

# Addendum No. 1

For Construction of

## City of Port Townsend Water Supply Metering Improvements

Prepared by:

City of Port Townsend  
Department of Public Works  
250 Madison Street, Suite 2R  
Port Townsend, WA 98368



7-19-23

Exp. 12/24/23

**ADDENDUM NO. 1  
TO THE CONTRACT PROVISIONS AND PLANS**

**FOR CONSTRUCTION OF**

**Water Supply Metering Improvements**

ISSUED: July 20, 2023

BID OPENING: 2:00 PM July 28, 2023

Please include this Addendum No. 1 with your Bid Proposal and acknowledge receipt of the same on the Bid Proposal.

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**TO PROSPECTIVE BIDDERS:**

The attention of all prospective bidders on the above project is directed to the following modifications and additions to the Contract Documents, which are hereby made a part of the Contract Provisions and Plans.

**INSTRUCTIONS AND INFORMATION FOR BIDDERS**

**Substantial Completion**

Replace this section with the following:

The work must be substantially complete by October 27, 2023. The contract shall be physically completed within 30 working days.

**Liquidated Damages**

Replace this section with the following:

The 48-hour water transmission line shutdown is critical to this project. Restoration of water flow, both to the City and to the Port Townsend Paper Corporation, shall occur no later than 48 hours from the turning off of the water

at City Lake. It is anticipated that it will take six hours for the water to drain out of the transmission line and two hours to flush after turning on the water.

See the Contract Plan Cover Sheet General Notes for the specific timeline and dates, and the times for the water shut-off and turn-on.

The Contractor is expected to complete as much pre-work ahead of the water shut-off including fitting preparation, excavation, mobilization of materials, and any other work that can be done to expedite completion of the 14-inch and 20-inch pipe and meter installation such that water can be turned back on and flow through the meters to the City and to the Port Townsend Paper Corporation.

The meters may be wired and functioning following water turn-on to provide extra time.

Liquidated damages apply to this project at the following amount:

<b>Liquidated Damages</b>			
<b>Date/Time (From)</b>	<b>Date/Time (To)</b>	<b>Amount</b>	<b>Grand Total</b>
10/13/23 7:00 AM	10/13/23 1:00 PM	\$10,000	\$10,000
10/13/23 1:01 PM	10/13/23 7:00 PM	\$15,000	\$25,000
10/13/23 7:01 PM	10/14/23 7:00 AM	\$25,000	\$50,000

### **TECHNICAL SPECIFICATIONS**

The Technical Specifications were inadvertently left out of the Bid Documents and are attached to this Addendum.

### **ATTACHMENTS**

1. Technical Specifications

**CITY OF PORT TOWNSEND**

**PORT TOWNSEND, WASHINGTON**

**TECHNICAL SPECIFICATIONS AND PLANS**

for the

**Water Supply Meeting Improvements**

**SUMMER 2023**

**THE TECHNICAL SPECIFICATIONS AND PLANS WERE PREPARED UNDER THE DIRECT SUPERVISION OF  
THE PROFESSIONAL ENGINEERS IDENTIFIED BELOW.**

THE CONTENT OF THIS DOCUMENT, AS A MEANS OF PROFESSIONAL SERVICE, IS PROTECTED BY 17 U.S.C. § 101, ET SEQ. AS SUCH, IT SHALL NOT BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT OR PURPOSE WITHOUT WRITTEN AUTHORIZATION FROM RH2 ENGINEERING. © 2023 RH2 ENGINEERING, INC.



Ryan J. Feskens, PE  
Project Engineer  
Signed: 07/07/2023



Mark W. Braaksma, PE  
Electrical Engineer  
Signed: 07/07/2023



Prepared by:  
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# Division 1

## General

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### 1.10 GENERAL

Sections in these specifications titled “*Common Work for . . .*” shall apply to all following subsections whether directly referenced or not.

Sections in these specifications titled “*Related Sections*” shall be read as integral to the specification as if they were fully detailed within. All work and materials described in such sections shall be provided and performed by the Contractor.

