides and a placement strap.

2. Direct threaded taps shall engage a minimum of four (4) full threads.

3. Direct taps shall require the use of two (2) layers of 3 mil tetrafluoroethylene (TFE) tape on the threads of the corporation stop. Liquid TFE will not be allowed.

4. Direct taps for 1-inch diameter services are allowed only on mains that are 6 inches in diameter or larger.

5. Service saddles are required on water mains 4 inches in diameter and larger and for all services taps larger than 1-inch diameter.

6. Install corporation stop at a 45-degree angle from the cross section vertical axis of the water main being tapped, unless otherwise shown on the Plans.

7. Install swing joint on all 2-inch diameter services.

E. Piping

1. Cut service pipes using tools specifically designed to leave a smooth, even, and square end on the material being cut.

2. Ream cut ends to the full inside diameter of the pipe.

3. Clean pipe ends to a sound, smooth finish prior to using compression connections which seal to the outside surface of the pipe.

F. Water Meters:

1. Install positive displacement meters according to AWWA M6 and as shown in the Drawings.

G. Backflow Preventers:

1. Install backflow preventers where indicated on Drawings and according to manufacturer instructions.

2. Testing and Installation Requirements: Comply with local water company requirements and plumbing codes.

H. Service Connections:

1. Install water services according to details in the Drawings.

2. Install water meters and backflow preventers in precast concrete meter boxes and vaults as specified in Section 33 05 17, Precast Concrete Valve Vaults and Meter Boxes.

3. Locate meter boxes and vaults as shown in the Drawings. Final location to be determined in the field by Engineer.

I. Service Renewal:

1. Install service line and angle meter stop from the water main to the inside of existing meter box location.

2. Where service renewals are to be connected to existing meters, stub up and terminate service run at angle meter stop where shown.

3. Where no meter is to be installed, place angle meter stop at 18 inches from face of curb with 12 inches to the springline in an approved box.

4. Owner will connect all service lines at the new meters or to existing service piping as shown.

5. Adjust meter box to finished grade after the service piping has been installed and surface has been restored to the satisfaction of the Engineer.

J. Trenchless Installation:

1. All water service installations under existing pavement, curbs, sidewalks or other surface improvements may be installed by trenchless construction techniques at Contractor option where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks and other structures.

2. The Owner must approve all trenchless installation methods.

3. Where trenchless pipe installation is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks and other surface improvements whose replacement is avoided by use of a trenchless method, such as tunneling.

3.3 FLUSHING AND DISINFECTION

A. Flush and disinfect all service connections and appurtenances in accordance with Section 33 13 00, Testing and Disinfection of Water Utility Piping.

3.4 FIELD QUALITY CONTROL

A. Pressure test water distribution system according to AWWA C600 and Section 33 11 10, Water Utility Distribution and Transmission Piping.

B. Compaction Testing for Bedding: See Section 33 11 10, Water Utility Distribution and Transmission Piping for compaction testing requirements. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION

SECTION 33 12 16 - WATER UTILITY DISTRIBUTION VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes valves and valve boxes for installation with buried water distribution and transmission main, including fire hydrants and tapping sleeves.

B. Section Includes:

1. Valves.
2. Valve boxes.
3. Valve operator extensions.

C. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete: Concrete for thrust restraints

2. Section 33 11 10 - Water Utility Distribution and Transmission Piping: Piping trenching, backfilling, and compaction requirements.

3. Section 33 12 13 - Water Service Connections: Pipe materials, fittings, and service connection appurtenances and installation requirements.

4. Section 33 12 19 - Water Utility Distribution Fire Hydrants: Execution requirements for fire hydrants.

5. Section 33 13 00 - Testing and Disinfecting of Water Utility Distribution: Flushing and disinfection requirements.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys

3. ASME 1.20.1 - General Purpose Pipe Threads (Inch)

B. American Water Works Association (AWWA):

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. Through 72 In.

2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service

3. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants

4. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances

5. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings

C. ASTM International (ASTM):

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications

D. NSF International (NSF):

1. NSF 61 - Drinking Water System Components - Health Effects
2. NSF 372 - Drinking Water System Components - Lead Content

1.3 COORDINATION

A. The Contractor shall cause the Supplier of valves to coordinate installation such that all pipes, valves, fittings, appurtenances, and equipment are compatible and capable of achieving the performance requirements specified in the Contract Documents.

B. Coordinate Work of this Section with City of Woodburn standards and utilities within construction area.

1.4 SUBMITTALS

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

B. Product Data: Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling: Schedule of valves to be labeled indicating in each case the valve location and the proposed labeling for the valve.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves.
B. Operation and Maintenance Data: Submit information for valves.

1.6 QUALITY ASSURANCE

A. Cast manufacturer's name, maximum working pressure, size of valve, and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, American National Standards Institute (ANSI), ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.

E. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves and accessories for shipment according to applicable AWWA standards.

B. Seal valve and ends to prevent entry of foreign matter.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Storage:

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

E. Handle products carefully to prevent damage to interior or exterior surfaces.

F. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RESILIENT WEDGE GATE VALVES

A. As specified in Section 40 05 61, Gate Valves.

B. Connecting Hardware:

1. As specified in Article 2.3, Nuts, Bolts and Washers of Section 33 11 10, Water Utility Distribution and Transmission Piping.

C. Gaskets:

1. As required for the end connection types specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

2.3 RUBBER-SEATED BUTTERFLY VALVES

A. As specified in Section 40 05 64, Butterfly Valves.

B. Operation:

1. All buried valves shall be provided with 2-inch square operating nuts.

C. Connecting Hardware:

1. As specified in Article 2.3, Nuts, Bolts and Washers of Section 33 11 10, Water Utility Distribution and Transmission Piping.

D. Gaskets:

1. As required for the end connection types specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

2.4 ACTUATORS

A. Unless otherwise indicated, all valves shall be furnished with manual actuators.

B. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

C. All gear-assisted valves that are buried and submerged shall have the actuators hermetically sealed and grease-packed.

D. All valves 6 inches to 30 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

2.5 VALVE BOXES

A. Provide all buried valves with valve boxes, covers and risers.

B. Valve Boxes:

1. Materials: Cast iron.

2. Construction:

a. Walls not less than 3/16-inch thick at any point.
b. Internal diameter not less than 5 inches.

3. Type: Two-piece extension.

4. Manufacturers:

a. East Jordan Iron Works Model No. 3639A1, or approved equal.

C. Covers:

1. Construction:

a. Prevents dislodging and rotation from traffic.
b. Allows a hand-held pry bar to be applied for easy removal.

2. Materials: Cast iron.

3. Lid Inscription: WATER.

4. Manufacturers: Matching that of valve box.

D. Riser:

1. Polyvinyl Chloride (PVC) Pipe:

a. ASTM D3034, SDR 35 PVC.
b. White, Schedule 40, 8-inch diameter.
c. Length as shown on details in the Drawings.

2.6 VALVE OPERATOR EXTENSIONS

A. As shown in the Drawings.

B. Provide operator extensions to a maximum of 12 inches below grade where depth to valve exceeds 36 inches.

2.7 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 03 30 00 - Cast-in-Place Concrete.

PART 3 EXECUTION

3.1 PREPARATION

A. Conduct operations to not interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures, utilities, and landscape in immediate or adjacent areas.

B. Identify required lines, levels, contours, and datum locations.

C. Locate, identify, and protect from damage utilities to remain.

D. Access:

1. All valves shall be installed to provide easy access for operation, removal, and maintenance.

2. Avoid conflicts between valve operators and above grade construction such as structural members or handrails.

E. Valve Accessories:

1. Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly.

2. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.2 INSTALLATION

A. General:

1. All valves, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as shown in the Drawings and as specified herein.

2. Valves shall be firmly supported to avoid undue stresses on the pipe.

3. Stem extensions shall be braced at no greater than 10 feet intervals and be provided with double universal joints to allow for misalignment, where applicable.

B. Perform trench excavation, backfilling, and compaction as specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

C. Install valves in conjunction with pipe laying.

D. Set valves plumb.

E. Provide buried valves with valve boxes installed flush with finished grade.

1. Valves installed out of paved or otherwise hard-surfaced areas shall be set in a concrete pad at finished grade.

2. Concrete valve box pads shall be 18 inches square and be not less than 6 inches thick.

F. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

3.3 FIELD QUALITY CONTROL

A. Pressure test valving for water distribution system according to AWWA C600 and in accordance with Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

B. Field Testing of Valves:

1. All valves 24-inch diameter or larger, and all in-line transmission main valves, shall be pressure and leakage tested at the Site and shall pass the field testing prior to installation.

2. Valves shall be tested at 1.5 times normal operating pressure, 150 pounds per square inch (psi) minimum.

3. No valve shall be accepted for installation that fails to pass the field pressure test. Any valves failing field pressure tests shall be replaced by the Contractor at no additional cost to the Owner.

4. Engineer shall witness field testing.

END OF SECTION

SECTION 33 12 19 - FIRE HYDRANTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section addresses dry-barrel fire hydrants used in water supply service.

B. Section includes:

1. Fire hydrants used in water main installations.

1.2 RELATED SECTIONS:

A. Section 03 11 00 – Concrete Work
B. Section 31 05 16 - Aggregates for Earthwork
C. Section 31 23 17 - Trenching
D. Section 33 13 00 – Testing and Disinfecting of Water Utility Piping

1.3 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

1. AWWA C502 - Dry-Barrel Fire Hydrants
2. AWWA C550 - Protective Interior Coatings for Valves and Hydrants
3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances

B. National Fire Protection Association (NFPA):

1. NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants

1.4 COORDINATION

A. All hydrants supplied for the Project shall be of like kind from a single manufacturer.

1.5 SUBMITTALS

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

B. Product Data: Submit manufacturer's latest published literature, including illustrations, installation and maintenance instructions, and parts lists.

C. Shop Drawings: Submit description of proposed installation.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of fire hydrants and service valves.
B. Operation and Maintenance Data: Submit data for hydrants.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare hydrants and accessories for shipment according to AWWA standards.

B. Seal hydrant and ends to prevent entry of foreign matter.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Storage:

1. Store materials in areas protected from weather, moisture, or potential damage.
2. Do not store materials directly on ground.

E. Handle materials in a way that prevents damage to interior and exterior surfaces.

PART 2 PRODUCTS

2.1 FIRE HYDRANTS

A. Manufacturers:

1. Mueller Company, Super Centurion Model A-423.
2. M&H Reliant model 929T.

B. Dry-Barrel Breakaway Type:

1. Comply with AWWA C502.
2. Body: Cast iron.
3. Valve: Compression type.
4. Burial Depth: As indicated on Drawings.

5. Inlet Connection Size: 6 inches (150 millimeters).
6. Valve Opening: 5-1/4 inches (133 millimeters) in diameter.
7. End Connections: Mechanical joint or bell end.
8. Bolts and Nuts: Galvanized steel.
9. Interior Coating: Comply with AWWA C550.
10. Direction of Opening: Counterclockwise unless otherwise indicated.

C. Hose Connections:

1. One 4-1/2-inch diameter pumper, two 2-1/2-inch diameter hose nozzles.
2. N.S.T. thread type.
3. Attach nozzle caps by separate chains.

D. Finishes:

1. Primer and two coats of enamel.
2. Color: Per OWNER.

2.2 NSF INTERNATIONAL (NSF) REQUIREMENTS

A. All fire hydrants must be NSF/ANSI Standard 61 certified and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.

2.3 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 03 1 00, Concrete Work.

B. Aggregate: Aggregate for hydrant drainage as specified in Section 31 05 16, Aggregates for Earthwork.

2.4 OUT OF SERVICE COVERS/OUT OF SERVICE RINGS

A. Provide orange plastic bag with reflective tape, or red plastic hydrant out of service rings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify location and size of hydrants from Drawings. Final location of hydrants to be determined by Engineer in the field.

B. Obtain clarification and directions from Engineer prior to execution of Work.

C. If installing a hydrant on an existing water system, verify invert elevation of existing piping is as indicated on Drawings prior to excavation and installation of fire hydrant.

3.2 PREPARATION

A. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures, utilities, and landscape in immediate or adjacent areas.

B. Identify required lines, levels, contours, and datum locations.

C. Locate, identify, and protect from damage utilities to remain.

D. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.

1. Notify Owner and Engineer not less than 48 hours in advance of proposed utility interruption.

2. Do not proceed without written permission from Engineer.

3. Only District staff shall operate valves in existing system.

3.3 INSTALLATION

A. Perform trench excavation, backfilling, and compaction as specified in Section 31 23 17, Trenching.

B. Install pier support block and drainage gravel for fire hydrants; do not block drain hole.

1. Place drainage gravel around the pier block and bottom of hydrant to 6 inches above the hydrant drain opening.

2. Place textile fabric to cover drain rock prior to placement of backfill.

3. Setting shall allow the hydrant barrel to drain into drainage gravel at base of hydrant.

C. Set fire hydrants plumb with pumper nozzle facing roadway.

D. Set fire hydrants with centerline of pumper nozzle 18 inches (450 millimeters) above finished grade, and with safety flange not more than 6 inches (150 millimeters) nor less than 2 inches (50 millimeters) above grade. Install hydrant extensions where required and as approved.

E. Paint hydrants according to color scheme of local authorities having jurisdiction. Touch up paint after hydrant installation and testing.

F. After hydrostatic testing, flush hydrants and check for proper drainage.

G. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Piping.

3.4 FIELD QUALITY CONTROL

A. Pressure test water distribution system according to AWWA C600 and Section 33 13 00, Testing and Disinfection of Water Utility Piping.

3.5 CONCRETE HYDRANT PADS

A. When hydrant is place within sidewalks, form and pour-in-place 36-inch by 36-inch by 6-inch, 4,000 pounds per square inch (psi) concrete pad around the hydrant after the hydrant has been installed and set to grade.

B. Center hydrant pad on the hydrant. Set hydrant pad so top of pad is flush with surrounding surface, or as directed by the Engineer.

C. Hydrant pads may be adjusted to reach the back of curb if the hydrant pad is no less than 1-foot in any one direction.

3.6 OUT-OF-SERVICE HYDRANTS

A. To indicate that the fire hydrant is NOT operational, secure reflective tape, an orange plastic bag over the entire hydrant assembly or an approved out-of-service cover.

B. An out-of-service ring may also be used in addition to the bag or cover in case of removal of the cover.

C. Maintain the plastic bag up until the waterline is accepted by the Owner.

END OF SECTION

SECTION 33 13 00 - TESTING AND DISINFECTING OF WATER UTILITY PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hydrostatic pressure testing, disinfection, and purity testing of potable water systems piping, fittings, valves, and domestic water services.

B. Section Includes:

1. Pressure testing and disinfection of potable water distribution and transmission piping systems and appurtenances.

2. Testing and reporting of results.

C. Related Requirements:

1. Section 33 11 10 - Water Utility Distribution and Transmission Piping
2. Section 33 12 16 - Water Utility Distribution Valves
3. Section 33 12 19 - Fire Hydrants
4. Section 33 12 13 - Water Service Connections

1.2 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

1. AWWA B300 - Hypochlorites
2. AWWA B301 - Liquid Chlorine
3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances
4. AWWA C605 - Underground Installation of PVC and PVCO Pressure Pipe and Fittings
5. AWWA C651 - Disinfecting Water Mains
6. AWWA C655 - Field Dechlorination

1.3 SUBMITTALS

A. Section 01 33 00 –Submittals Procedures: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Pipeline Testing and Disinfection Plan: To be submitted for review and approval by the Engineer a minimum of 1 month before testing is to start. As a minimum, the plan shall include the following:

1. Testing schedule.

2. Hydrostatic Testing Plan:

a. Narrative of the proposed process.
b. Proposed equipment to be used.
c. Disposal location for excess water used to fill mains.

3. Disinfection Plan:

a. Narrative of the proposed process.

b. Proposed chemicals and equipment (including list of all pumps and meters) to be used.

c. Calculations for the amount of chlorine required to achieve required chlorine residual levels.

d. Proposed method of mixing, injecting, and distributing of chlorine solution throughout all portions of the new water system facilities.

e. Proposed plan for testing chlorine levels throughout the length of pipeline.

4. Proposed testing locations.

5. Proposed plan for water conveyance, including flow rates.

6. Proposed plan for water control.

7. Proposed plan for water disposal, including flow rates. Include proposed plan for dechlorination of disinfection water, including discharge points.

8. Proposed measures to be incorporated in the project to minimize erosion while discharging water from the pipeline.

1.4 CLOSEOUT SUBMITTALS

A. Disinfection Report:

1. Type and form of disinfectant used.

2. Date and time of disinfectant injection start and time of completion.

3. Test locations.

4. Name of person collecting samples.

5. Initial and 24-hour disinfectant residuals in treated water in parts-per million (ppm) for each outlet tested.

6. Date and time of flushing start and completion.

7. Disinfectant residual after flushing in ppm for each outlet tested.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future functions.

B. All temporary thrust restraint and equipment and facilities required for hydrostatic testing will be considered incidental.

C. As a minimum, furnish the following equipment and materials for the testing:

Amount	Description
2	Graduated containers approved by the Engineer.
1	Hydraulic pump approved by the Engineer with hoses, valves, and fittings as needed and required for the testing and disinfection of the facilities.
1	High range chlorine test kit, as approved by Engineer, with digital readout. Range of detection shall be between 5 and 200 ppm. Accuracy of 3 percent.
2	Pressure gauges with pressure range at least 120 percent greater than the required maximum test pressure with graduations in 2 pounds per square inch (psi) increments. Gauges shall have been calibrated with 90 days of pressure testing.

2.2 DISINFECTION CHEMICALS

A. Chemicals:

1. Hypochlorite: Comply with AWWA B300.
2. Liquid chlorine: Comply with AWWA B301.

2.3 DECHLORINATION CHEMICALS

A. Chemicals:

1. Comply with AWWA C655.

PART 3 EXECUTION

3.1 HYDROSTATIC TESTING OF WATER PIPING

A. Make all necessary provisions for conveying water to the points of use and for the disposal of test water.

B. No section of the pipeline shall be hydrostatically tested until backfill has been placed, compacted, and passed required density testing and all field-placed concrete or mortar has attained full strength.

1. At the Contractor's option, early strength concrete may be used when the full-strength requirements conflict with schedule requirements.

2. All such substitutions and installations shall be approved by the Engineer prior to installation.

C. Provide 72-hour notification to the Engineer and Owner prior to conducting hydrostatic testing.

1. Provide coordination and scheduling required for the Owner and Engineer to witness and provide necessary labor for operating Owner's existing system during hydrostatic testing and disinfecting procedures.

2. The Contractor shall not operate any part of the existing water systems.

D. Pipe Filling:

1. Fill pipes slowly from the lowest elevation to highest point along test section with potable water.

2. Take all required precautions to prevent entrapping air in the pipes.

3. Allow for natural absorption of water by the lining of the pipe to occur.

4. Apply specified test pressure by pumping.

E. Testing of Mains:

1. Ductile Iron: In accordance with AWWA C600.

2. Polyvinyl chloride (PVC): In accordance with AWWA C605.

3. General:

a. Tests shall be conducted under a hydrostatic test pressure not less than 1.25 times the stated anticipated maximum sustained working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section, minimum 150 psi, unless otherwise shown in the Drawings.

b. In no case shall the test pressure exceed the rated working pressure for any joint, thrust restraint, valve, fitting, or other connected appurtenance of the test section.

c. Testing shall be performed by applying the specified test pressure by pumping.

d. Once the test pressure has been attained, the pump shall be valved off.

e. The test will be conducted for a 2-hour period with the allowable leakage not to exceed the value as calculated per the Allowable Leakage formula below.

f. During the test period, there shall be no appreciable or abrupt loss in pressure.

4. Allowable Leakage:

a. Flanged Joints: Pipe, fittings, and valves with flanged joints shall be completely watertight. No leakage allowed.

b. Mechanical or Push-on Joints: Pipe, fittings and valves with rubber gasketed joints shall have a measured loss not to exceed the rate given in the following Allowable Leakage formula:

$$AL = \frac{LD(P)^{1/2}}{148{,}000}$$

In the above formula:

AL = Allowable leakage, in gallons per hour
L = Length of pipe tested, in feet
D = Nominal diameter of pipe, in inches
P = Average test pressure during the leakage test, in pounds per square inch.

5. Maintaining Pressure:

a. During the test period, operate the pump as required to maintain pressure in the pipe within 5 psi of the specified test pressure at all times.

b. At the end of test period, operate the pump until the specified test pressure is again obtained.

1) The pump suction shall be in a clean, graduated barrel, or similar device or metered so that the amount of water required to restore the test pressure may be accurately measured.

2) Sterilize this makeup water by adding chlorine to a concentration of 25 milligrams per liter (mg/L).

c. The Engineer will determine the quantity of water required to maintain and restore the required pressure at the end of the test period.

d. Each hour's loss stands on its own and will not be averaged.

6. Defects, Leakage, Failure:

a. If the test reveals any defects, leakage in excess of the allowable, or failure, furnish all labor, equipment, and materials required to locate and make necessary repairs.

b. Correct any visible leakage regardless of the allowable leakage specified above.

c. All leaks shall be repaired in a manner acceptable to the Engineer.

d. The testing of the line shall be repeated until a test satisfactory to the Engineer has been achieved.

3.2 DISINFECTION OF WATER PIPING

A. Disinfection shall be in accordance with the latest version of AWWA C651 following Engineer's acceptance of hydrostatic testing.

B. Chlorination by means of tablets or powders (calcium hypochlorite) placed in each length of pipe during installation is specifically prohibited.

C. Flush all foreign matter from the pipeline, branches and services.

1. Provide at no additional cost to the Owner, hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties.

2. Flushing velocities shall be at least 2.5 feet per second (fps).

3. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipe in place from the inside by brushing and sweeping, then flush the line at a lower velocity.

D. Chlorine Application:

1. Fill the test section of main from the lowest elevation and maintain a steady flow rate while injecting the water main with chlorinated water.

2. Flow (bleed) a blow-off, standpipe or hydrant at the water main's high point(s) to allow air to escape and ensure all interior pipe surfaces are wetted.

E. Chlorine Residual:

1. Measure chlorine residual with a high-range chlorine test kit at a point near to the injection point while filling the main.

2. Adjust the dose rate as necessary to maintain the target dose rate.

F. Potable water piping shall be disinfected with a solution containing a minimum 25 ppm and a maximum 50 ppm chlorine.

1. Once the main is completely filled with super-chlorinated water, measure the chlorine residual a minimum of once every 200 feet of main and once for each main branch, 2-inch service, or as directed by the Engineer.

2. The chlorine solution shall remain in the piping system for a period of 24 hours, after which time the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.

3. If check samples fail to produce acceptable results, the disinfection procedure shall be repeated at the expense of the Contractor until satisfactory results are obtained.

G. Flush piping, branches, and services with municipal potable water until the chlorine residual is below 1.5 ppm and approximately the same as the source water.

1. There is no minimum flushing velocity for this step.

H. Disposal of any water containing chlorine shall be performed in accordance with the latest edition of AWWA C651 and C655, and all state or local requirements.

1. Disposal may be made into existing sanitary sewer systems providing approvals are obtained from the respective system owners.

2. Any chlorinated water discharged to open stream channels must be dechlorinated prior to discharge to levels acceptable by Oregon State Department of Environmental Quality (DEQ).

3.3 DISINFECTION AND TESTING OF WATER MAIN END CONNECTIONS AND TIE-INS

A. Disinfection of potable water piping and appurtenances at end connections and tie-ins to the existing system which are required to remain in service due to restrictions in allowable shutdown time shall be disinfected as described below.

B. Prior to connecting new potable water piping and appurtenances with existing piping and appurtenances, the interior of all new pipe, fittings, valves and appurtenances shall be swabbed or sprayed with a 1 percent to 5 percent calcium hypochlorite solution.

C. In accordance with AWWA C651, swabbing or spraying of connection piping is allowed only if the total length of piping is equal to or less than one pipe length (18 feet). All runs of new piping over 18 feet in total length will require hydrostatic pressure testing, flushing and disinfection as detailed elsewhere in this Section.

D. Following the disinfection procedures described above, connection of the new piping and appurtenances to the existing water system shall be made.

1. During the system startup, the Engineer and Contractor shall visually inspect all new fittings, piping, valves and appurtenances for evidence of leakage.

2. Any leakage observed during this period shall be promptly repaired by the Contractor, at Contractor's expense, as required by the Engineer.

3.4 FIELD QUALITY CONTROL

A. Testing procedures will be per City of Woodburn standards, Section 5100.

B. SAMPLE SET:

1. A sample set is the total of individual samples taken on a project at the rate of one for each sample point.

2. Two (2) consecutive sample sets shall be taken and pass lab test before the line shall be accepted and put in service.

C. SCHEDULING:

1. Contractor shall notify the Engineer 48-hours in advance of the time he proposes to schedule sampling operations and indicate the lab doing the testing.

2. The first sample set shall be taken at or about 48-hours after final flushing is accomplished and the second sample set shall be taken a minimum of 72-hours after final flushing. There must be a minimum of 24 hours between sample sets.

D. TESTING PROCEDURES:

1. The samples shall be collected by the Contactor or a designee and witnessed by a representative of the City then transported to a State of Oregon certified laboratory for testing. Each of the second set shall be custody sealed by the City immediately after collection prior to transport to the lab.

2. The Lab shall be notified by the City to not test samples that the custody seal has been tampered with.

3. Samples shall be taken only at approved sample points, no samples will be allowed at fire hydrants or hoses.

4. Samples shall be placed and transported in, a sterile bottles treated with sodium thiosulfate as required by Standard Methods for the Examination of Water and Wastewater.

5. Samples in a given sample set shall be tested in conformance with approved State of Oregon test methods for microbiological analysis of coliform.

6. Sample set must show no coliform (total coliform and E.coli) presence at all sample points. The Contractor shall supply an original signed copy or carbon copy of the satisfactory test results to the City Engineer.

7. If testing confirms coliform presence the system shall be completely flushed and re-disinfection repeating the aforementioned procedure.

8. When samples are satisfactory and all other applicable installation standards are complied with, the City will then assume responsibility for the new main.

9. Additional testing may be required by the City prior to allowing the line to be placed in service.

END OF SECTION

SECTION 33 21 20 - DISINFECTION OF WATER SUPPLY WELLS

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers the disinfection of an existing well or wells associated with a well development and pump project. Prior to their use, disinfection, and purity testing of each existing well and associated pumps, piping, fittings, and valves will be accomplished. All costs for labor and materials necessary to conduct the disinfecting and testing procedures specified herein shall be borne by the CONTRACTOR. The work under this section will be coordinated with that required under Section 33 21 20, Testing and Disinfection of Water Utility Piping.

B. The CONTRACTOR shall provide 72-hour notification to the ENGINEER and OWNER prior to conducting disinfection of each well and associated appurtenances. CONTRACTOR shall provide coordination and scheduling required for the OWNER and ENGINEER to witness and provide necessary labor for operating OWNER's existing system, if necessary, during the disinfecting procedures. CONTRACTOR shall not operate any part of the existing water system.

C. The CONTRACTOR shall perform flushing and testing of the each well and associated pumps, piping, fittings, and valves pipelines for potable water, complete, including conveyance of test water to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

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

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C651-99	Disinfecting Water Mains
ANSI/AWWA C600-99	Installation of Ductile-Iron Water Mains and Their Appurtenances

1.3 CONTRACTOR SUBMITTALS

A testing schedule, including proposed plans for water conveyance, control, disposal, disinfection, and dechlorination shall be submitted in writing for approval a minimum of 1-week before testing is to start.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the CONTRACTOR subject to the ENGINEER's review. No materials shall be used which would be injurious to the construction or its future functions.

B. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

C. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300.

PART 3 EXECUTION

3.1 DISINFECTION OF WATER WELLS AND APPURTENANCES

A. At all times during the progress of the work, the CONTRACTOR shall protect each existing well in such a manner as to effectively prevent either tampering with the well or entrance of foreign matter.

B. Each existing well will be provided to the CONTRACTOR capped and in a completed and tested condition and free of foreign substances. If the CONTRACTOR contaminates the existing well or wells with foreign substances, the CONTRACTOR shall clean the well or wells of those foreign substances.

C. Before sterilizing, flush all foreign matter from each well and associated piping, valves, and appurtenances. The CONTRACTOR is to provide at no additional cost to OWNER, hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties.

D. Each well shall be disinfected in conformance with the state, local, and federal codes and regulations (OAR 690-210-0380-Appendix 2) and as follows. Place chlorine solution at a strength and volume to produce an available chlorine concentration of at least 50 milligrams per liter to the entire water depth in each well. Mix to ensure distribution throughout water depth of the well. The chlorine solution shall remain in the well for a period of 24 hours at which time the sterilizing mixture shall have a residual concentration of at least 25 parts per million of chlorine. If check samples fail to produce acceptable results, the disinfection procedure shall be repeated at the expense of the CONTRACTOR until satisfactory results are obtained. The interior of all new pipe, fittings, valves and appurtenances shall be swabbed or sprayed with a 1 percent calcium hypochlorite solution.

E. After disinfection, each well and associated appurtenances shall be thoroughly flushed by the CONTRACTOR in accordance with AWWA C651-99. The CONTRACTOR shall make all necessary provisions for conveying water to the points of use and for the disposal of test water. Disposal of any water containing chlorine shall be performed in accordance with AWWA C651 and C655, and any other state and local requirements. Disposal may be made into existing sanitary sewer systems providing approvals are obtained from the respective sewerage agency. Any chlorinated water discharged to open stream channels must be dechlorinated prior to discharge.

F. The OWNER will collect samples after each well is flushed at a location directed by ENGINEER. The chlorine residual must be below 1.5 milligrams per liter when the sample is taken. Results of the bacteriological testing shall be satisfactory with the State Department of Health and/or other appropriate regulatory agencies, or disinfection shall be repeated at the expense of the CONTRACTOR.

END OF SECTION

SECTION 33 41 10 - STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials and accessories normally used with gravity storm drainage sewers.

B. Section includes:

1. Storm drainage piping
2. Piping accessories
3. Connection to existing manholes
4. Catch basins and area drains
5. Cleanouts
6. Bedding and cover materials

1.2 RELATED SECTIONS

A. Section 03 11 00 – Concrete Work
B. Section 03 60 00 - Grouting
C. Section 31 05 13 - Soils for Earthwork
D. Section 31 05 16 - Aggregates for Earthwork
E. Section 31 23 16 - Excavation
F. Section 31 23 17 - Trenching
G. Section 31 23 23 - Fill
H. Section 33 01 30.13 - Sewer and Manhole Testing
I. Section 33 05 13 - Manholes

1.3 REFERENCE STANDARDS

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

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

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

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

5. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.

6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

7. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

8. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

8. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

9. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

10. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

11. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

13. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

15. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

16. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

17. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.

5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

1.4 COORDINATION

A. Notify affected utility companies at least 72 hours prior to construction.

1.5 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:

1. Indicate special procedures required to install specified products.

2. Submit detailed description of procedures for connecting new storm sewer to existing storm sewer line.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture, dust, and direct sunlight by storing in clean, dry location remote from construction operations areas.

2. Block individual and stockpiled pipe lengths to prevent moving.

3. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Polyvinyl Chloride (PVC) Pipe:

1. Material:

a. Manufactured from rigid polyvinyl chloride compounds conforming to ASTM D1784, Class 12454-B.

b. At locations indicated in the Drawings, pipe shall conform to AWWA C900.

2. Pipe and fittings 4 inches to 15 inches in diameter, non-pressurized:

a. Comply with ASTM D3034, SDR 35.

3. Pipe and fittings 18 inches and larger in diameter, non-pressurized:

a. Comply with ASTM F679, PS46.
b. Pipe shall have a minimum stiffness of 46 pounds per square inch (psi).

4. AWWA C900 Pipe:

a. At locations shown in the Drawings.
b. Four inches to 12 inches in diameter.
c. DR 25.
d. Pipe shall have minimum stiffness of 149 psi.

5. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.

6. Joints:

a. Integral bell push-on type: Comply with ASTM D3212.

b. For use with AWWA C900 pipe: Integral bell push-on type comply with ASTM D3139.

7. Gaskets:

a. Factory installed.

b. Elastomeric gaskets: Comply with ASTM F477.

B. Ductile Iron Pipe:

1. Comply with AWWA C151.

2. Minimum Special Thickness Class: 52.

3. End Connections: Bell and spigot or plain, as shown in the Drawings.

4. Outside Coating:

a. Type: Asphaltic coating, minimum 1-mil uniform thickness.
b. Comply with AWWA C151.

5. Lining:

a. Cement mortar lined.
b. Comply with AWWA C104.

6. Fittings:

    a. Material: Ductile iron.
    b. Comply with AWWA C153 or AWWA C110.
    c. Lining: Cement-mortar lined according to AWWA C104.

7. Coating:

    a. Asphaltic exterior coating in accordance with AWWA Standard C151.

8. Joints:

    a. Rubber gasket joint devices.

    b. Comply with AWWA C111.

C. High Density Polyethylene (HDPE) Pipe:

1. Double wall, ribbed pipe with smooth interior.

2. Solid pipe, perforated pipe, and fittings shall meet the requirements of ASTM F-405 and F-667

3. Pipe 3 inches to 10 inches in diameter: Comply with AASHTO M-252.

4. Pipe 12 inches to 36 inches in diameter: Comply with AASHTO M-294.

5. Joints: Integral bell push-on type.

6. Manufacturers:

    a. ADS, N-12 with Pro Link joints, or approved equal.

2.2 FLEXIBLE COUPLINGS

A. Description:

1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
2. Attachment: Two Series 300 stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Ethylene propylene rubber (EPDM).
2. Comply with ASTM C923.
3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 11 00, Concrete Work.
2. Strength: Minimum 3,000 psi at 28 days.
3. Air entrained.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 11 00, Concrete Work.

2.5 CATCH BASINS AND AREA DRAINS

A. Construction:

1. Material: Reinforced pre-cast concrete pipe sections.

a. Minimum compressive strength of 3,000 psi at 28 days.

2. Joints: Lipped male/female.

3. Nominal Interior Dimensions: As shown in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron.

2. Lid:

a. Removable.
b. Design: Linear grill.

3. Nominal Lid and Frame Size: As shown in the Drawings.

2.6 CLEANOUTS

A. Construction:

1. Per details provided in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron. Meet H20 load requirement.

2.7 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

    a. Material type varies by location, as shown in the Drawings.

    b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

    c. Subsoil Type S1 or S2, as specified in Section 31 05 13, Soils for Earthwork.