#### 1.10.16 Definitions

*[CSI 01 42 16]*

**Approximate:** Generally as shown or described, but has not been verified, or may require adjustment. No level of accuracy is implied or should be assumed.

**Or Equal (Or Approved Equal):** An alternate product, assembly, or method that the Owner’s Representative has reviewed based on information provided by the Contractor and determined to provide functional equivalence, or better, than that specified. Such determination does not relieve the Contractor from responsibility should the product, assembly, or method fail to perform as needed.

**Owner’s Representative:** Person(s) authorized by the Owner to observe the work, administer the contract, approve tests, make decisions, and otherwise act as an agent of the Owner. The terms Engineer, Owner’s Observer, Owner’s Inspector, and Owner are generally interchangeable with the term Owner’s Representative.

**Proposed:** The word refers to work that is part of the Contract, to be performed by the Contractor. The word “proposed” does not need to show up to indicate work by the Contractor. Unless work is specifically noted to be performed by others, all work is to be performed by the Contractor.

#### 1.11.00 Summary of Work

*[CSI 01 11 00]*

This project consists of the construction of two (2) water supply metering facilities on adjacent sites that will allow the City to track and report water consumption. The City has procured a large portion of the materials for the project to facilitate construction/installation during a short allowable shut down window for the City’s main supply pipeline.

#### 1.11.02 Reuse of Documents

*[CSI 01 11 30]*

Contractor and any Subcontractor or Supplier shall not:

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

2. Reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.
3. The prohibitions of this Paragraph will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

### 1.11.03 Electronic Data

#### *[CSI 01 31 26]*

1. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner to Contractor, or by Contractor to Owner, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.
2. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 30 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 30-day acceptance period will be corrected by the transferring party.
3. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.
4. Computer Aided Design (CAD) files may be made available to the Contractor upon request, but only at the discretion of the Engineer. This includes AutoCAD™, Civil3D™, or other similar file types. If CAD files are provided, no level of accuracy is implied or should be assumed unless the Engineer expressly states a level of accuracy. CAD files by nature include extraneous information used to develop the drawings but are not part of the final design. Any use of CAD files is solely at the Contractor's risk and neither the Engineer nor the Owner take responsibility for interpretations by the Contractor, missing information, or inaccurate information.

### 1.13 Permits and Licenses

#### *[CSI 01 41 26]*

The Contractor shall acquire and pay all costs for all other necessary permits which may include:

- Right-of Way or Street Use Permit
- Electrical Permit

## **1.30 ADMINISTRATIVE**

*[CSI 01 30 00]*

### **1.31 Project Management and Coordination**

*[CSI 01 31 00]*

#### **1.31.01 Contractor's Responsibility**

*[CSI 01 31 01]*

The work included in this contract is shown on the contract plans and described in these project specifications. All work incidental and necessary to the completion of the work described and shown shall be performed by the Contractor. In submitting a bid for this project, the Bidder warrants that they are an expert in this and related work, that they understand the process and functions shown, and that various work and processes not shown but necessary for the successful operation of this project will be provided by the Contractor.

The General (or Prime) Contractor is fully responsible for providing the subcontractors and suppliers with all relevant portions of the plans and specifications necessary to bid and construct the improvements.

Damage to existing utilities or property shall be repaired or replaced by the Contractor at the discretion of the Owner.

The Contractor and each of the Subcontractors are responsible for coordinating the required inspections. There are specific requirements for inspection responsibilities and the advance notice that must be given to minimize construction delays. It is the Contractor's responsibility to be familiar with these requirements, include the coordination necessary in this estimate of project costs and schedule, and to comply with the requirements during construction. Failure to follow proper inspection and notification procedures may result in on-site work stoppages and removal or demolition of unapproved structures or systems, all at the Contractor's expense. See Starting and Adjusting section for details.