2.8 MIXES

A. Grout: As specified in Section 03 60 00, Grouting.

2.9 ACCESSORIES

A. Underground Pipe Markers: As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut, or excavation base is ready to receive Work.

B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation in accordance with Section 31 23 17, Trenching.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.

2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.

3. Pipe base shall be observed by Engineer prior to placement of the pipe.

4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.

5. Placement:

   a. Place bedding material at trench bottom.
   b. Level materials in continuous layer not exceeding 6 inches compacted depth.
   c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.

   a. PVC, HDPE, ABS: Comply with ASTM D2321.
   b. Ductile Iron: Comply with AWWA C600.

2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

3. Lay pipe to slope gradients and line as indicated on Drawings.

4. Variations:

   a. Maximum Variation from Indicated Line: 1/32-inch per inch of pipe diameter, but no more than 1/2-inch, providing that such variation does not result in a level or reverse-sloping invert.

   b. Maximum Variation from Indicated Grade: 1/32-inch per inch of pipe diameter, but no more than1/4-inch.

   c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64-inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.

6. Assemble and handle pipe according to manufacturer's instructions, except as may be modified on Drawings or by Engineer.

7. Make straight field cuts without chipping or cracking pipe.

8. Keep pipe and fittings clean until Work has been completed and accepted by Engineer.

9. Assemble pipe joints in accordance with manufacturer's recommendations/specifications.

10. Cap open ends during periods of Work stoppage.

11. Lay bell and spigot pipe with bells upstream.

12. Backfill and compact as specified in Section 31 23 17, Trenching.

13. Do not displace or damage pipe when compacting.

14. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.

2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.

3. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.

4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.

5. The pipe is then forced "home" firmly and fully.

6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Connection to Existing Manholes:

1. Drilling:

a. Core drill existing manhole to clean opening.

b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.

2. Install watertight neoprene gasket and seal with non-shrink concrete grout.

3. Encasement:

a. Concrete encase new sewer pipe minimum of 24 inches to nearest pipe joint.

b. Use epoxy binder between new and existing concrete.

4. Prevent construction debris from entering existing sewer line when making connection.

E. Manholes:

1. Install manholes as specified in Section 33 05 13, Manholes.

F. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.

2. Use standard fittings of same material and joint type as sewer main.

3. Maintain minimum 5-foot separation distance between wye connection and manhole.

4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.

5. Mount saddles with solvent cement or gasket and secure with metal bands.

6. Lay out holes with template and cut holes with mechanical cutter.

G. Catch Basins

1. Form bottom of excavation clean and smooth, and to indicated elevation.

2. Cast-in-place Concrete Construction:

a. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe end sections.

b. Level top surface of base pad.

c. Sleeve concrete shaft sections to receive storm sewer pipe sections.

d. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.

3. Mount lid and frame level in grout, secured to top cone section to indicated elevation.

H. Backfilling:

1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.

2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

A. Request inspection by Engineer prior to and immediately after placing bedding.

B. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

2. Pipe Testing: As specified in Section 33 01 30.13, Sewer and Manhole Testing.

3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 56 13

DIESEL FUEL STORAGE TANK

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers the furnishing and installation of an assembled fuel storage and supply system with alarm controls and fuel maintenance system to manage fuel supply to a generator. Generator fuel system shall include above grade diesel storage tank, fuel tank appurtenances as shown on plans, and fuel piping as specified.

B. This Section also covers factory testing by an authorized agent of the equipment manufacturer, and on-site testing of the system and fuel tank independently.

C. The fuel storage and delivery system supplier shall warrant all equipment provided under this section, regardless of manufacturer, such that there is one source for warranty and product service. Technicians trained and certified by the manufacturer to support the product and employed by the tank supplier shall service the fuel system.

D. A single supplier shall provide all the equipment and training specified herein for a complete and operational generator fuel system. The fuel system supplier shall be responsible for compliance to all specification requirements for the fuel tank, fuel system, and associated equipment.

1.2 RELATED SECTIONS

A. Section 26 32 13.13 – Diesel Engine Driven Generator Sets.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures.

B. Shop drawings

1. Outline drawings of assembly.
2. Diagrams and wiring diagrams for assembly and components.
3. Interconnection wiring diagrams.
4. Names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site

C. Product Data

1. Technical data on all major components.
2. Seismic certification, demonstrating compliance to local requirements.

3. Test reports and certifications.
4. Factory test procedures.
5. Operating and maintenance data.

1.4 CODES AND STANDARDS

A. The fuel system installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The fuel system shall include necessary features to meet the requirements of these standards:

1. IEEE446—Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

2. NFPA 30—Flammable and Combustible Liquids.

3. NFPA 37—Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.

4. NFPA 70—National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

5. NFPA 99—Essential Electrical Systems for Health Care Facilities.

6. NFPA 110—Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

B. The fuel tank and accessories shall meet the requirements of the following standards:

1. UL2085—Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids.

2. UL142—Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.

C. The fuel system shall comply with the following requirements, as required:

1. ANSI B31.1 - Power Piping.

2. ANSI B31.4 - Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids.

3. ANSI B31.9 - Building Service Piping.

4. ANSI / ASME A13.1 Labeling Guide (General Pipe Marking Standards).

5. API 2000 - Venting Atmospheric and Low Pressure Storage Tanks.

6. ASME RTP1 - Reinforced Thermal Plastic Corrosion-Resistant Equipment.

7. ASME Section 9 - Welding and Brazing Qualifications.

8. ASME B16.3 - Malleable Iron Threaded Fittings.

9. ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

10. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

11. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

12. NFPA 30 - Flammable and Combustible Liquids Code..

13. NFPA 31 - Installation of Oil Burning Equipment.

1.5 QUALITY ASSURANCE

A. The manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

B. The manufacturer of this equipment shall have produced similar equipment for a minimum of ten years. When requested, a list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

C. Fuel systems supplier shall have service staff that are trained and factory certified in the equipment provided. Staff shall be located within 100 miles of the site.

D. The manufacturer shall perform a complete operational test prior to shipping from the factory.

E. A certified test report shall be provided documenting the results of these tests

1.6 WARRANTY

A. The supplier shall provide warranty coverage on the material and workmanship for a minimum of twenty-four (24) months from acceptance.

PART 2 PRODUCTS

2.1 FUEL SYSTEM MONITORING, SENSING, AND PROTECTION

A. Fuel system sensing, alarms, and alarm controls shall be mounted on the fuel tank. The control system shall also be designed to allow local monitoring, remote monitoring, and provisions for other controls as described in this specification. The control shall be prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

B. Fuel Tank Alarm and Status Display: The fuel tank shall be provided with a panel providing alarm and status indicating lamps to indicate fuel level, leak status and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright outdoor lighting conditions. Installation of tank shall be coordinated with generator installation to determine contacts needed for generator control panel. The following alarm and status conditions are required, as a minimum on the tank alarm control panel:

1. High fuel, critical high fuel alarm
2. Low fuel, critical fuel alarm
3. Low fuel shutdown
4. Tank leak alarm
5. Fuel tank level indication

C. The control panel shall annunciate all alarm conditions.

D. Coordinate connection interfacing required for the generator control panel to ensure a fully functional generator set capable of delivering backup power on demand.

E. Control panel shall provide discrete and analog signals, as shown on the plans, for remote monitoring of tank status.

2.2 FUEL STORAGE TANK

A. Fuel tank shall be rectangular in shape in the size shown on the plans and consist of a primary steel tank, integral secondary containment, lightweight concrete, an outer steel shell, and shall conform to UL Standard 2085, Insulated/ Secondary Containment for above grade storage tanks and shall be listed for above ground storage of flammable liquids per UL 142. Fuel tank shall be engineered and manufactured to the latest NFPA 30, 30A, and 31 fire safety standards.

B. Ports shall be installed on tank top as required to accommodate fuel lines, fuel level and level alarm sensors, leak detection equipment, and ventilation as shown on the plans.

C. The fuel tank shall be equipped with an integral spill container with fill pipe with over fill prevention valve.

D. Flame Arrestor—Tank shall include a flame arrestor on the normal vent connection with cast iron body, cast iron cover, brass cap and stainless-steel arrestor plates.

E. Overfill Prevention Valve—The main tank compartment shall include an overfill prevention valve in the refueling connection port to automatically stop the flow of fuel into the tank at 90 percent of maximum tank capacity. The valve shall be two stage, float operated, and suitable for above grade tanks as required by project conditions. Valve assembly shall be UL listed and include a drop tube extended to within 6-inch of tank bottom.

F. The tank system shall include an impervious barrier to contain leaks from the primary tank. A leak detection access tube shall be located between the inner tank and secondary barrier. In the event of a leak, a positive space shall be available to permit leaked fluid to flow to the detection tube.

G. Tank level monitoring and leak detection instrumentation shall be provided and connected to the OWNERS telemetry and SCADA as shown on the plans. Tank mounted fuel monitoring instruments shall include the following:

1. Float switches for high, low and low/low level alarms.

2. Alarm control panel LC1000 by Pneumercator, or equivalent.

3. Top mounted liquid level gauge with visible read out; to be visible during tank filling.

4. Top mounted liquid level gauge with visible read out for on-site interstitial space leak monitoring.

5. Float level sensor with analog sending unit, Model C-series by Madison Co., or equivalent.

6. Level sensor installed in tank detection tube to detect tank leakage.

2.3 GENERATOR FUEL PIPING AND MAINTENANCE SYSTEM

A. The fuel system includes, but is not limited to, the following:

1. Supply and overflow return lines.
2. Fuel maintenance/ filtration system.
3. Integrated control and monitoring.

B. Contractor shall coordinate the size of the fuel and return lines with the generator's fuel flow and restriction requirements. Pipe system shall bear a UL label for petroleum

products piping and comply with ASTM D2996 for non-metallic and ASTM A 53 and A 106 for steel fuel oil piping. All flexible and non-ferrous fuel lines shall be vacuum rated.

C. Fuel piping system shall provide the required transition fittings, entry boots, and adapters for connections to the tank and generator.

D. Flexible Connectors: Stainless steel inner hose and braided exterior sleeve, suitable for minimum 200 psi WOG and 250 degrees F. All flexible connectors must have welded (not swaged or crimped) ends. All flexible connectors shall be vacuum rated.

E. Generator fuel tank system shall include inlet and outlet connections for future installation of an FM approved and NFPA compliant automated diesel fuel maintenance system. Inlet and outlet connections shall be located on diagonally opposite corners of the tank to ensure complete treatment of the fuel contained therein.

F. Acceptable Products:

1. Acceptable fuel containment products including pipe, fittings, sumps and boots: Flexworks as manufactured by OPW, Franklin Fueling Systems, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided The contractor shall perform interconnecting wiring between equipment sections under the supervision of the equipment supplier.

C. Equipment shall be installed on concrete slabs as shown on the Plans. Equipment shall be permanently fastened to the slab in accordance with manufacturer’s instructions and seismic requirements of the site.

D. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

E. On completion of the installation by the contractor, the fuel storage tank supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

F. Fuel system components shall be supported and anchored in a manner consistent with those submitted by the tank manufacturer and the supplier. The supports and anchoring must be designed and stamped by an Oregon registered Professional Engineer with a current license to work in the state of Oregon.

3.2 ACCEPTANCE TETSING

A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by CONTRACTOR. The Engineer shall be notified in advance and shall witness the tests.

B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

C. Installation acceptance tests to be conducted on site shall be in accordance with those described by the Steel Tank institute and as required by local authorities.

3.3 TRAINING

A. Equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than four hours in duration and the class size shall be limited to five persons.

END OF SECTION

SECTION 40 05 07

HANGERS, SUPPORTS AND ANCHORS FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall design, furnish and install hangers, supports, guides, anchors, seismic restraints and bracing and all related items for piping, ducting, and equipment to produce complete installations in accordance with the Contract Documents.

1.2 REQUIREMENTS

A. The piping shown in the Contract Documents is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the CONTRACTOR's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all hangers, supports, guides, anchors, seismic restraints and bracing for a complete and functional system.

B. Special pipe supports and support details shown in the Contract Drawings are the minimum required and are illustrative of additional supports that may be necessary to resist loads. The CONTRACTOR shall design, furnish and install additional supports necessary to avoid transferring pipe system loads to pumps, equipment or pump and equipment flanges.

C. Pipe support details shown in the Drawings are not designed to resist seismic and wind forces. The CONTRACTOR shall provide additional supports as needed to resist such forces.

1.3 COORDINATION

A. Coordinate installation of specified items with installation of pipes, valves and equipment.

1.4 SUBMITTALS

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

B. Product Data:

1. Submit manufacturer catalog information, construction details and performance characteristics for each type and size of anchor, hanger and support.

2. Submit materials of construction list.

C. Arrange for the services of a structural engineer registered in the state of Oregon to design pipe supports in accordance with Section 13 05 41 Seismic Requirements for Non-Structural Components and Systems and shall provide submittals in accordance with that Section

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

A. ANSI/MSS Types: Except as otherwise indicated, pipe support components shall comply with the requirements of MSS SP-58, MSS SP-69, ANSI/MSS SP-89 and MSS-SP-127

B. Supports shall comply with ANSI/ASME B31.l - Power Piping, except as otherwise indicated. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local requirements.

C. Manufacturer's recommendations, hanger style and load shall determine support type.

D. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe, shall allow for free expansion and contraction of the piping, and shall prevent excessive stress on equipment. Hangers shall have a means of vertical adjustment after erection. Hangers shall be designed so that they cannot become disengaged by any movement of the pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of valves, shall include hydraulic shock suppressors. All hanger rods shall be subject to tensile loading only.

E. Piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, forces applied during construction and stresses on piping, equipment, and structures.

F. Where possible, pipes shall be supported from structural members. Where it is necessary to frame supplementary structural members between existing members, such supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction.

G. Overhead pipe: Design support system to maintain access for personnel to all equipment and instruments located beneath overhead pipe. Maintain minimum required horizontal and vertical clearances for the transport and handling of all materials that may pass beneath overhead pipe as part of regular operations and routine maintenance. Maintain minimum required horizontal and vertical clearances for the installation of all future pipe and equipment beneath overhead pipe. For new

trusses, determine loads resulting from supporting overhead pipe from above, including future overhead pipe, and coordinate resulting loads with truss manufacturer. For existing trusses, support overhead pipe from below, unless the structural engineer engaged per 1.2.A can demonstrate that loads can be transferred to existing structural members without exceeding design limits on those members.

H. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is indicated, suitable linkage shall be provided to permit movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees as a result of fluctuations between the minimum and maximum anticipated temperature, the hanger rod and structural attachment shall be offset in such a manner that the rod is in a vertical position at the maximum temperature.

I. Thermal Expansion and Contraction: Wherever thermal expansion and contraction of piping is possible, a sufficient number of expansion loops or joints shall be provided, with rolling or sliding supports, anchors, guides, pivots, and restraints. They shall permit the piping to expand and contract freely in directions away from the anchored points and shall be structurally suitable to withstand all loads imposed.

J. Install hangers and supports to allow for controlled movement of piping systems, to permit freedom of movement between pipe anchors and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.

K. Heat Transmission: Supports, hangers, anchors, and guides shall be designed and insulated so that excessive heat shall not be transmitted to the structure or to other equipment.

L. Riser Supports: Risers shall be supported independent of the connected horizontal piping. Risers shall be supported on their respective floor with riser clamps and lugs.

M. Point Loads: Meters, valves, heavy equipment, and other point loads on PVC, fiberglass, and other plastic pipes, shall be supported on both sides according to manufacturer's recommendations to avoid pipe stresses. Supports on plastic and fiberglass piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

N. Insulated Pipe: Insulated pipe supports shall be supplied and installed on all insulated pipe and tubing.

O. Noise Reduction: To reduce transmission of noise in piping systems, copper tubes shall be wrapped with a 2-inch wide strip of rubber fabric at each pipe support, bracket, clip, and hanger.

2.2 MATERIALS

A. All pipe support assembly anchors shall be Type 316 stainless steel, unless otherwise indicated.

B. Concrete Anchors: Unless otherwise indicated, concrete anchors for pipe supports shall be as follows:

1. New Concrete: Use embedded concrete insert anchors.

2. Existing Concrete: Use non-shrink grouted anchors, metallic type expansion anchors, or epoxy anchors with the following exceptions:

a. Vibrating loads: Metallic type expansion anchors and epoxy anchors are not permitted for supports subject to vibrating loads.
b. High Temperatures: Epoxy anchors are not permitted where the concrete temperature is in excess of 100 degrees F or higher than the limiting temperature recommended by the manufacturer.
c. Fire: Epoxy anchors are not permitted where anchors are subject to or fire

C. Submerged Supports: Submerged piping and piping, conduits and equipment located inside hydraulic structures within 24-inches of the water level shall be supported with hangers, brackets, clips or fabricated supports constructed of Type 316 stainless steel.

D. Corrosive Environments: Piping in chemical rooms and other corrosive environments shall be supported with hangers, brackets, clips or fabricated supports constructed of Type 316 stainless steel or FRP.

E. Galvanizing: Fabricated pipe hanger and support products, except stainless steel or non-ferrous components, shall be blasted clean after fabrication and hot-dip galvanized in accordance with ASTM 123.

F. Provide adjustable hangers, complete with adjusters, swivels, rods, etc. Size hangers to clear insulation and to guide piping, where required, in addition to providing support.

G. All rigid hangers shall provide a means of vertical adjustment after erection.

H. Hanger rods shall be machine-threaded. Continuous threaded rods will not be allowed

I. Strap hangers are not permitted

J. Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to the pipe. Size guide and spiders to clear pipe and insulation (if

any), and cylinder. Provide guides of the length recommended by the manufacturer to allow indicated travel.

K. Steel plates, shapes and bars shall conform to ASTM A36.

L. Cement grout shall be Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume with only the minimum amount of water required for placement and hydration.

M. Fabricate heavy duty steel trapezes from steel shapes selected for the loads required; weld steel in accordance with AWS Standards

PART 3 EXECUTION

3.1 PIPE SUPPORT AND HANGER INSTALLATION

A. Proceed with the installation of hangers, supports and seismic restraints only after the required building structural work has been completed in areas where the pipe and equipment are to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors, restraints and other building structural attachments.

B. Install hangers, supports, clamps, and attachments to support piping and equipment properly from the building structure. Use no wire or perforated metal to support piping. For exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in the support of copper tubing by the use of hangers and supports that are copper plated, or by other recognized industry methods.

D. Support fire sprinkler piping independently of other piping and in accordance with NFPA Pamphlet 13.

E. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping. Special consideration shall be given to supporting piping where components such as flanges and valves impose concentrated loads.

F. Supports shall be provided with at least one support adjacent to the joint for each length of pipe, at each change in direction and at each branch connection. Support spacing shall not exceed manufacturer's recommendations nor the spacing listed below:

Pipe	Maximum Support Spacing (Feet)
Steel Pipe	
Under 3 inches	6
3 inches to 18 inches	12
20 inches to 24 inches	12 supported on grade; 9 supported on hangers
Cast or Ductile Iron	
Under 4 inches	6
4 inches and Over	10
Stainless Steel and Galvanized Iron	
Under 1-1/2 inches	4
1-1/2 inches to 4 inches	6
Over 4 inches	12
Copper Pipe	6
PVC Pipe	
Under 2-1/2 inches	4
2-1/2 inches and Over	6

G. For temperatures other than ambient, pipe support spacing shall be modified in accordance with the pipe manufacturer's recommendations.

H. Horizontal banks of piping may be supported on common steel channel members spaced not more than the shortest allowable span required on the individual pipe. Maintain piping at its relative lateral position using clamps or clips. Allow lines subject to thermal expansion to roll axially or slide. Size channel struts for piping weights.

I. Hanging of any pipe from another pipe or from equipment or metal decking is prohibited.

J. Place a hanger within 12 inches of each horizontal elbow.

K. Spacing of clamps for support of vertical piping shall be close enough to keep the pipe in alignment as well as to support the loads of the piping and contents. In no case shall spacing exceed 10-feet.

L. Cast Iron Soil Pipe: Support hubless and compression joints at every other joint, except when developed length exceeds four feet, in which case provide support at each joint.

Provide additional support at each horizontal branch and/or at concentrated loads to maintain alignment and prevent sagging.

M. Install hangers and supports to provide the indicated pipe slopes, and such that that maximum pipe deflections allowed by ANSI B31.1 are not exceeded.

N. Insulated Pipe: Attach clamps, including spacers if required, to piping outside the insulated piping support. Do not exceed pipe stresses allowed by ANSI B31.1. All insulated pipe supports shall be load rated by the manufacturer based upon testing and analysis in conformance with ASME B31.1, MSS SP-58, MSS SP-69 and MSS SP-89.

O. Equipment shall be positioned and aligned so that no strain shall be induced within the equipment during or subsequent to the installation of pipework.

P. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work.

Q. In erecting the pipe, a sufficient number of screwed unions or flanged joints shall be used to allow any sections or runs of pipe to be disconnected without taking down adjacent runs. Flexible couplings and dismantling joints shall be installed where shown on the drawings and at such other points as may be required for ease of installation or removal of the pipe, subject to approval of the ENGINEER. Flexible couplings shall be restrained where necessary to prevent separation of pipe due to internal pressures.

R. Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs and edges.

S. Fabricate structural steel frames to suspend equipment from structure above or to support equipment from floor. Place grout under supports for equipment and make smooth bearing surface.

T. Fabricate heavy duty steel trapezes from steel shapes selected for the loads required; weld steel in accordance with AWS Standards.

3.2 INSTALLATION POF SEISMIC RESTRAINTS

A. Install seismic restraints at the proper locations to prevent stresses from exceeding those permitted by ANSI B31.1, to comply with the recommendations in SMACNA "Seismic Restraint Manual" and to avoid exceeding manufacturer’s recommended loading. Anchors and seismic restraints shall be installed to prevent the transfer of loading and stresses to connected equipment.

B. Provide seismic restraints by welding or fastening steel shapes, plates and bars to the piping and/or equipment and to the structure. Comply with ANSI B31.1 and AWS Standards and SMACNA "Seismic Restraint Manual."

C. Provide standard plate washers under heads and nuts of bolts bearing on wood. Soap threads of lag bolts prior to installing.

D. Locate structural blocking as indicated and as required to support mechanical piping and equipment.

E. Where expansion compensators are required or shown, install seismic restraints in accordance with the expansion unit manufacturer's written instructions to limit movement of piping and forces to the maximum recommended by the manufacturer of each unit.

F. Install seismic restraints at the ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends, as recommended by SMACNA. Make provisions for presetting of seismic restraints as required to accommodate both expansion and contraction of piping.

END OF SECTION

SECTION 40 05 13

COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section applies to the furnishing and installation of piping inside a building, structure, enclosure piping and miscellaneous yard piping.

1.2 RELATED SECTIONS

A. Section 05 50 00, Metal Fabrications.
B. Section 09 90 00, Painting and Coating.
C. Section 31 23 17, Trenching.
D. Section 33 11 10, Water Utility Distribution Piping.
E. Section 33 05 17, Precast Concrete Valve Vaults and Meter Boxes.
F. Section 33 13 00, Disinfecting of Water Utility Distribution.
G. Section 40 05 23, Common Work Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.20.1 Pipe Threads, General Purpose (inch)

2. ASME A13.1 - Scheme for the Identification of Piping Systems.

3. ASME B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys

4. ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250.

5. ASME B31.3 - Process Piping.

6. ASME B31.9 - Building Services Piping.

B. ASTM International:

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

2. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile.

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

4. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.

5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

6. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

7. ASTM D792 - Test Methods for Specific Gravity and Density of Plastics by Displacement.

8. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

10. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

11. ASTM D2000 - Classification System for Rubber Products in Automotive Applications.

12. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

13. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

C. American Water Works Association:

1. AWWA C200 - Steel Water Pipe - 6 In. (150 mm) and Larger.

2. AWWA C207 - Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.

3. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

4. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

5. AWWA C510 - Double Check Valve Backflow Prevention Assembly.

6. AWWA C511 - Reduced-Pressure Principle Backflow Prevention Assembly.

7. AWWA C606 - Grooved and Shouldered Joints.

8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 COORDINATION

A. Coordinate installation of specified items with installation of valves and equipment.

1.5 SUBMITTALS

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

B. Product Data:

1. Submit manufacturer catalog information for each product specified.

C. Shop Drawings:

1. Identification:

a. Submit list of wording, symbols, letter size, and color coding for pipe identification.

b. Comply with ASME A13.1.

2. Provide all necessary dimensions and details on pipe joints, restraints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists.

3. Provide detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, couplings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.

D. Manufacturer's Statement: Certifying pipe fabrication and products meet or exceed specified requirements.

E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS and ASME qualification within previous 12 months.

F. Manufacturer Instructions: Submit special procedures and setting dimensions.

G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping appurtenances.

B. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Drawings:

1. Piping layouts shown in the Drawings are intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

B. Inspection:

1. All pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Welding:

1. All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1.

2. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring

attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welders:

1. Skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used shall do all welding.

2. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local approved testing agency prior to commencing work on the pipeline.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

4. The Contractor shall furnish all material and bear the expense of qualifying welders.

E. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.

1.8 MATERIAL DELIVERY, STORAGE AND INSPECTION

A. Inspection:

1. Accept materials on Site in manufacturer's original packaging and inspect for damage.

2. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition.

B. Storage:

1. Store materials according to manufacturer instructions.

2. Store materials off the ground, to provide protection against oxidation caused by ground contact

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.

3. Provide additional protection according to manufacturer instructions.

D. All defective or damaged materials shall be replaced with new materials.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

B. Unless specified otherwise or indicated differently in the Drawings, all piping systems and process piping materials shall be as listed in the table below or as shown on the Drawings:

Service	Material
Drainage/Sanitary Sewer	See Division 33.
Exposed ≥ 4"	Class 52 Ductile Iron or Heavy Wall Welded Steel
Buried ≥ 4"	Class 52 Ductile Iron
Submerged/Buried < 4"	Stainless Steel - Type 316 Schedule 40 Threaded - ASTM A 312 Fittings Welded or Threaded
Exposed < 4"	Brass - ASTM B 43, Fittings - Bronze - ASTM B 62 Threaded - ANSI/ASME B 16.15
Buried < 4"	Copper Tubing - ASTM B88 Type K Soft / Fittings - Wrought Copper - ANSI B16.22, Joints-Soldered
Miscellaneous Pipelines	As shown in the Drawings

2.2 DUCTILE IRON PIPE AND FITTINGS

A. See Article 2.1.B, Ductile Iron Pipe of Section 33 11 10, Water Utility Distribution Piping.

2.3 STEEL PIPE AND FITTINGS

A. General Service Piping:

1. ASTM A53, seamless, Grade B.
2. Schedule: 40, unless indicated otherwise on Drawings.

B. Water Piping, 6 Inches and Larger: See Section 33 11 10.30, Steel Water Utility & Distribution Piping.

2.4 COPPER PIPE AND FITTINGS

A. Description:

1. Seamless; ASTM B88.

2. Type:

a. Type L, hard drawn.
b. For pipe under floor slabs, underground or cast in concrete: Type K, annealed, seamless.

B. Joints:

1. Compression.
2. Manufacturer: Mueller Model 110 or approved equal

C. Dissimilar Metals: See Dielectric Unions specified herein.

2.5 BRASS PIPE AND FITTINGS

A. Pipe: ASTM B43, chrome plated.

B. Fittings:

1. ASTM B584, brass.
2. ASTM B16.15.

C. Joints:

1. Mechanical compression.
2. Threaded: Tapered and smooth threads, ASME B1.20.1 and ASTM B43.

D. Dissimilar Metals: See Dielectric Unions specified herein.

2.6 POLYVINYL CHLORIDE (PVC) WATER PIPE AND FITTINGS

A. PVC Pipe and Fittings:

1. 4-inch diameter and smaller:

a. Pipe: ASTM D1785, Schedule 40.
b. Fittings: ASTM D2466, Schedule 40.
c. Joints: Socket, solvent-welded, ASTM D2855.
d. Materials: ASTM D1784, minimum cell classification 12545-C.

2. 6-inch diameter and larger:

a. Pipe: AWWA C900, Class 235.
b. Fittings: AWWA C111, cast iron.
c. Joints: ASTM D3139, compression gasket ring.
d. Materials: ASTM D1784, minimum cell classification 12545-C.

2.7 FLEXIBLE TUBING

A. Polyethylene thermoplastic tubing:

1. Standard weight, conforming to ASTM D1248 Type 1, Class A, Category 4, Grade E5.

2.8 GALVANIZED STEEL PIPE AND FITTINGS

A. Pipe: Seamless, or electric resistance welded, ASTM A53, Schedule 40.

B. Joints: Threaded.

C. Fittings:

1. Threaded, 150 lb. malleable iron, galvanized, ASTM A197 or ASTM A47, dimensions conforming to ANSI B16.3.

2. Unions, 300 lb. malleable iron, galvanized with dimensions conforming to ANSI B16.3, brass to iron seat.

3. Thread lubricant shall be Teflon tape or joint compound that is insoluble in water.

D. Buried Service:

1. Galvanized pipes shall be spirally wrapped with polyvinyl chloride or polyethylene pressure sensitive tape, applied with a suitable primer.

2. The wrap shall have a nominal thickness of 20 mils, consisting of either one layer of 20-mil tape or two separate layers of 10-mil tape.

3. Before the primer and wrap is applied, the piping shall be thoroughly cleaned so that all surfaces shall be dry and free of dirt, dust, rust, oil scale, oil, grease, or other foreign matter.

4. Any solvents used shall be totally volatile so as to leave no trace of oil.

5. Weld spatters, burrs, or sharp points and edges shall be removed by chiseling, ball peening or filling.

6. After thorough cleaning, the piping shall be coated with a primer applied in accordance with the tape manufacturer's recommendations. Spiral wrappings shall be applied with an overlap of at least 1-inch.

2.9 STAINLESS STEEL TUBING AND FITTINGS

A. Type 316 stainless steel, unless otherwise specified or shown in the Plans.

B. Meet the material standards set forth in ASTM A269.

C. Fittings: ASTM A276 and ASTM A182.

1. Threaded fittings: National pipe thread meeting the requirements of ASME B1.20.1.
2. Compression fittings: Two-ferrule, mechanical grip design.

D. Unions: Provide to facilitate installation and maintenance of tubing.

E. Manufacturer:

1. Swagelock, or approved equal.

2.10 STAINLESS STEEL PIPE AND FITTINGS

A. Pipe:

1. Size: 4 inches and smaller, schedule 80, type 304, unless otherwise specified.
2. Conforming to ASME B36.19 dimensions.
3. Conforming to ASTM A312 material requirements.

B. Fittings: Conform to ASME B16.11 dimensions and ASTM A182 material requirements.

C. Threads: Conform to ASME B1.20.1.

D. Socket welds: Conform to ASME B16.11.

2.11 FLEXIBLE COUPLINGS

A. Description:

1. Sleeve-type, couplings. Comply with AWWA C219.

2. Minimum design pressure rating: 150 psi.

3. Middle Ring: As required for coupling based upon connecting pipe materials, steel or ASTM A536, ductile iron.

4. Followers: As required for coupling based upon connecting pipe materials, steel or ASTM A536, ductile iron.

5. Gaskets:

   a. Material: Buna-N.
   b. Comply with ASTM D2000.

6. Bolts:

   a. Buried: Steel.
   b. Submerged: Stainless steel.

7. Center Pipe Stop: Required where shown on the Drawings.

B. Finishes:

1. Buried Couplings, Bolts: Factory epoxy coated.

C. Manufacturers:

1. For ductile iron and steel pipe:

   a. Dresser, Style 38.
   b. Romac, Model 501.
   c. Smith-Blair.

2. For PVC pipe:

   a. Romac, Model 501 or approved equal.

3. For flanged steel and ductile pipe:

   a. Dresser, Style 128 or approved equal.

2.12 RESTRAINED FLANGE ADAPTERS FOR DUCTILE IRON PIPE

A. Description:

1. ASTM A536, ductile iron.

2. Flange bolt circles compatible with ANSI/AWWA C115/A21.15.

3. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges.

4. Capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6-inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

5. Safety factor of 2:1 minimum.

6. Manufacturer:

a. EBAA Iron, Series 2100 Megaflange or approved equal.

2.13 FLANGED INSULATING JOINTS

A. Set shall include a full faced gasket, a full length insulating sleeve for each flange bolt, and two insulating washers and two steel washers for each bolt.

1. Gaskets:

a. Full face, comply with ASME 16.21.

b. Non-asbestos and non-phenolic compressed sheet packing with nitrile rubber binder.

c. Manufacturer: Garlock, Style 3505, or equal.

2. Insulating sleeves:

a. G-10 glass epoxy.

b. Extend the full width of both flanges, except where one flange hole is threaded where the sleeve shall extend through one flange and the gasket.

3. Insulating washers:

a. G-10 glass epoxy.
b. 1/8-inch thickness.

4. Washers:

    a. Buried: Cadmium plated steel.
    b. Submerged: Stainless steel.

B. The complete assembly shall have an ANSI/AWWA pressure rating equal to or greater than that of the flanges between which is installed.

C. After assembly, the joint shall be tested for continuity. Electrical resistance between flanges and between each bolt and each flange shall be not less than 100,000 ohms.

2.14 INSULATING UNION

A. Description:

1. Material: Galvanized malleable iron with a ground joint.

2. Iron pipe threads: Conform to ANSI B2.1.

3. Insulations: Nylon, bonded and molded onto the metal body.

4. Union: Rated for the operating and test pressures of the pipe system.

5. Joint connections to copper alloy pipe and tube shall be copper solder or threaded brass ground joints.

6. Isolation Barrier: Impervious to water.

2.15 BACKFLOW PREVENTERS

A. Manufacturers:

1. Nibco.
2. Watts.

B. Reduced-Pressure Backflow Preventers:

1. Size: 3/4 inch to 2 inches.

2. Comply with AWWA C511.

3. Materials:

    a. Body: Bronze.
    b. Internal Parts: Bronze.
    c. Springs: Stainless steel.

4. Check Valves:

    a. Quantity: Two, operating independently.
    b. Spring loaded.

5. Differential Pressure Relief Valve:

    a. Type: Diaphragm.
    b. Located between check valves.

6. Ball Valves:

    a. Type: Full port, resilient seated.
    b. Quantity: Two.
    c. Operation: Quarter turn.
    d. Material: Bronze.