Do not start work on this project or on any public or private right-of-way or easement until clearance is given by the Owner. It will be the responsibility of the Contractor to comply with the requirements of any permit for the project. Do not hinder private property access without a 24-hour notice to the private property owner, and do not hinder access for more than an 8-hour period. Do not disrupt emergency aid access to private property.

The Contractor is solely responsible for all elements of site safety. Inspections performed by the Owner are only to monitor and record that project plans and specifications are being complied with and construction is consistent with the design intent.

The Contractor is responsible for managing, coordinating, and overseeing its subcontractors, suppliers, manufacturers' representatives, or any other persons performing Work. The Contractor shall designate and have a competent person, familiar with the project and work being performed, on site at all times when work is being performed.

### **1.31.19 Progress Meetings**

*[CSI 01 31 19 23]*

The Contractor shall schedule and hold regular on-site progress meetings at least every week and at other times as requested by the Owner or as required by progress of the work. The Contractor, Owner, and all Subcontractors active on the site must attend each meeting.

### **1.32.13 Scheduling of Work**

*[CSI 01 32 13]*

See plans for sequencing of work as it pertains to allowable pipeline shutdown period and timing for construction for the various portions of the proposed improvements.

Where the plans or specifications mention notification periods in hours or days, these time periods are assumed to be working days unless specifically stated otherwise. For example, a requirement of 48-hours notification for work desired to be performed at 1:00 pm Monday requires notification be provided no later than 1:00 pm the preceding Thursday.

### **1.32.16 Construction Progress Schedule**

*[CSI 01 32 16]*

Contractor is responsible for providing an up to date construction schedule with each monthly pay estimate and at other times as requested by the Owner or as required by progress of the work. If the current schedule is still in-line with the previous schedule, the Contractor shall inform the Owner with each pay estimate. Non-working day requests shall also be submitted by the Contractor with each monthly pay estimate. Owner may delay monthly progress payments if Contractor fails to submit updated schedule and non-working day requests.

### **1.32.29 Periodic Work Observation**

*[CSI 01 32 29]*

The Owner may elect to have an observer on site to monitor, observe and record construction progress. The Contractor maintains complete responsibility to verify construction is meeting the design intent and is being constructed in accordance with the plans and specifications. It is not the responsibility of the Owner's observer to address neither means and methods issues nor direct safety issues. The Owner's observer does not have the authority to stop work if unsafe conditions are observed.

### **1.33 Submittals**

*[CSI 01 33 00]*

### 1.33.23 Shop Drawings, Product Data, and Samples

*[CSI 01 33 23]*

Submittals are required for all items installed on this contract. Address submittals to:

RH2 Engineering, Inc.  
22722 29th Dr. SE, Suite 210  
Bothell, WA 98021

Attn: Ryan Feskens

Email: rfeskens@rh2.com

Submittals may be provided in electronic format (preferred) or hard copy. Owner reserves the right to require the Contractor to provide hard-copy submittals at no additional cost to the Owner. When hard-copy submittals are provided, submit three (3) copies; one set will be returned to the Contractor after review.

Electronic submittal via email is acceptable, however the Contractor shall follow up with the Owner to verify that the submittal was received. The Owner assumes no responsibility for emails that do not make it to the recipient. In the case of electronic submittals, only one copy will be returned to the Contractor, either electronically or hard copy at the Owner's discretion.

Submittal data shall contain sufficient information on each item to determine if it complies with the contract requirements. Submittal cutsheets and datasheets shall be annotated by the Contractor to clearly indicate the equipment and materials that will be provided, including any options or additive items. No generic cutsheets or datasheets will be accepted.

Items installed in the work that have not been approved through the submittal process shall be removed and an approved product shall be furnished, all at the Contractor's expense.

Shop drawing review will be limited to general design requirements only and shall not relieve the Contractor from responsibility for errors or omissions, or responsibility for consequences due to deviations from the contract documents. No changes may be made in any submittal after it has been reviewed except with written notice and approval from the Owner.