7. Accessories: Strainer and test cocks.

2.16 DISMANTLING JOINT

A. Description:

1. Comply with AWWA C219, where applicable.

2. Self-contained flanged restrained joint fitting, including both flanged components and sufficient harness bars to withstand the imposed thrust.

3. Design: No part of the restraint system extends outside the flange diameter. The internal bore shall match that of the pipe system.

4. Dismantling joints will allow for a minimum of 2 inches of longitudinal adjustment.

5. Furnish as a complete assembly consisting of spigot piece, flange adaptor, tie bars and gasket.

6. The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system. Tie Rod diameter shall be compatible with the corresponding bolt diameter of the mating flange. The Tie Rod restraint system shall be capable of withstanding the full pressure thrust that the pipe system can develop at no more than 50% of the yield strength of tie rod material.

7. Pressure Rating:

    a. Determined by the flange configuration, and all commonly used flanges shall be available.

b. Design pressure rating shall be equal to or greater than the mating flanges.

c. Dismantling joints will be specially fabricated to accommodate pressure requirements with ANSI B16.5 or ANSI B16.47 300-pound class flanges, depending on size of dismantling joint.

8. Lining and Coating:

a. Shop-applied fusion bonded epoxy coating applied by fluidized bed method, complying with the requirements of NSF 61 and AWWA C550 as applicable.

b. As an alternative, a shop-coat primer suitable for field applied coatings can be supplied.

9. Flanges: Flat-faced, rated to pressure requirements as shown on the Drawings.

a. Where design pressure is greater than 300 psi, flanges shall conform to ASME B16.5 and ASME B16.47 300-pound class.

B. Materials:

1. Spigot piece: Steel, ASTM A283 Grade C.

2. Flange adaptor:

a. Up to 12-inch diameter: Ductile iron, ASTM A536 Grade 65-45-12.
b. Above 12-inch diameter: Steel, ASTM A283 Grade C.

3. Tie bars: ASTM A193 Grade B7 threaded rod with rolled threads.

4. Gasket: EPDM Grade E.

5. Nuts, Bolts and Washers: Type 304 stainless steel.

C. Manufacturer:

1. Romac or approved equal.

2.17 PIPE SUPPORTS

A. Floor Support for Pipe:

1. Flanged Pipe Support:

a. Construction:

1) Adjustable vertical pipe support, flange plate, extension pipe from base cup to top collar cup with threaded stud.

2) Bolts directly to flange.

3) Anchorable base plate.

b. Material: Steel, comply with ASTM A36.

c. Finish: Corrosion resistant, electro-galvanized or prime coated.

d. Manufacturers:

1) Standon - Model S89.

2. Cradle Pipe Support:

a. Construction:

1) Adjustable vertical pipe support with saddle strap, extension pipe from base cup to top collar cup with threaded stud.

2) Anchorable base plate.

b. Material: Steel, comply with ASTM A36.

c. Finish: Corrosion resistant, electro-galvanized or prime coated.

d. Manufacturers:

1) Standon - Model S92.

2.18 PIPE PENETRATIONS

A. Sleeves for Pipes through Walls and Floors:

1. Material: Galvanized steel.

2. Thickness: Schedule 40.

3. Inside surface of all wall sleeves shall be coated with coal-tar.

4. Annular space between penetrating pipe and wall sleeve shall be filled with an approved permanently flexible sealant.

5. Diameter of wall sleeve shall be as shown in the Drawings.

B. Mechanical Sleeve Seals:

1. Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve,

connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2. Manufacturer: Link-Seal or approved equal.

C. Pipes Cast-In Walls and Floors:

1. Material: Ductile iron or steel pipe, as required by the Drawings and the intended service.

2. Diameter: As shown in the Drawings.

3. End Type: As shown in the Drawings.

D. Seep Rings:

1. Material: 3/8-inch thick steel plate conforming to ASTM A36, unless otherwise noted.

2. Inside diameter: Equal to the outside diameter of the pipe or sleeve to which it is attached plus 1/4-inch.

3. Outside diameter: As shown in the Drawings.

4. Attach to the pipe or sleeve by means of a continuous seal weld located on both sides of the ring.

2.19 PIPE COATINGS

A. See Section 09 90 00, Painting and Coatings.

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.

3.2 INSTALLATION

A. Buried Piping Systems:

1. Establish elevations of buried piping with not less than 3 feet of cover.

2. Remove scale and dirt from inside of piping before assembly, as may be required.

3. Excavate pipe trench as specified in Section 31 23 17, Trenching.

4. Install pipe to accurate lines, elevations, and grades as shown on the Drawings.

5. Where grades are not shown, pipe shall be laid to grade between control elevations shown on the Drawings.

6. Place bedding material at trench bottom to provide uniform bedding for piping.

7. Level bedding material in one continuous layer not exceeding 6 inches compacted depth.

8. Install pipe on prepared bedding.

9. Route pipe in straight line.

10. Install pipe to allow for expansion and contraction without stressing of pipe or joints.

11. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.

12. Pipe Cover and Backfilling:

    a. Backfill trench as specified in Section 31 23 17, Trenching.

13. All buried non-ferrous piping shall be installed with detectable tracer tape.

    a. Tape shall be buried 12 inches above the top of the pipe or as recommended by manufacturer.

    b. Tape shall be continuous and labeled the same as the piping system.

B. Interior Piping Systems:

1. Install non-conducting dielectric connections wherever joining dissimilar metals.

2. Establish elevations of buried piping outside valve vault to obtain not less than 3 feet of cover.

3. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting as specified in Section 09 90 00, Painting and Coating.

4. Install water piping according to ASME B31.9.

5. Install unions downstream of valves and at equipment or apparatus connections.

6. Install brass male adapters each side of valves in copper piped system; solder adapters to pipe.

C. Backflow Preventer Assemblies:

1. Install backflow preventers of type, size, and capacity indicated.
2. Comply with applicable code and authority having jurisdiction.
3. Install air-gap fitting on units with atmospheric vent connection.
4. Pipe relief outlet drain to nearest floor drain.
5. Do not install bypasses around backflow preventers.

D. Pipe Supports and Hangers

1. Install pipe supports according to MSS SP-58 & ASME B31.10.

2. All pipe shall be secured in place by use of blocking, hangers, brackets, clamps or other approved methods, and the weight thereof shall be carried independently of pump casings or equipment.

3. Special hangers and supports are shown on the Drawings.

4. The Contractor shall be responsible for determining the location of and providing all additional supports.

5. Hanger supports shall be as noted below with at least one support adjacent to the joint for each length of pipe, at each change in direction and at each branch connection. Sufficient hangers shall be provided to maintain proper slope without sagging. Support spacing shall not exceed manufacturer's recommendations, nor as listed below.

Pipe	Maximum Support Spacing (Feet)
Steel Pipe	
Under 3 inches	6
3 inches and Over	12
Cast or Ductile Iron	
Under 4 inches	6
4 inches and Over	12
Stainless Steel and Galvanized Iron	

Under 1-1/2 inches	4
1-1/2 inches to 4 inches	6
Over 4 inches	12
Copper Pipe	6
PVC Pipe	
Under 2-1/2 inches	4
2-1/2 inches and Over	6

6. Spacing of clamps for support of vertical piping shall be close enough to keep the pipe in alignment as well as to support the weight of the piping and contents unless other vertical support is shown, but in no case shall be more than 12 feet.

7. Provide adjustable hangers for all pipes, complete with adjusters, swivels, rods, etc. Size hangers to clear insulation and guide where required, as well as support piping. All rigid hangers shall provide a means of vertical adjustment after erection. Hanger rods shall be machine-threaded. Continuous threaded rods will not be allowed.

8. Clevis or band-type hangers (B-Line FIG B3100) or approved equal shall be provided as required. Strap hangers not permitted.

9. Provide floor stands, wall bracing, concrete piers, etc., for all lines running near the floors or near walls and which cannot be properly supported or suspended by the walls or floors. Pipe lines near concrete or masonry walls may also be hung by hangers carried from wall brackets at a higher level than pipe. Hanging of any pipe from another is prohibited.

10. Equipment shall be positioned and aligned so that no strain shall be induced within the equipment during or subsequent to the installation of pipework.

11. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work.

E. Pipe Penetrations:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals or grout, as shown in the Drawings.

2. Whenever a pipe line of any material terminates at or through a structural wall or floor, install piping or sleeve in advance of pouring of concrete required for the particular installation.

3. Plastic pipe shall not be cast in concrete or masonry walls.

4. Set sleeves in position in forms and provide reinforcing around sleeves.

5. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.

6. Extend sleeves through floors 1 inch above finished floor level and caulk sleeves.

7. Pipe other than concrete, to be cast in water-bearing walls or more than four feet below grade shall have seep rings.

8. All buried piping entering structures shall have a flexible connection installed less than two feet outside the structure line or as close to the wall as practical.

3.3 CLEANING, TESTING AND DISINFECTION

A. Testing and Disinfection: Piping shall be hydrostatically tested, flushed and disinfected as specified in Section 33 13 00, Testing and Disinfection Water Utility Pipelines.

END OF SECTION

SECTION 40 05 23

COMMON WORK RESULTS FOR PROCESS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes basic materials and methods related to valves commonly used for process systems, including pump stations, utility vaults and water treatment.

B. Section Includes:

1. Valves.
2. Valve actuators.

1.2 RELATED SECTIONS

A. Section 03 30 00, Cast-in-Place Concrete.
B. Section 05 50 00, Metal Fabrications.
C. Section 09 90 00, Painting and Coating.
D. Section 33 11 10, Water Utility Distribution Piping.
E. Section 33 12 16, Water Utility Distribution Valves.
F. Section 40 05 13. Common Work Results for Process Piping.
G. Section 40 05 23.15, Gate Valves.
H. Section 40 05 23.18, Butterfly Valves
I. Section 40 05 23.72, Miscellaneous Valves

1.3 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. Through 72 In.

2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

3. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.

4. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.

5. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International (ASTM):

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.

D. National Electrical Manufacturers Association (NEMA):

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC).

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 COORDINATION

A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

1.5 SUBMITTALS

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

B. Product Data:

1. Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

2. Submit valve cavitation limits.

3. Submit manufacturer data for actuator with model number and size indicated.

C. Shop Drawings:

1. Submit description of proposed installation, including associated wiring diagrams and electrical data as may be specified elsewhere in the contract documents.

2. Provide assembly drawings indicating parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams and control system schematics.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.

F. Lining and coating data.

G. Valve Labeling Schedule: Indicate valve locations and nametag text.

H. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

I. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and actuators.

B. Operation and Maintenance Data: Submit information for valves.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

B. Tools:

1. Furnish special wrenches and other devices required for Owner to maintain equipment.

2. Furnish compatible and appropriately labeled toolbox when requested by Owner.

1.8 QUALITY ASSURANCE

A. Cast manufacturer's name, pressure rating, size of valve and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Maintain clearances as indicated on Drawings and Shop Drawings.

E. Unless otherwise noted, all water works materials provided for the Project shall be new, of first class quality and shall be made by reputable manufacturers.

F. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

D. Handle products carefully to prevent damage to interior or exterior surfaces.

E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required and shown in the Drawings.

B. Operation:

1. Open by turning counterclockwise; close by turning clockwise.

2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

C. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.

D. Connecting Nuts and Bolts: Stainless steel.

2.3 RESILENT-SEATED GATE VALVES

A. As specified in Section 40 05 23.15, Gate Valves.

2.4 RUBBER-SEATED BUTTERFLY VALVES

A. As specified in Section 40 05 23.18, Butterfly Valves.

2.5 VALVE ACTUATORS

A. All valves shall be furnished with manual actuators, unless otherwise indicated in the Drawings.

B. Valves in sizes up to and including four inches in diameter shall have direct acting lever or handwheel actuators of the manufacturer's best standard design.

C. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

D. Provide actuators with position indicators for shutoff valves 6 inches and larger.

E. For exposed in-plant valves that require remote indication of valve position per the design, provide actuators with Manufacturer's standard limit switch assembly for remote indication of open or closed valve position.

F. Comply with AWWA C541 and C542, where applicable.

G. Furnish gear operators for valves 8 inches and larger, and chainwheel operators for valves mounted over 7 feet above floor.

H. Provide gear and power actuators with position indicators.

I. Gear-Assisted Manual Actuators:

1. Provide totally enclosed gears.

2. Maximum Operating Force: 60 lbf.

3. Bearings: Permanently lubricated bronze.

4. Packing: Accessible for adjustment without requiring removal of actuator from valve.

J. Handwheel:

1. Furnish permanently attached handwheel for emergency manual operation.

2. Rotation: None during powered operation.

3. Permanently affix directional arrow and cast OPEN or CLOSE on handwheel to indicate appropriate direction to turn handwheel.

4. Maximum Operating Force: 60 lbf.

K. Valve Actuators in NEC Class I, Group D, Division 1 or 2 Hazardous Locations: UL approved.

L. Electric Motor Actuators:

1. Not used.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping system is ready for valve installation.

3.2 PREPARATION

A. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.

B. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.3 INSTALLATION

A. Install valves, actuators, extensions, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Coat studs, bolts, and nuts with anti-seizing lubricant.

D. Clean field welds of slag and splatter to provide a smooth surface.

E. Install valves with stems upright or horizontal, not inverted.

F. Install valves with clearance for installation of insulation and allowing access.

G. Provide access where valves and fittings are not accessible.

H. Comply with Section 40 05 13, Common Work Results for Process Piping for piping materials applying to various system types.

I. Valve Applications:

1. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.

2. Install shutoff and isolation valves.

3. Isolate equipment, part of systems, or vertical risers as indicated on Drawings.

4. Install valves for throttling, bypass, or manual flow control services as indicated on Drawings.

J. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

3.4 FIELD QUALITY CONTROL

A. Valve Field Testing:

1. Test for proper alignment.

2. If specified by valve Section, field test equipment to demonstrate operation without undue leakage, noise, vibration, or overheating.

3. Engineer will witness field testing.

END OF SECTION

SECTION 40 05 61 - GATE VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes gate valves for use in buried service, vaults, and building plant piping. Coordinate with Section 33 12 16, Water Utility Distribution Valves and Section 40 05 23, Stainless Steel Process Pipe and Tubing.

B. Section Includes:

1. Resilient-seated gate valves.
2. General duty gate valves smaller than 3 inches.

1.2 RELATED SECTIONS

A. Section 33 12 16, Water Utility Distribution Valves
B. Section 33 11 10, Water Utility Distribution and Transmission Piping
C. Section 40 05 13, Common Work Results for Process Piping
D. Section 40 05 51, Common Requirements Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International (ASTM):

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

3. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. American Water Works Association (AWWA):

1. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
2. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants.

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
2. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

E. NSF International (NSF):

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

1.4 SUBMITTALS

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

B. As required by Section 33 12 16 - Water Utility Distribution Valves and/or Section 40 05 51, Common Requirements Results for Process Valves.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RESILIENT-SEATED GATE VALVES

A. Description:

1. Comply with AWWA C509.

2. Minimum Pressure Rating:

a. Twelve-inch Diameter and Smaller: 200 pounds per square inch (gauge) (psig).
b. Sixteen-inch Diameter and Larger: 150 psig.

3. End Connections: As shown in the Drawings.

    a. Standard mechanical joint ends comply with ANSI/AWWA C111.

    b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125. Comply with AWWA C115 & ASME 16.5.

        1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.

4. Gear Actuators: Conforming to AWWA C509 for manual valves.

5. Linings and Coatings:

    a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

    b. All internal and external ferrous surfaces.

    c. Do not coat flange faces of valves.

6. Bi-directional flow.

B. Operation:

1. Non-rising stem.

2. Open counterclockwise when viewing the valve from above, unless otherwise indicated in the Drawings.

3. Buried Valves: All buried valves shall be provided with 2-inch square operating nuts.

4. In-Plant Service Valves: Valves for in-plant or exposed service shall be furnished with handwheel operators, unless otherwise specified in Section 40 05 51, Common Requirements Results for Process Valves.

C. Materials:

1. Wedge:

    a. ASTM A126, cast iron or ASTM A536, ductile iron.

    b. Fully encapsulated with molded rubber.

2. Body and Bonnet:

    a. ASTM A126, cast iron or ASTM A536, ductile iron.

3. Stem, Stem Nuts, Glands, and Bushings: ASTM B584, bronze.

4. Valve Body Bolting: Stainless steel.

D. Manufacturers:

1. Clow Valve Company.
2. M&H Valve.
3. U.S. Pipe.
4. American Flow Control.
5. Mueller Company.

2.3 GENERAL-DUTY GATE VALVES - SMALLER THAN 3 INCHES

A. Two inches and Smaller:

1. MSS SP 80, Class 125.
2. Body and Trim: ASTM B584, bronze.
3. Bonnet: Union.
4. Operation: Handwheel.
5. Inside screw [with back-seating stem].
6. Wedge Disc: Solid; ASTM B584, bronze.
7. End Connections: Threaded.

B. Two and one-half inches to 3 inches:

1. MSS SP 70, Class 125.
2. Stem: Non-rising.
3. Body: ASTM A126, cast iron.
4. Trim: Bronze.
5. Bonnet: Bolted bonnet.
6. Handwheel, outside screw and yoke.
7. Wedge Disc: Solid, with bronze seat rings.
8. End Connections: ASME B16.1, ASME B16.5, ASME B16.42, flanged.

2.4 SOURCE QUALITY CONTROL

A. Testing: Test gate valves according to AWWA C509.

PART 3 EXECUTION

3.1 INSTALLATION

A. As required by Section 33 12 16, Water Utility Distribution Valves and/or Section 40 05 51 - Common Requirements Results for Process Valves.

B. Install according to manufacturer's instructions.

C. Support valves in plastic piping to prevent undue stresses on piping.

END OF SECTION

SECTION 40 05 64 - BUTTERFLY VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes butterfly valves for use in buried and plant service. Coordinate with Section 33 12 16, Water Utility Distribution Valves and Section 40 05 51, Common Requirements Results for Process Valves.

B. Section Includes:

1. Rubber-seated butterfly valves.

1.2 RELATED SECTIONS

A. Section 33 12 16, Water Utility Distribution Valves
B. Section 33 11 10, Water Utility Distribution and Transmission Piping.
C. Section 40 05 13, Common Work Results for Process Piping.
D. Section 40 05 51, Common Requirements Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

B. ASTM International (ASTM):

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

4. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. American Water Works Association (AWWA):

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).

2. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants.

D. NSF International (NSF):

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects

2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

1.4 SUBMITTALS

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

B. As required by Section 33 12 16 - Water Utility Distribution Valves and/or Section 40 05 51, Common Requirements Results for Process Valves.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RUBBER-SEATED BUTTERFLY VALVES

A. Description:

1. Comply with AWWA C504, Class 150B and 250B as indicated in the Drawings.

2. Minimum Pressure Rating:

a. Twelve-inch (300-millimeter) Diameter and Smaller: 200 pounds per square inch (gauge) (psig).

b. Sixteen-inch (400-millimeter) Diameter and Larger: 150 psig.

3. End Connections: As shown in the Drawings.

a. Standard mechanical joint ends comply with ANSI/AWWA C111.

b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125, unless shown otherwise. NTS: Class 125 drilling is typically desired for Class 250 valves. Comply with AWWA C115 & ASME 16.5.

1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.

4. Gear Actuators: Conforming to AWWA C504 for manual valves.

5. Linings and Coatings:

a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

b. All internal and external ferrous surfaces.

c. Do not coat flange faces of valves.

6. Bubble-tight at the rated pressure for bi-directional flow.

7. Style: Wafer.

8. Shaft: Self-lubricating, sleeve-type bearings. One-piece, through-shaft construction.

a. Valve shafts shall be full size for that portion of the shaft extending through the valve bearings, valve disc, and shaft seal.

b. Any portion of the shaft turned down for any reason shall have fillets with radii equal to the offset to minimize stress concentrations at the junction of the different shaft diameters. The turned down portion of the shaft shall be capable of transmitting the maximum operator torque without exceeding a torsional steel stress of 11,500 pounds per square inch (psi).

9. Seats: Mounted on body for valves 24 inches and smaller; field replaceable (mechanically retained in a machined groove) for valves larger than 24 inches.

10. Packing: Replaceable without dismantling valve.

B. Operation:

1. Open counterclockwise, unless otherwise indicated in the Drawings.

2. Operators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between full open and fully closed without creeping or fluttering.

3. Buried Valves: All buried valves shall be provided with 2-inch square operating nuts.

4. In-Plant Service Valves: Valves for in-plant or exposed service shall be furnished with handwheel operators, unless otherwise specified in Section 40 05 51, Common Requirements Results for Process Valves.

C. Materials:

1. Body: ASTM A126, cast iron or ASTM A536, ductile iron. Integrally cast flanged or mechanical end joints.

2. Shaft: Stainless steel.

3. Disc: ASTM A126, cast iron or ASTM A536, ductile iron.

4. Seats: Resilient, replaceable, Buna-N.

5. Seating Surfaces: Type 316 stainless steel.

6. Bearings:

a. Sleeve: Corrosion-resistant and self-lubricating.

D. Manufacturers:

1. M&H Valve.
2. Henry Pratt Company.
3. Mueller Company.
4. Kennedy Valve Company.
5. Dezurik.
6. Val-Matic Valve & Manufacturing Corporation.

2.3 SOURCE QUALITY CONTROL

A. Testing: Test butterfly valves according to AWWA C504.

PART 3 EXECUTION

3.1 INSTALLATION

A. As required by Section 33 12 16, Water Utility Distribution Valves and/or Section 40 05 51 - Common Requirements Results for Process Valves.

B. Install according to manufacturer's instructions.

END OF SECTION

SECTION 40 05 23.24

CHECK VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Work in this Section includes check valves for use in water facilities. Work includes the furnish and install of all swing and silent check valves, complete, as shown on the Drawings and specified herein, including coating and lining, appurtenances, operators, and accessories.

B. Section includes:

1. Swing check valves, 4-inch diameter and larger
2. Silent check valves
3. Spring check valves

1.2 RELATED SECTIONS:

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings.

B. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.

5. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

6. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

7. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.

8. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

C. American Water Works Association:

1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.

D. National Sanitation Foundation International:

1. NSF 61 - Drinking Water System Components - Health Effects.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. As required by Section 40 05 23, Common Work Results for Process Valves.

PART 2 PRODUCTS

2.1 SWING CHECK VALVES, 4-INCH DIAMETER AND LARGER

A. Description:

1. Meeting requirements of AWWA C508.

2. Type: Swing, resilient-seated, with outside lever and adjustable spring.

3. Flow Area: Full open.

4. Mounting: Horizontal or vertical.

5. Shall close tightly when the pressure downstream of the valve disc exceeds the upstream pressure.

6. Working Pressure: 150 psi

7. Tight sealing, shockless in operation and absolutely prevent the return of water back through the valve.

8. The disc shall be attached to the sic arm by means of a center pin, disc nut and washer providing 360-degree angular articulation but not rotation.

9. Pin Shaft:

    a. Discs shall be suspended from a non-corrosive hinge pin shaft that shall rotate freely without the need for external lubrication.

    b. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable packing.

10. End Connections: As shown on Drawings. End connections shall be rated to the working pressure requirements specified above.

B. Materials:

1. Body and Disc: Constructed of heavy cast iron conforming to ASTM A126 class B, or ductile iron conforming to ASTM A536.

2. Cover: Steel conforming to ASTM A36 or Ductile iron conforming to ASTM A536.

3. Disc Arm: Ductile iron conforming to ASTM A536.

4. Body Seat: Type 316 stainless steel or Bronze ASTM B62.

5. Disc Seat: Field-replaceable, NBR or Buna-N.

6. Hinge Pin and Key: Stainless steel.

7. Rubber Components: NBR or Buna-N.

8. Connecting Hardware: Stainless steel.

C. Finishes:

1. Epoxy lining and coating conforming to AWWA C210.

2. For potable water service, epoxy lining and coating shall meet be provided with NSF 61 certification.

D. Manufacturer:

1. Val Matic Series 7800
2. GA Industries, Figure No. 220-D.
3. Cla-Val, 585 Series.
4. Approved equal.

2.2 SOURCE QUALITY CONTROL

A. Testing:

1. Hydrostatically test check valves at twice rated pressure, in conformance with requirements of AWWA C508.

2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install check valves according to AWWA C508 and as recommended by manufacturer.

3.2 SERVICES PROVIDED BY MANUFACTURER'S REPRESENTATIVES

A. Provide the services of the valve manufacturer's representative to verify proper installation of the valves and to adjust the valves when construction is complete.

END OF SECTION

SECTION 40 05 23.72 - MISCELLANEOUS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes miscellaneous valves not included in other Sections for use in buried service, pump stations, utility vaults, and water and wastewater treatment plants.

B. Section Includes:

1. Mud valves.
2. Solenoid valves.
3. Air release valves.
4. Combination air/vacuum valves.
5. Blow-off hydrant assemblies.
6. Flap valves.
7. Shear gates.
8. Ball valves, 2 inches and under.

1.2 RELATED SECTION

A. Section 05 50 00, Metal Fabrications
B. Section 09 90 00, Painting and Coating
C. Section 33 11 10, Water Utility Distribution and Transmission Piping.
D. Section 40 05 13, Common Work Results for Process Piping.
E. Section 40 05 51, Common Requirements Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.

4. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

5. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International (ASTM):

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

1.4 COORDINATION

A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

1.5 SUBMITTALS

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

B. Product Data:

1. Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

2. Submit valve cavitation limits.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling Schedule: Indicate valve locations and nametag text.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and actuators.
B. Operation and Maintenance Data: Submit information for valves.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

B. Tools:

1. Furnish special wrenches and other devices required for Owner to maintain equipment.

2. Furnish compatible and appropriately labeled toolbox when requested by Owner.

1.8 QUALITY ASSURANCE

A. Cast manufacturer's name, pressure rating, size of valve, and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Maintain clearances as indicated on Drawings.

E. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.

F. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

D. Handle products carefully to prevent damage to interior or exterior surfaces.

E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 MUD VALVES

A. (not used)

2.3 SOLENOID VALVES

A. Solenoid valves shall be normally closed (energize to open) unless otherwise specified. The valves shall have a minimum operating pressure differential of five (5) psi and a maximum operating pressure differential of 125 psi. The valves shall have a minimum Cv flow factor of 5. The valves shall have threaded ends and be constructed of the following materials: brass body; copper shading coil; Type 305 stainless steel core tube; Type 430F stainless steel core and plug nut; and Type 302 stainless steel springs. The solenoid enclosure shall be watertight NEMA 4X. Operating voltage shall be 120VAC unless otherwise specified. Power consumption: 6.1 watts or less with inrush of 40 VA maximum and holding power of 16 VA maximum. Manufacturer ASCO, Series 8210.

All solenoid valves shall have a manual operator to permit actuation of the solenoid valve in the absence of power

2.4 AIR RELEASE VALVES

A. Description:

1. Inlet Size: 2-inch diameter and smaller.
2. Cast-iron body and cover. Comply with ASTM A126, Class B.
3. Stainless steel orifice and float. Comply with ASTM A240.
4. Design test pressure: 450 psig.

B. Manufacturers:

1. DeZurik - APCO Series 200A or approved equal.

2.5 COMBINATION AIR/VACUUM VALVES

A. Description:

1. Construction: Two independent valves: one air/vacuum valve, one air release valve.
2. Inlet Size: Greater than 2-inch diameter.
3. Cast iron body and cover. Comply with ASTM A126, Class B.
4. Stainless steel orifice and float. Comply with ASTM A240.
5. Valves seats: Buna-N.

B. Manufacturers:

1. DeZurik - APCO Series 1700 or approved equal.

2.6 BLOW-OFF HYDRANT ASSEMBLIES

A. (not used)

2.7 FLAP VALVES

A. Description:

1. Material: ASTM A126, cast iron.
2. Seat and hinge pin: Bronze.
3. End connection: 125-pound flange, unless otherwise noted on the Drawings.
4. Two pivot points.
5. Valves 14-inches and smaller shall have the hinge pin secured with cotter pins.
6. Valves 16-inches and larger shall have the hinge pin secured with nuts.

B. Manufacturers:

1. M & H, Style 47 or approved equal.

2.8 SHEAR GATES

A. (not used)

2.9 BALL VALVES, 2 INCHES AND UNDER

A. Description:

1. Four hundred-pound. Water, oil, and gas rating (WOG) with bronze body and trim, unless otherwise shown on the Drawings.

2. Seat ring: Tetrafluoroethylene (TFE).

3. O-ring seals: Fluorocarbon.

4. Three-piece construction so that maintenance can be performed without distributing the valve body after installation.

B. Manufacturer:

1. Nibco T-590-Y or equal.

2.10 SOURCE QUALITY CONTROL

A. Testing Pressure-Reducing and Pressure-Sustaining Valves:

1. Leakage Testing:

a. Test each assembled valve hydrostatically at 1-1/2 times rated working pressure for minimum five minutes.

b. Test each valve for leakage at rated working pressure against closed valve.

c. Permitted Leakage: None.

2. Functional Testing:

a. Test each valve to verify specified performance.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install valves per manufacturer requirements and recommendations.

B. Install all valves with valve seats level.

C. Install protective strainers upstream of solenoid valves, pressure-reducing valves, and pressure-sustaining valves.

END OF SECTION

SECTION 40 06 70 - SCHEDULES OF INSTRUMENTATION FOR PROCESS SYSTEMS

INSTRUMENT	OPTIONS	Spec. Section
SYSTEM FLOWTUBE & TRANSMITTER	CAL: 0 TO 2000 GPM	40 71 13
SYSTEM PRESSURE TRANSMITTTER	CAL: 0 TO 100 PSI	40 73 26
WELL SUBMERSIBLE LEVEL TRANSDUCER	CAL: 0 TO 300 FT	40 72 43
STORMWATER LEVEL TRANSDUCER	CAL: 0 TO 30 FT	40 72 43
STORMWATER MANHOLD LEVEL FLOATS		40 72 76

END OF SECTION

SECTION 40 71 13 - MAGNETIC FLOW METERS

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
8. Manufacturer's Services

1.2 SCOPE

A. This Section specifies requirements for supply and installation of the Magnetic Flow Meters measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required 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. 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.

B. The manufacturer of the flow sensor and transmitter shall provide a 1-year extended warranty in addition to the warranty specified above.

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.

1) Must include:

a) Dimensional Drawings
b) Materials of Construction

(1) Sensor
(2) Liner
(3) Electrodes
(4) Process Connection

2) Accuracy

3) Range

4) Enclosure Rating

5) Classification Rating

6) Power Requirements

7) Output Options

C. Manufacturer's installation instructions, including mounting requirements.

D. Operation and maintenance information.

E. Warranty information.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Flow Meter candidate manufacturers and models:

1. Siemens Sitrans FM mag 5100W flow sensor with integral MAG 6000 transmitter.
2. No exceptions.

2.2 GENERAL

A. Magnetic flow meter provided as a system consisting of a flow tube with locally or remotely mounted converter / indicating transmitter as listed in the instrument schedule or as shown on the drawings. Meters to be provided with all required interconnecting cables between flow tube and transmitter.

2.3 FULL PIPE FLOW METERS

A. Flow Tube:

1. The flow meter shall be microprocessor based and possess a method in which to store the sensor calibration and transmitter setup information in non-volatile memory. The electronics shall be interchangeable for meters sizes 1" – 120"

2. The sensor shall consist of a stainless-steel flow tube with ANSI B16.5 or AWWA C207 carbon steel or stainless-steel flanges. The flanges shall carry Class 150 or 300 for 24" and smaller, and AWWA Class D for 28" and larger as specified.

3. The sensor tube shall be lined with polyurethane.

4. The sensor shall house two measuring electrodes, a grounding electrode, and one for physical empty pipe detection. The electrodes shall be made of 316L SS.

5. The full-bore magnetic flowmeter in sizes 1"-120" shall maintain zero pressure loss while achieving 0.5% of rate accuracy even when mounted directly before or after a piping elbow, T-fitting or insertion device. This flow tube shall have four measuring electrodes (sizes 1-2.5") and six measuring electrodes (sizes 3"-120") plus a grounding electrode and an empty pipe electrode.

6. The external sensor housing shall enclose the coil assemblies and internal wiring. The materials shall be designed and constructed to prevent moisture ingress and promote corrosion resistance.

7. Process Connection: Flange, ANSI B16.5, Class 150, raised face.

8. Flow tubes shall be pressure rated from full vacuum to 300 psig, unless otherwise noted.

9. Flow tube sizes below 2 inches may be wafer-style ductile-iron or full-body flanged construction.

10. Grounding Ring required and must be provided with flow meter.

11. The sensor shall be rated for NEMA 6P/IP68 service and shall allow for permanent immersion in water depths up to 10 feet.

12. Materials:

    a. Flow Tube: Stainless steel.
    b. Flange: Stainless steel or epoxy coated steel
    c. Electrodes: 316 L stainless steel
    d. Grounding Rings: Same metal as for the electrodes
    e. Liner: Polyurethane

B. Indicating Transmitter:

1. The transmitter shall be a three-stage microprocessor controller mounted remotely as specified in the instrument schedule. The transmitter shall operate on AC (100 to 240V) or DC (24 V) via a dedicated or universal power supply as specified. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

2. The measurement signals from the sensor shall be conducted up to 1,000 feet to the transmitter.

3. The transmitter display shall indicate simultaneous flow rate and total flow with three Totalizers (eg. forward, reverse and net total) and user-selectable engineering units, readout of diagnostic remedy messages.

4. 4-20 MA output proportioned to flow range.

5. The transmitter shall internally retain all setup parameters, calibration parameters and accumulated measurements in non-volatile memory in the event of power failure.

6. Pulse output selectable settable for flows from 1 to 500 gallons per pulse.

7. Hazardous Approval for installation is Class I Div 1 areas.

    a. FM &CSA approved

8. Internal circuitry to drive flow signal to zero upon flow meter determined empty pipe condition.

2.4 PARTIAL PIPE FLOW METERS

A. Flow Tube:

1. Flow meter shall operate on electromagnetic induction principle for velocity and capacitance principle for level measurement. Output signal shall be directly

proportional to the liquid rate of flow at pipe filing levels between 10% and 100% of pipe cross-section.

a. When partly filled:v @ Full Scale ≥ 1 m/s / 3.3 ft/s: ≤ 1% of FS

b. When fully filled: v ≥ 1 m/s / 3.3 ft/s: ≤ 1% of MV; v < 1 m/s / 3.3 ft/s: ≤ 0.5% of MV + 5 mm/s / 0.2 inch/s

c. Minimum Level: 10% of inner diameter

2. The sensor shall consist of a stainless-steel flow tube with ANSI B16.5 or AWWA C207 carbon steel or stainless-steel flanges. The flanges shall carry Class 150 or 300 for 24" and smaller, and AWWA Class D for 28" and larger as specified.