Shop drawings shall be submitted on 8½-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch sheets and shall contain the following information:

- Project Name as it appears on the Document Cover.
- Prime Contractor and Applicable Subcontractor.
- RH2 Engineering.
- Owner's Name (City of Port Townsend).
- Applicable Specification and Drawings Reference.
- A stamp or statement that the Contractor has checked the equipment for conformance with the contract requirements, coordination with other work on the job, and dimensional suitability.

- A place for the Engineer to respond. (Engineer may elect to respond using the Engineer's standard forms.)

Submittals that do not comply with these requirements may be returned to the Contractor for re-submittal. The Contractor shall revise and resubmit as necessary. Acceptable submittals will be reviewed as promptly as possible and transmitted to the Contractor not later than 10 working days after receipt by the Engineer. Delays caused by the need for re-submittal shall not be a basis for an extension of contract time or delay damages.

Shop drawings and submittals shall contain the following information:

1. Drawings, dimensions, and weights.
2. Catalog information.
3. Model number, including descriptions for option and accessory codes.
4. Manufacturer's specifications.
5. Special handling instructions.
6. Maintenance requirements.
7. Wiring and control diagrams.
8. List of contract exceptions.

For integrated or package systems (see also 1.61.31), the components, shop drawings, instructions, and other elements may be submitted and reviewed individually. But the initial submittal must include the complete proposed system, and the final submittal must also be for the complete system clearly indicating all changes made during the submittal process.

The Contractor warrants that they have determined and verified all field measurements, field construction criteria, materials, catalog numbers, and similar data, and have checked and coordinated each submittal with the requirements of the work and of the contract documents.

The Owner will pay the costs and provide review services for a first and second review of each submittal item. Additional reviews shall be paid by Contractor by deducting up to \$200 for each hour of review time from the next scheduled payment.

The Contractor is responsible for identifying the shop drawings and submittals required for this project. Specific submittal requirements may be listed in each section of these specifications. Contractor shall keep a complete and up to date copy of all submittals and review responses at the job site readily available to the Owner for inspection.

## **1.40 QUALITY REQUIREMENTS**

*[CSI 01 40 00]*

### **1.42.19 Reference Standards**

*[CSI 01 42 19]*

Work under this contract shall be performed in accordance with applicable sections of the current Standard Specifications for Road, Bridge and Municipal Construction, Washington

State Chapter, American Public Works Association, and Washington State Department of Transportation, hereafter referred to as the Standard Specifications.

Certain other referenced standards used in this specification are from the latest editions of:

- IBC International Building Code
- UPC Uniform Plumbing Code
- IMC International Mechanical Code
- IFC International Fire Code
- NEC National Electrical Code
- AWWA American Water Works Association
- ANSI American National Standards Institute
- ASA American Standards Association
- ASTM American Society for Testing and Materials

### **1.43.20 Warranty**

*[CSI 01 43 20]*

The Contractor shall warrant all work and products for a period of one (1) year following the warranty start date except for those components and listed warrantees below.

The warranty start date is the date the final payment (not retainage payment) is sent to the Contractor from the Owner.

Warranty does not cover damage due to misuse by the Owner or conditions outside of the Owner or Contractor's control or exceptional events (force majeure) including war, strikes, floods (water exceeding normal high water mark), rainfall in excess of 100 year storm event, fire, earthquakes, high winds (over 85 mph for 3 seconds peak gust), freezes below 10 degrees Fahrenheit (Western Washington), freezes below minus 10 degrees Fahrenheit (Eastern Washington), governmental restrictions, vandalism, utility power failures, or utility power surges (unless due to Contractor provided surge suppressor failure). The Contractor has control over workmanship, third party subcontractors and parts and materials used to complete the project.

Warranties in addition to this warranty are listed in the following sections:

- Division 2.13.1 Vegetation Protection
- Division 2.90.1 Landscaping
- Division 17.05 and 17.90.1 Telemetry systems

## 1.45.16 Field Quality Control Procedures

*[CSI 01 45 16]*

Unless otherwise noted on the plans or within these specifications, provide 48-hour notice to the Owner and appropriate reviewing agency for all inspections required. 48-hour notice is defined as two complete working day notice. Time is not counted on weekends and holidays (inspections required on a Monday or the day after a holiday shall be scheduled a minimum of 48 hours in advance not including the holiday hours or weekend hours.)

## 1.50 TEMPORARY FACILITIES AND CONTROLS

*[CSI 01 50 00]*

### 1.51 Temporary Utilities

*[CSI 01 51 00]*

Provide all necessary water for construction-related fire protection and utilities required by this contract, or by laws and regulations. Sanitary facilities adequate for all workers shall comply with all codes and regulations.

At the close of this contract, the Contractor shall pay all utility bills that are outstanding, remove all temporary electrical, sanitary, gas, telephone and water facilities, and any other temporary service equipment that may remain. In addition, the Contractor shall arrange for the transfer of electrical and water accounts to the Owner's name.

The Contractor shall make all arrangements for the required construction power. Power is available at some locations on the construction site. The Contractor is responsible for reviewing what is available and providing what is required.

The Contractor shall make arrangements for and provide all necessary facilities for the necessary water supply for construction at their own expense unless otherwise provided.

### 1.55.26 Traffic Control

*[CSI 01 55 26]*

Any traffic control activities required during construction shall be consistent with the Uniform Traffic Control Manual, latest edition and applicable local codes. The Contractor shall limit delay of traffic to 5 minutes or as required by Jefferson County.

If flaggers are used, orientation meetings per WAC 296-155-305 of the Standard Specifications shall be held each time a new flagger is introduced to the site or if site conditions change significantly. The Contractor is responsible for scheduling such meetings.

## 1.70 EXECUTION AND CLOSEOUT REQUIREMENTS

*[CSI 01 70 00]*

### 1.71 Examination and Preparation

*[CSI 01 71 00]*

### **1.71.23.16 Construction Surveying**

*[CSI 01 71 23 16]*

Replace all damaged survey monuments in accordance with WAC 332-120. Do not remove monuments until obtaining a permit from the WA Dept. of Natural Resources per WAC 332-120-050. Provide a copy of the application, permit, and re-monumentation report to the Owner.

### **1.74 Cleaning and Waste Management**

*[CSI 01 74 00]*

#### **1.74.23 Final Cleaning**

*[CSI 01 74 23]*

All areas impacted by the work shall be restored to at least original condition, unless specifically identified otherwise in the plans or specifications. All costs are incidental.

Clean up debris and unused material and remove from the site and any buildings. If vehicle traffic causes ruts, repair asphalt (new or existing) in paved areas. In non-traffic areas back track with dozer or excavator and repair to final surface condition including necessary hydroseed, mulch, and landscaping. Eliminate weeds within the construction area prior to project closeout.

Buildings shall be broom clean and all foreign damage or markings removed or repaired.

Equipment shall be washed clean using appropriate methods.

Unpainted exposed concrete structures shall be cleaned to a consistent bare concrete surface finish. Remove extraneous substances such as efflorescence, leakage residue, and excess repair materials.

### **1.75 Starting and Adjusting**

*[CSI 01 75 00]*

#### **1.75.16 Startup Procedures**

*[CSI 01 75 16]*

##### **1.75.16.10 Startup**

*[CSI 01 71 16 10]*

See the Automatic Control section for control system startup.

Startup shall consist of a simulated operation of all equipment and controls. The purpose of startup shall be to check that all equipment will function under operating conditions, that all interlocking controls and sequences are properly set, and that the facility will function as an operating unit.

Startup shall not occur on a Saturday, Sunday, Monday, Friday, on an Owner recognized holiday, or the day before or after an Owner recognized holiday unless approved in advance by the Owner.

Technically qualified product representatives shall be present for the startup phase. All representatives shall be trained, qualified, and have experience in troubleshooting and fixing field issues. The startup shall continue until it is demonstrated that all functions, controls, and equipment are functioning correctly.