3. Flow tube sizes below 2 inches may be wafer-style ductile-iron or full-body flanged construction.

4. Grounding Ring required.

5. Materials:

a. Flow Tube: Austenitic Stainless steel.
b. Flange: Stainless steel or polyurethane coated steel.
c. Electrodes: Hastelloy
d. Grounding Rings: Stainless Steel – made to match inner diameter of pipe
e. Liner: Polyurethane

B. Indicating Transmitter:

1. Transmitter to be remotely mounted as shown on the plans.

2. Power Supply standard 12 to 24 VDC @ 12 W

3. System error shall not exceed the greater of +/- 0.5% of flow rate or 0.1 foot per second from 3 to 30 feet per second.

4. IP 68 enclosure

5. 4-20 MA output proportioned to flow range and capable of supporting a 100-ohm load

6. Pulse output selectable from 1 to 5000 gallons per pulse.

a. Pulse output shall be a dry contact compatible with PLC input module.

7. Provide Ethernet/IP communication port that makes available all flow meter data.

8. FM & CSA approved

9. Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4X, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry.

10. Cable: Signal cable between the flow tube and transmitter provided by the system manufacturer with sufficient length of cable for continuous installation between the flow tube and the transmitter.

11. 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all components of Magnetic Flow Meters system in accordance with manufacturer's specifications and instructions for the specified functional requirements.

B. Ensure proper installation of the Magnetic Flow Meters system so as to not result in false reading due to ambient conditions or equipment at the installation site.

C. Comply with mounting details provided on the drawings.

3.2 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

B. On-site testing shall be documented and shall comply with the requirements of Section 01 75 00.

C. Certified copies of the factory calibration certificates shall be provided for each flow meter.

3.3 MANUFACTURER'S SERVICES

A. CONTRACTOR shall provide the services of the manufacturer's representative to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 72 43 - PRESSURE TYPE LEVEL TRANSDUCERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance.
4. Submittals.
5. Products Requirements.
6. Installation.
7. Testing.

1.2 SCOPE

A. This Section specifies requirements for supply and installation of Pressure and Differential type level measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required 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. 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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Pressure Transmitter candidate manufacturers and models:

1. Druck, model PTX 1830,

2. Endress + Hauser, FMX21 series,

3. TE Connectivity KPSI 735 series,

4. Approved equal by Project Engineer.

5. To conform to specified requirements, the manufacturer’s standard product may require modification.

2.2 GENERAL

A. Level shall be sensed and transmitted by a submersible type pressure transmitter. Level measurement provided as a system consisting of a pressure transmitter, sensor termination enclosure with desiccant and waterproof vent, integral cable, hanger and weight.

B. The Contractor shall supply weights as necessary to ensure that the pressure transducer will hang straight down the well and not float in the well water column.

C. The unit shall be purchased with sufficient length to set the transmitter at 1 foot above the pump as indicated on the Drawings and extend to the junction box as shown on the Plans, with a spare 10 feet of cable.

2.3 FEATURES

A. Process Connection: Sealed/Submersible in media.

B. System error shall not exceed ± 0.25% of level range

C. Combined non-linearity, hysteresis, and repeatability accuracy of 0.1% of full scale.

D. Where slurry or solids are present:

1. Non-fouling, integral protective cage, non-clogging 2.75" PTFE coated Elastomeric diaphragm.

E. Temperature Range: -20 to 60 ºC (Operating), 0 to 50ºC (Compensated).

F. Environmental Ratings:

1. Transmitter and cable: IP 68, NEMA 6P.
2. Junction Box: IP 66, NEMA 4.

G. Transmitter Materials:

1. Body: Welded 316 stainless steel.
2. Cable: FMK Polyurethane or ETFE.

H. Cable Hanger Materials: 304 stainless steel.

I. Weight Materials: Stainless steel, brass, or other material that will not corrode, and will not contaminate the water supply well. Lead weights are not acceptable.

J. Transmitter to be FM approved for Class I & II, Div. 1 Groups A, B, C & D.

K. Transmitter shall be supplied with a sensor termination enclosure with desiccant and waterproof vent. Sensor and termination enclosure shall be of same manufacturer and intended for use with each other.

2.4 ELECTRICAL REQUIREMENTS

A. Input current: 20 mA max (loop Power)

B. Signal Output: 4-20mA, 0-5 VDC, 0-2.5VDC Analog signal. Signal shall change in direct linear proportional to changes in measured level.

C. Insulation resistance: 100 Mega Ω @ 500 VDC Capable of withstanding a 600 Volt spike in accordance with ENV 50142 without damage.

D. Circuit protection: polarity, surge/ shorted output.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all instruments and components of level measuring system in accordance with manufacturer's specifications and instructions for the specified functional requirements.

B. Comply with mounting details provided on the drawings and or recommendations of the manufacturer.

3.2 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

B. On-site testing shall be documented and shall comply with the requirements of Section 01 75 00.

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 listed in section 40 06 70 Schedules of Instrumentation for Process Systems.

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. 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.

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. Install in accordance with manufacturer's instructions.

B. Verify size and type of mounting hardware required for each float switch to be installed.

3.2 TESTING

A. Ensure proper installation per manufacturers 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 26 - GAUGE PRESSURE TRANSMITTERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance.
4. Submittals.
5. Products Requirements.
6. Installation.
7. Testing.
8. Manufacturer's Services.

1.2 SCOPE

A. This Section specifies requirements for supply and installation of Pressure and measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required 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. ASTM – American Society for Testing and Materials

B. NEMA – National Electrical Manufacturer's Association

C. NEC – National Electrical Code

D. NFPA No. 70, NEC - National Electrical Code

E. NFPA No. 79, Electrical Standard for Industrial Machinery.

F. ICS-1 – General Standards for Industrial Control and System

G. ICS-2 – Standards for Industrial Control Devices, Controllers and

H. ICS-3 – Industrial Systems.

I. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1.4 QUALITY ASSURANCE

A. 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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Siemens SITRANS P, DS III series for gauge pressure

B. Approved equal by Project Engineer.

C. To conform to specified requirements, the manufacturer's standard product may require modification.

2.2 GENERAL

A. Pressure measurement provided as a system consisting of a pressure transmitter with integral process connection.

2.3 FEATURES

A. Process Connection: as shown on the drawings.

B. System error shall not exceed ± 0.25% of range

C. Combined non-linearity, hysteresis, and repeatability accuracy of 0.1% of full scale.

D. Temperature Range: -20 to 60 ºC (Operating), 0 to 50ºC (Compensated).

E. Environmental Ratings:

1. Transmitter and cable: IP 68, NEMA 6P.
2. Junction Box: IP 66, NEMA 4.

F. Transmitter Materials:

1. Body: Welded 316 stainless steel.

G. Transmitter to be FM approved for Class I & II, Div. 1 Groups A, B, C & D.

2.4 ELECTRICAL REQUIREMENTS

A. Input current: 20 mA max (loop Power)

B. Signal Output: 4-20mA, 0-5 VDC, 0-2.5VDC Analog signal. Signal shall change in direct linear proportional to changes in pressure.

C. Insulation resistance: 100 Mega Ω @ 500 VDC Capable of withstanding a 600 Volt spike in accordance with ENV 50142 without damage.

D. Circuit protection: polarity, surge/ shorted output.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all components in accordance with manufacturer's recommendations and as shown on the drawings.

B. Comply with mounting details provided on the drawings.

3.2 TESTING

A. Instruments shall be calibrated and tested on site in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

B. On-site testing shall be documented and shall comply with the requirements of Section 01 75 00.

C. Certified copies of the factory calibration certificates shall be provided for each instrument.

3.3 MANUFACTURER'S SERVICES

A. CONTRACTOR shall provide the services of the manufacturer's representative to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 43 21 00

LIQUID PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated.

B. Where two or more pump systems of the same type or size are required, all pumps shall all be produced by the same manufacturer.

C. Provide all labor, equipment and materials and perform all operations in connection with the installation and testing of pumps selected by the OWNER.

D. Coordinate and utilize all factory testing, installation, start-up and field testing services supplied in conjunction with the pumping equipment.

E. All work performed under this Section shall be in accordance with all approved trade practices and manufacturer's recommendations.

F. Section includes:

1. General design requirements for liquid pumps.
2. Factory testing.

G. Related Requirements:

1. Section 43 21 52 – Deep Well Vertical Turbine Pumps

1.2 SUBMITTALS

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

B. Shop Drawings: Provide the following information:

1. Pump name, identification number and applicable Section number from Project specifications.

2. Performance Data Curves:

a. Showing head, capacity, horsepower demand, NPSH required and pump efficiency over the entire operating range of the pump.

b. Pump manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.

c. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable speed drive, and a curve for each speed on two-speed pumps.

3. The limits on the performance curves recommended for stable operation without surge, cavitation or excessive vibration.

4. Assembly and Installation Drawings: Including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

C. Complete motor nameplate data as defined by NEMA, motor manufacturer and any motor modifications.

D. Operation and Maintenance Manual: Containing the required information for each pump section.

E. Spare Parts List: Containing the required information for each pump section.

F. Factory Test Data: Signed, dated and certified for each pump system which requires factory testing submitted before shipment of equipment.

G. Certifications:

1. Manufacturer's certification of proper installation.
2. CONTRACTOR's certification of satisfactory field testing.

H. All pump motor information as required in Division 43.

I. Provide lateral and torsional analysis as specified under Submittals Article of Section 11 05 00, Common Work Results for Equipment.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and equipment shall be standard products of a manufacturer and distributor regularly engaged in the manufacture and distribution of such products for at least 2 (two) years and shall be suitable for the service intended.

B. All materials and equipment shall be new and unused except for the testing specified herein.

C. Compliance with the requirements of the individual pump sections may necessitate modifications to the manufacturer's standard equipment.

D. All centrifugal pumps shall have a continuously rising performance curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine or encroach on the service factor.

E. All components of each pump system provided under the pump sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings and appurtenances.

F. The pumps shall be supplied by a distributor authorized to service them throughout the warranty period and beyond. The distributor shall be located within a 100-mile radius of the site.

G. The pumps shall be warranted by the manufacturer for a minimum of one (1) year from the date of installation.

H. All materials and coatings coming in contact with potable water shall be ANSI/NSF Standard 61 approved.

I. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, motors, suction cans, baseplates, couplings, guards and other accessories.

J. The complete pump assembly shall be designed and built for continuous service at any and all points within the specified range of operation, without overheating, without damaging cavitation, and without excessive vibration or noise.

2.2 MATERIALS

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Casings, Class 30, or equal.

2. Stainless steel pump shafts shall be Type 416 or 316.

3. Miscellaneous stainless steel shall be of Type 316, except in a septic environment.

4. Anchor bolts, washers, and nuts supplied by the CONTRACTOR for non-corrosive applications shall be galvanized steel in accordance with the requirements of

Section 05 50 00, Metal Fabrications. Anchor bolts, washers and nuts in corrosive service applications shall be stainless steel in accordance with that Section.

2.3 PUMP COMPONENTS, GENERAL

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 12, 125, 250, and 800 or B16.5 - Flanges and Flanged Fittings dimensions.

B. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed and manufacturer's name and model number.

B. Gauges: Provide and install pressure gauges as shown on the Drawings.

1. All pumps (except sample pumps, sump pumps, hot water circulating pumps and chemical metering pumps) shall be equipped with pressure gauges on the pump discharge.

2. Pump suction lines shall be provided with compound gauges.

3. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

4. Isolation diaphragms shall be provided for all gauges except where pumping potable water.

5. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

2.5 FACTORY TESTING

A. The following tests shall be conducted on each indicated pump system:

1. Tests shall be performed using the complete pump system to be furnished, including the motor.

2. For motors 100 hp and smaller , the manufacturer's certified test motor shall be acceptable. The following minimum test data shall be submitted:

a. Hydrostatic test data.

b. A minimum of five (5) hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.

c. Pump curves showing head, flow, bhp, efficiency and NPSH requirements.

d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

e. Pump test data curves showing head, flowrate, bhp, and efficiency. Acceptance level shall be Grade 1E as defined by ANSI/HI 14.6.

3. Factory Witnessed Tests: Factory witnessed testing for this project not required.

4. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR and Pump Manufacturer shall make all necessary modifications, repairs or replacements to conform to the requirements of the Contract Documents and the pump shall be retested at no additional cost to the OWNER until found satisfactory.

B. The pump manufacturer shall complete a lateral and torsional analysis where required and as specified in the Submittal Article of Section 11 05 00, Common Work Results for Equipment. This analysis shall identify the dry and wet lateral critical and the torsional critical speeds of the pump system, and shall be submitted for review as part of the pump submittal.

PART 3 EXECUTION

3.1 SERVICES OF PUMP MANUFACTURER

A. As part of this construction contract, the CONTRACTOR shall utilize the full value of the OWNER- acquired services for start-up and testing services from the Pump Supplier as specified in specification section 01 75 16 Testing, Training and System Startup.

B. An authorized service representative of the manufacturer shall visit the Site to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted and readied for operation:

1. Installation of the equipment.

2. Inspection, checking and adjusting the equipment.

3. Startup and field testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.

5. Requirements are more specifically detailed herein and in individual pump specifications.

C. Instruction of the OWNER's Personnel:

1. An authorized training representative of the manufacturer shall visit the Site to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

2. Instruction shall be specific to the models of equipment provided.

3. The pump manufacturer's representative shall have at least two years' experience in training.

4. Training shall be scheduled a minimum of three weeks in advance of the first session.

5. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.

6. The training materials shall remain with the trainees.

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

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment:

1. All equipment shall be field tested to verify proper alignment, operation as specified and freedom from binding, scraping, vibration, shaft runout or other defects.

2. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing.

3. Equipment shall be secure in position and neat in appearance.

C. Lubricants: Provide the necessary oil and grease for initial operation.

3.3 FIELD TESTS

A. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation or overheating of bearings.

B. Field testing methods and allowable tolerances shall comply with current version of the Hydraulics Institute standards for the type of pumps installed.

C. The following field testing shall be conducted:

1. Startup, check and operate the pump system over its entire speed range. Where vibration analysis and measurement is required, it shall be within the amplitude limits specified and recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.

3. Electrical and instrumentation tests shall conform to the requirements of the Section under which that equipment is specified.

4. Field vibration readings shall be conducted by an Owner-selected certified testing agency, paid for by the CONTRACTOR, with readings taken at the following positions with the average not exceeding the current Hydraulic Institutes standards for the type of pump installed. Measurements shall be taken at the locations as specified in the current Hydraulic Institute standards for the type of pump installed.

5. Provide written proof of vibration readings and provide test data.

D. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.

E. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

F. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests and a listing of all persons present during the tests and the test data.

G. CONTRACTOR shall bear all costs of field tests, including additional services of the manufacturer’s representative required beyond those specified.

END OF SECTION

SECTION 43 21 52 –VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.1 DESCRIPTION

Work covered in this Section includes furnishing, installing, start-up and operation training for a vertical turbine pump of the deep well (lineshaft) type. Vertical turbine pumps shall be of the open line shaft and fresh water lubricated type. Like items of equipment specified herein shall be the end product of one manufacturer. The pump supplier shall be responsible for coordinating the pump requirements with the pump motor manufacturer and shall be responsible for the overall pump and motor requirements.

1.2 SUBMITTALS DURING CONSTRUCTION

A. Shop drawing submittals in accordance with 43 21 00.

B. Name of nearest location of permanent parts supply from which parts may be obtained in sufficient quantity on a 24-hour basis.

C. Four copies of operating and maintenance manuals shall be supplied.

D. Manufacturer's warranty.

E. Results of a N/W Performance Test conducted at the Factory, test results must be approved by engineer prior to shipment of equipment. Five hydraulic points must be taken, each point will show the horsepower, amperage, flow, head and net positive suction head required (NPSHR). Results will be stamped by a licensed engineer who works for the pump manufacture, results will be sent to design engineer for approval prior to shipment from the factory.

F. Results for a N/W Factory Hydro Test will be performed on the Discharge Head, the test will be conducted to show the Discharge Head is built for 150 percent of Shut-off Head Conditions. Test Results will be stamped by a licensed engineer and provided to the design engineer for approval prior to shipment.

G. Pump Manufacture/Distributor will be required to present during the submittal phase a copy of their well license certificate, the supplier of the well equipment must also be the installer of the well equipment. Usage of a separate company other than the one supplying all the equipment for the project will not be permitted. Unit responsibility for the installation and supply of equipment will be required.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

Pumps shall meet the requirements of the latest version of ANSI/AWWA E-101, Vertical Turbine Pumps – Line Shaft and Submersible Types and the Hydraulic Institute Standards, except where modified herein.

1.4 VIBRATION ANALYSIS TESTING

Pump vendor shall provide vibration analysis per Paragraph 1.3 E. within Section 11 05 00 – Common Work Results for Equipment.