Authorized manufacturer's representatives shall be provided for the following items:

- Motor control centers (electrician may qualify if approved by manufacturer)
- Field sensors (electrician may qualify if approved by manufacturer)
- Programmable controllers

### **1.75.16.12 Startup and Testing Coordination**

*[CSI 01 75 16 12]*

The Contractor shall conduct all testing and startup. Testing and startup shall not be a cause for claims for delay by the Contractor and all expenses for testing and startup shall be incidental to this contract.

The placing of all improvements in service shall consist of three parts: "testing", "startup", and "operation". Not less than 21 calendar days before the anticipated time for beginning testing, the Contractor shall notify and submit to the Owner for approval, a complete plan for the following:

1. Schedules for tests:
  - A. Control system
  - B. Meter calibration
2. Detailed schedule of procedures for startup.
3. Complete schedule of events to be accomplished during testing.
4. An outline of work remaining under the contract that will be carried out concurrently with the operation phases.

Failure to provide proper notification to the Owner may lead to liquidated damages if schedule cannot be maintained. If rescheduling is required because components are not ready for testing, the notification requirements are reset as needed to provide 21 calendar days advance notice to reserve the Owner Representatives' time.

The Contractor shall arrange for all materials, supplies, and labor necessary to efficiently complete the testing, startup, and operation. Measuring devices must be functional, accurate, legible, and scaled appropriately for the test. The Owner has the right to reject or require verification for any measuring device the Owner suspects in its accuracy.

At a minimum, the Contractor shall provide:

- Calibrated pressure gauge(s) (max scale of 120% to 200% of test pressure)

- Voltmeter
- Amp meter.

Work under other contracts will occur concurrently with this project. The Contractor shall incorporate the schedules of the other work. Work by others includes:

- SCADA programming and testing: 2 weeks.

### **1.75.16.20 Testing**

*[CSI 01 75 16 20]*

The Contractor may periodically request preliminary testing for items that must be covered or tested before other work can proceed. In these cases, do not cover up or test the work without timely notice to the Owner of its readiness for testing. Should any work be covered up without notice, approval, or consent, it must, if required by the Owner, be uncovered for examination at the Contractor's expense. All necessary equipment shall be set up and the work given a preliminary test so that defects may be discovered and repaired prior to calling out the Owner to witness the test.

Final testing consists of individual tests and checks made on equipment intended to provide proof of performance, operation, and control in the presence of the Owner. Assure proper alignment, size, condition, capability, strength, adjustment, lubrication, pressure, hydraulic test, leakage test, and all other tests deemed necessary by the Owner to determine that all materials and equipment are of specified quality, properly situated, anchored, and in all respects ready for use. Any certificates required in these specifications by the manufacturer's representatives shall be supplied to the Owner prior to startup.

All piping shall be tested as required by specifications and applicable codes. Tests on individual items of equipment shall be as necessary to show proper system operation. During testing, the Contractor shall correct any defective work discovered. Startup shall not begin until all tests required by these specifications have been completed and approved by the Owner.

Not less than five working days before the anticipated time for beginning the testing, the Contractor shall provide a list of representatives that will be attending the testing. The Owner may request additional representatives at no additional cost if said representatives are identified in these specifications.

Qualified product representatives are to be on site for startup and testing of specific pieces of equipment. Representatives required are listed in the relevant specification sections.

### **1.75.16.22 Scheduling of Owner Review for Testing**

*[CSI 01 75 16 22]*

See Division 1.75.16.10 for scheduling and notification requirements.

The Contractor shall provide notification two working days and two working hours (to confirm readiness) of the scheduled test(s) to the Owner confirming that the Contractor has successfully completed all preliminary testing and that all equipment, tools, materials, labor, subcontractors, manufacturer's representatives, and all other items required for witnessed testing are available and fully functional. Failure to provide advance notification and

confirmation or meet any of the testing requirements will constitute a failed test in accordance with the section Inspection and Tests of the General Conditions.

A detailed testing schedule shall be provided by the Contractor and updated as needed to be at least 48 hours ahead of actual testing. If testing requires downtime in order to perform repairs due to failed test, the Contractor shall pay the Owner in the amount of \$200 per hour per Owner Representative on site (minimum of \$400 per scheduled visit) for downtime lasting longer than 2-hours required to complete repairs to verify the complete construction is ready for startup and operation. This amount will be deducted from the appropriate bid item that relates to the finished construction and documented by the Owner at their discretion. The Contractor must have all systems pre-tested prior to calling the Owner for formal testing.

Schedule shall include control system testing starting on Mondays, Tuesdays or Wednesday so that the remainder of the week can be used to identify the stability of the control system for the SCADA system. Control system testing shall not start on a Friday, or the day before an Owner recognized holiday.

### **1.75.16.40 Electrical and Control Systems Testing**

*[CSI 01 75 16 40 or 25 08 00 or 26 08 00]*

See also the applicable electrical sections for electrical system testing.

See also the applicable automation sections for automatic control system testing.

The following is a list of components that shall be tested prior to project completion. This list is intended as a general guide and is not necessarily complete:

- Pressure sensors and alarms
- Flow sensors and alarms
- Intrusion sensors and alarms
- Local control
- Automatic control

### **1.78 Closeout Submittals**

*[CSI 01 78 00]*

#### **1.78.23 Operation and Maintenance Data**

*[CSI 01 78 23]*

See also the Automatic Controls section for additional requirements for automatic control systems manuals. Detailed requirements for specific equipment and systems may also be included in their respective specification sections.

Remove and preserve all tags and instructions that come packaged with or attached to equipment. Deliver all such documents to the Owner bound in a three-ring binder or with the O&M Manual. Insert documents in sleeves if they cannot be punched. Scan all such documents to Adobe PDF format and provide with the O&M Manual.

Prior to the receipt of payment for more than 90 percent of the work, deliver to the Owner acceptable manufacturer's instructions covering equipment and systems O&M procedures, for coatings furnished under this contract, and any additional items indicated by the Owner.

The operating and maintenance instructions shall include, as a minimum, the following data for each coating and equipment item:

### **Products**

- A. Identification including brand name, model number, and serial numbers.
- B. Date of manufacture and date of installation on job site.
- C. Complete as-built elementary wiring and one-line diagrams.
- D. Complete parts list, by generic title and identification number, complete with exploded views of each assembly.

### **Maintenance**

- A. Recommended spare parts.
- B. Lubrication schedule including the applicable lubricant designation available from the Standard Oil Company of California.
- C. Recommended preventive maintenance procedures and schedules. Schedule shall be provided for daily, weekly, monthly, quarterly, semi-annually and annually maintenance.
- D. Disassembly and re-assembly instructions including parts identification and a complete parts breakdown for all equipment.
- E. Weights of individual components of each item of equipment weighing over 50 pounds.
- F. Name, location, and telephone number of the nearest suppliers and spare parts warehouses.
- G. All manufacturers' warranties. Include name, address, and telephone number of the manufacturer's representative to be contacted for warranty, parts, or service information.
- H. Cleaning, repair, and maintenance instructions for each coating system.
- I. Provide USB flash drive or DVDs utilized in the manufacturer's instruction program.

### **Operation**

- A. Recommended trouble-shooting and startup procedures.
- B. Recommended step-by-step operating procedures.
- C. Emergency operation modes, if applicable.
- D. Normal shutdown procedures.
- E. Long term shutdown (mothballing) procedures.
- F. Equipment specifications and guaranteed performance data.

- G. General manuals which describe several items not in the contract will not be accepted unless all references to irrelevant equipment are neatly eradicated or blocked out.

Provide 2 hard copies of O&M manuals. A duplicate USB or DVD copy may be provided but shall not substitute for a hard copy unless approved by the Owner.