PART 2 PRODUCTS

2.1 DESCRIPTION

A. Identification:

Location	Parr Road Municipal Water Supply Well, City of Woodburn
Address	900 Parr Rd NE, Woodburn, Oregon
Pump Label(s)	Parr Road Supply Well
Quantity	1

B. Performance Requirements at Full Pump Speed:

Maximum Shutoff Head (ft)	440
Minimum Shutoff Head (ft)	390
Guaranteed Design Point:	1,200 gpm at 283 ft TDH
Duty Pt. 2	1,500 gpm @ 184 ft TDH
Duty Pt 3	700 gpm @ 345 ft TDH
Operating Speed, rpm	1770

Minimum Bowl Efficiency at Guaranteed Design Point:	78%
Minimum Bowl Efficiency at Duty Pt. 2	66%
Minimum Bowl Efficiency at Duty Pt. 3	70%
Nominal Motor Speed (rpm)	1,800
Nominal Motor HP	125
Maximum Net Positive Suction Head Required at Duty Pt. 2 (ft)	50
Maximum Number of Stages	7
Maximum MHP Across Entire Pump Performance Curve	125
Motor 'BD' Dimension (inches)	16.5 or 20

C. Operating Conditions:

Duty	Continuous
Drive	Constant Speed Drive
Ambient Environment	Indoor
Ambient Temperature	33° - 104° F
Fluid Service	Groundwater
Fluid Temperature	33° - 65° F
Fluid pH Range	6.0 to 8.0
Fluid Specific Gravity	1.0
Fluid Viscosity (absolute) (centipoises at 60° F)	1.12
Pump Station Floor Elevation	184 ft msl
Minimum Available Submergence Above Lowest Impeller	60 feet

D. Pump Dimensions:

Discharge Diameter (in)	10
Discharge Flange Rating (ANSI) (psi)	250
Minimum Column Shaft Diameter (in)	1 11/16
Minimum Pump Bowl Shaft Diameter (in)	1 11/16
Maximum Bowl Outer Diameter (in)	11.5
Column Diameter (in)	10
Existing Casing Diameter (in)	16” nominal (15.25-inch inside diameter)
Existing Screening (in)	150-slot stainless steel wire wrap

Setting (ft)(Distance from underside of discharge head or base plate to bottom of pump intake suction bell)	265 ft

E. Other Requirements

The head-capacity curve shall exhibit a uniformly rising characteristic from free discharge to shutoff. The pump motor shall be non-overloading throughout the entire pump curve.

2.2 Pump Construction

A. The bowls shall be ASTM A48 Class 30 cast-iron, factory epoxy lined; and coated on the outside with a two component, self-priming coating applied in a two-coat process, over a sandblasted surface, to a minimum dry film thickness of 8 mil or per manufacturer's recommendations.

B. The impellers shall be ASTM B584 bronze and shall be statically and dynamically balanced.

C. The bowl and impeller wear rings shall be bronze and replaceable.

D. The bowl shaft shall be stainless steel, A582 grade 416. The size of the shaft shall meet the minimum requirements of ANSI/AWWA E101.

E. The suction bell shall be cast-iron with a bottom bearing and streamlined ribs. Lining and coating shall be the same as bowls.

F. The column pipe shall be not less than ASTM A53 Type E Grade B Schedule 40 steel pipe joined with threaded sleeve-type couplings. Pipe sections shall not exceed 10 feet in length. The weight of the column shall be no less than that stated in ANSI/AWWA E101, Section A-5.1, Standard Specifications for Discharge Pip

G. The line shaft shall be stainless steel, A582 Type 416, turned and ground. Stainless steel sleeves (ASTM A269, grade 304) shall be provided at each line shaft bearing. Line shaft sections shall not exceed 10 feet in length. The shaft shall be such that elongation due to dynamic thrust will not exceed the axial clearance of the impellers in the pump bowls. Maximum runout in 10 feet shall not exceed 0.005 inches.

H. Line shaft lubrication shall be by water.

I. The shaft seal shall be the manufacturer's standard mechanical seal arrangement suitable for the pump discharge pressure.

J. The line shaft bearings shall be rubber with 70 minimum shore hardness, internally spiral-grooved to flush out sand and other abrasives and mounted in either ductile iron A536 or bronze bearing retainers at each joint for open line shaft. Bearing spacing shall not exceed 10 feet.

K. The discharge head shall be the manufacturer's fabricated steel. Fabricated steel discharge head shall be reinforced to withstand pipe thrust, coated with a fusion bonded epoxy and shall include flange and base plate. For intake and deep well applications, the discharge head shall include a connection to allow pre-lubrication of the pump shaft and bearings. Forged steel half-couplings for well column pre-lubrication (1-inch) and level sensor (1.25-inch) shall be 3000 lbs rated. Provide level sensor penetrations through discharge head baseplate as required.

L. The bottom bearing shall be a close tolerance sleeve type with a length minimum of 2 1/2 times shaft diameter. Suction case shall be permanently grease lubricated with non-soluble grease.

M. The bowl and suction case bearings shall be of the bronze sleeve type.

N. For deep well applications, a cone strainer shall be provided. Strainer shall be stainless steel and have a net inlet area of at least four times the suction pipe area.

2.3 Motors

Each pump shall be provided with a vertically mounted hollow shaft electric motor that conforms to the following requirements and the specifications in Section 26 05 88, Premium Efficiency Vertical Motors. In the event of conflicts, the more restrictive specification shall apply. The brake horsepower required by the driven equipment anywhere on the pump curve shall not exceed the rated nameplate horsepower of the motor. The ratings indicated are minimums. Motors shall be designed to accept the total, unbalanced thrusts imposed by the pump.

2.4 Pump Controls

Pump controls are specified by others. Minimum anticipated signals and alarms include:

<u>Instrumentation/signals:</u>

- Pre-lube flow switch (on/off)
- Pre-lube flow totalizer
- Motor control and status data
- Well water level transmitter
- Discharge pressure

Alarms:

- Pump fault
- Overpressure alarm (discharge pressure)
- Motor fault alarms

2.5 Spare Parts

Each pump shall be provided with the spare packing gland materials and tools.

2.6 Manufacturers

A. The CONTRACTOR shall use Peerless, Floway, Goulds, Layne/Verti-Line, Fairbanks-Morse, or approved equal.

2.7 Piping for Level Probes in Wells

Piping for installation of a level probe (transducer) shall be furnished and installed on each pump. The piping shall extend from a point not more than 3 feet above the highest pump bowl to and through the pump base. The piping shall be 1.5-inch diameter Schedule 80 PVC with flush-threaded joints unless noted or specified otherwise. Two (2) 3/8-inch diameter holes shall be drilled in the pipe at 10-foot intervals or less, within 3 inches of the pipe bottom and within 5 feet of the top of the well casing. Drilling burrs shall be removed from the inside and outside of the pipe prior to installation. A cap shall be installed at the bottom of the pipe.

The pipe shall be installed with the pump installation. The pipe shall be secured to the pump column at intervals not exceeding 10 feet in a manner approved by the ENGINEER. The pipe shall be installed straight and plumb along the pump column so that the probe with a length and diameter as specified elsewhere in the contract documents will pass easily and freely through the entire pipe length.

The transducer shall be as specified on the Drawings.

PART 3 EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Installation -- An approved service representative of the manufacturer shall be continuously present at the site to supervise the assembly and installation of the pump.

B. Inspection, Startup and Field Adjustment -- The service representative of the manufacturer shall be present at the site for up to 3 work days to include those days provided in the previous paragraph, to furnish the services required by

Section 43 21 00 Liquid Pumps. Coordinate with OWNER. Additional time will be negotiated and paid by OWNER.

C. Instruction of OWNER's Personnel -- The training representative of the manufacturer shall be present at the site for 1 work day in addition to those days provided in the previous paragraph, to furnish services required by Section 43 21 00 Liquid Pumps. Coordinate with OWNER.

D. For the purposes of this paragraph, a work day is defined as an eight hour period at the site, excluding travel time.

F. The ENGINEER may require that the inspection, startup, and field adjustment services above be furnished in three separate trips.

END OF SECTION

SECTION 43 23 14

NON-CLOG SUBMERSIBLE PUMPS

PART 1 GENERAL

1.1 Description

Work covered in this Section includes furnishing, start-up, testing, and operation training for non-clog submersible sewage pumps as required for this project. Specified appurtenances, such as rails, brackets, discharge elbows, and control/power cables shall also be included. Like items of equipment specified herein shall be the end product of one manufacturer. Electrical controls and motor design requirements are specified in this section and the electrical section of these specifications. The CONTRACTOR shall be responsible for coordinating the pump requirements with the pump drive manufacturer and shall be responsible for the overall pump and drive performance.

1.2 Submittals

A. Submittals during construction shall be made in accordance with Section 01 30 00 Submittals, and Section 43 21 00, Liquid Pumps.

B. Submittals for Record - The pump supplier shall submit a manufacturer's installation and operation certificate and a statement that the equipment is suitable for the intended use.

C. CONTRACTOR shall submit shop drawings for proposed power cable entry ports in top slab or top hatch for Engineer approval.

1.3 Reference Specifications, Codes and Standards

Pumps shall meet the requirements of Section 43 21 00, Liquid Pumps.; and the latest version of the Hydraulic Institute Standards for Centrifugal Pumps, except where modified herein.

1.4 Factory Testing

Pump manufacturer shall provide factory tests in accordance with Section 43 21 00, Liquid Pumps. All test results shall be certified to be acceptable per the testing standards, and shall be submitted to and approved by ENGINEER prior to shipment of equipment.

PART 2 PRODUCTS

2.1 Description

A. Identification:

Location	Parr Road WTP Wellhouse
Pump Label(s)	SP-1, SP-2, SP-3
Quantity	3

B. Power and Motor Requirements:

Voltage	460
Phase	3
Frequency	60 Hz
Motor Speed (Constant Speed)	3,340 rpm
Motor Horsepower	2.7 HP
Efficiency Class	Premium

C. Performance Requirements at Full Pump Speed, One Pump Running:

Duty Point 1 Minimum Flow Capacity	161 gpm
Duty Point 1 Total Dynamic Head	31 feet
Duty Point 1 Minimum Total Efficiency	52%
Maximum NPSH required at Duty Point 1	13 feet
Duty Point 2 Minimum Flow Capacity	100 gpm
Duty Point 2 Total Dynamic Head	45 feet
Duty Point 2 Minimum Total Efficiency	44%

D. Operating Conditions:

Duty	Continuous
Drive	Constant Speed
Ambient Environment	Wet Well – non-corrosive
Ambient Temperature	33° - 104° F
Fluid Service	Stormwater, raw and unscreened, containing rags, grit, sand, and debris.
Minimum Solids Passing Capability	Flygt N-Impeller
Fluid Temperature	50° - 90° F
Fluid pH Range	6.0 to 8.0
Fluid Specific Gravity	1.0
Net Positive Suction Head Available	>30 feet

E. Pumping System Dimensions:

Minimum Pump Discharge Size	2-inch
Base Elbow Discharge Size	3-inch
Discharge Flange Rating (ANSI)	N/A (3-inch NPT Conn.)
Minimum Submersible Cable Length	As Required

F. Other Requirements

1. The head-capacity curve shall exhibit a uniformly rising characteristic from free discharge to shutoff. The pump motor shall be non-overloading throughout the entire pump curve.

2.2 Pump Construction

A. General - The pump shall be heavy-duty vertical, submersible with integral drive motor, single suction, centrifugal, sewage type, suitable for a permanent-type wet well installation.

B. Pump - Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

C. Impeller - The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The screw-shaped leading edges of the gray iron impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater and stormwater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt.

D. Volute - The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain

unobstructed. The insert ring shall be cast of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

E. Shaft - Pump and motor shaft shall be a solid continuous shaft. The pump shaft shall be an extension of the motor shaft. Couplings will not be acceptable. The pump shaft shall be stainless steel ASTM A479 S43100-T. The shaft shall be adequately designed to endure alternating bending stresses and to provide for minimum overhang to reduce shaft deflection and prolong bearing life.

F. Bearings -The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

G. Mechanical Seal -Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable. For special applications, other seal face materials shall be available.

H. Seal lubricant shall be FDA Approved, nontoxic. The motor shall be able to operate continuously while non-submerged without damage while pumping under load. Seal lubricant shall be FDA approved and nontoxic.

I. Pump Discharge Elbow - The pump discharge connection shall be the elbow type. The discharge connection shall be bolted to the structure as recommended by the manufacturer and shall serve as a lower attachment for the guide rails, and as anchorage for the pump. The anchorage system shall be designed to transmit all forces safely to the structure, and may incorporate intermediate supports as required. Calculations and supporting documentation justifying the support design may be requested, and shall be provided with the submittals required under Section 01300. When in place, the discharge connection shall cause a watertight seal between the pump and the discharge elbow, accomplished by a machined metal to metal contact only, using simple linear downward motion of the pump with the entire weight of the pumping

unit guided to and pressing tightly against the discharge connections. Sealing of the discharge interface with a diaphragm, O-ring, or profile gasket shall not be acceptable. No portion of the pump shall bear directly on the floor of the wet well and no rotary motion of the pump shall be required for sealing.

J. Dual Rail Guide System - The pump shall be provided with a dual rail guide system to automatically and firmly connect the pump to the discharge piping when lowered into place on the discharge elbow. Once the pump has been positioned on its support fitting at the discharge elbow, the guide rail system shall not be required for pump support. The guide rail system shall allow easy removal of the pump without entering the wet well or disturbing the discharge piping. Single rail systems are not acceptable. All components of the guide system and pump anchorage shall be of stainless steel 316.

K. Lifting Device - Each pump shall be provided with Type 316 stainless steel lifting chain and shackles of adequate strength to support 150 percent of the entire pump and motor assembly weight. Minimum chain size shall be 1/2-inch.

2.3 Motors

A. General - Each pump shall be provided with a vertically mounted premium efficient electric motor that conforms to the following requirements. Motors shall be designed to accept the total, unbalanced thrusts imposed by the pump. The motor and the pump shall be produced by the same manufacturer. The motor shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

B. The pump motor shall be a NEMA B design, premium efficient, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) with an 80°C temperature rise and capable of at least 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum.

C. Service Factors - The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for

torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

D. Moisture Protection - A mechanical float switch (FLS) shall be mounted in the junction chamber to signal if there is water intrusion.

E. Power Cable- The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The power cable shall be of a shielded design in which an overall tinned copper shield is included and each individual phase conductor is shielded with an aluminum coated foil wrap. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

F. Cable Entry Seal - The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2.4 Protection

A. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 140°C (284°F), stop the motor and activate an alarm.

B. A leakage sensor shall be provided to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.

C. The thermal switches and float switches shall be connected to a Mini-CAS control and status monitoring unit. The Mini-CAS shall be designed to be mounted in the pump control panel.

2.5 Pump Manufacturer

Submersible sewage pump manufacturer shall be Xylem Water Solutions, Model Flygt NP 3069 SH 3 Adaptive 275 with 115 mm impeller, or approved equal.

PART 3 EXECUTION

3.1 Inspection

Inspect pumps and fittings before installation to verify quality of material.

3.2 Installation

A. Install and align pumps and fittings in accordance with the manufacturer's printed specifications and at the locations shown on the Plans. Use anchor bolts furnished or recommended by the manufacturer. Place the pumps using equipment templates.

B. Anchors for the unit shall be set in the concrete, and the unit shall be mounted as instructed by the manufacturer. Anchors shall be drilled and set with epoxy. CONTRACTOR shall provide ENGINEER 24 hours notice prior to installing base elbows, to allow for anchor bolt inspection. The manufacturer shall supervise installation to ensure that the unit is properly aligned and leveled; that all electrical and piping connections are properly made; and that lubricants have been provided and installed.

C. CONTRACTOR shall furnish and install power cable port entry through top of wet well or through wet well hatch, with sealing mechanisms to prevent rainwater or surface runoff from entering the wet well when the hatch is closed. Furnish all necessary conduit, junction boxes, and appurtenances. Avoid tripping hazards.

3.3 Inspection and Start-Up

A. The CONTRACTOR shall furnish a representative of the manufacturer to perform inspection, start-up and training services. The manufacturer's representative shall be experienced in the operation and maintenance of the equipment and shall instruct the OWNER’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. The representative shall check the installation and supervise initial start-up of the equipment, and shall perform, at a minimum, the following tests on each pump:

- Measure and record shutoff head and power draw at shutoff head.
- Measure and record actual operating head and power draw at actual operating head.
- Measure and record operating head and power draw at two separate partially throttled flow rates.
- Measure and record static head.

- Duplicate all normal operating modes and all failure modes, including the removal and installation of pumps from the wet well using the guide rail system.

B. CONTRACTOR shall verify that the pumps are operating at the design duty condition, and shall remove and replace units that do not meet the design operating criteria.

C. For all pump tests, ensure that the force main is full of liquid during the testing. The CONTRACTOR shall provide the necessary water and other materials required for the testing as defined herein and recommended by the manufacturer.

D. The manufacturer's representative shall provide written certification that the installation is correct and that the equipment has operated satisfactorily, verifying the complete assembly for proper alignment and connection, and quiet operation. This service shall be provided for a minimum period of one trip and one day. After the installation and operation of the equipment has been certified, the manufacturer's representative shall train the OWNER's personnel in the proper operation and maintenance of the equipment. The OWNER may videotape the training.

E. A start-up report, acceptable to and approved by the ENGINEER, shall be completed by the manufacturer's representative before final acceptance of the pumps.

3.4 Field Quality Control

A. Provide manufacturer's certifications verifying proper installation and operation of the pumps and pump assemblies.

B. Replace pumps and assemblies that fail testing or are otherwise damaged at no additional cost to the OWNER.

C. The CONTRACTOR shall bear all costs of field tests, including related services of the manufacturer's representative.

END OF SECTION