Bind each set of instructions into multiple volumes; each volume to be complete with an index and bound in a suitable, hard-covered binder. Binders shall be hardback construction with full-length metal hinge. 3-inch to 5-inch width as appropriate for the quantity of O&M documentation. More than one binder may be required for large projects. Binders equal to Wilson-Jones WLJ344 series or WLJ369 series or Specialty Loose Leaf models 87784, 98085, 98086, or 98984.

Manuals shall be assembled and indexed so that information on each coating and piece of equipment can be readily found.

The Contractor shall secure and deliver to the Owner all equipment warranties and other warranties and guarantees required for all equipment and processes. Delivery shall be done at one time covering all major and minor equipment warranties. Copies of the warranties shall be included in each O&M Manual.

See Division 1.43.20 for details regarding required warranties for specific components.

## 1.78.39 Project Record Documents

*[CSI 01 78 39]*

Prior to receiving final payment for the work, deliver a complete set of “As-Constructed” records (also called as-built, or record plans) to the Owner. The Owner has sole discretion to determine if the records provided are legibly and accurately presented and may request revisions, which shall be provided by the Contractor at no additional cost. Records shall be made as follows or as approved by the Owner:

- Yellow markings or highlights = deleted items
- Red markings = new or modified items

Records shall be provided in PDF format.

Provide “as-constructed” information on all items and work shown on the plans showing details of the finished product including dimensions, locations, outlines, changes, manufacturers, etc. The information must be in sufficient detail to allow the Owner’s personnel to locate, maintain, and operate the finished product and its various components.

See also electrical plan requirements in Division 16.05.

## 1.79 Demonstration and Training

*[CSI 01 79 00]*

### 1.79.10 Training

*[CSI 01 79 10]*

See the Automatic Control section for automatic control systems training.

At the time that the facility is ready to be put into operation, the Contractor is to conduct an operation and maintenance training meeting with the Owner to explain in detail the operation and maintenance requirements of each of the facility's components. The training meeting shall not occur on the same days as a startup.

Operation of the facility shall commence immediately after completion of testing, startup, and training and after satisfactory repairs and adjustments have been made.

# Division 2

## Sitework

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### 2.00 GENERAL

*[CSI 32 00 00]*

Sections in these specifications titled “*Common Work for . . .*” shall apply to all following subsections whether directly referenced or not.

### 2.05 Common Work for Exterior Improvements

*[CSI 32 05 00]*

This division covers the work for providing materials and performing all sitework as described in these specifications and as shown on the Plans.

#### Part 1 - General

##### Submittals

Submittal information shall be provided to the Owner for the following items:

- Erosion and Sedimentation Control Plan
- Erosion Control Fence Fabric
- Shoring Plan and Calculations
- Dump Site Permits
- General Fill
- Pipe Bedding
- Trench Backfill
- Crushed Surfacing
- Hydroseed
- Topsoil

Other items listed in this section or required by the Owner.

### 2.08 Special Inspections for Earth Work

*[CSI 31 08 20]*

#### Part 3 – Execution

##### Field Quality Control

Special inspections including visual, probing of subgrade, and compaction effort (nuclear densometer or probe) are required for the following locations:

- Trench backfill crossing roads (visual, probe and nuclear densometer testing)

- Crushed surfacing under roads, and structures (visual, probe, and nuclear densometer testing)
- Native (and fill if any) subgrade of vaults, (visual and probe)

Areas where fill (either native or non-native) is being placed shall be tested for compaction compliance by a special inspector. The Owner will pay for the initial testing. If tests indicate failure of compaction requirements, the Contractor shall pay for subsequent tests until tests indicate compliance with the specifications. Areas of native undisturbed subgrade shall be visually inspected by the Owner prior to placement of any material overtop. Contractor shall coordinate with the Owner a minimum of two (2) full working days prior to inspection being needed.

The Contractor shall fully cooperate with the special inspector, including providing safe access to the testing areas. No extra compensation will be provided for cooperation with and facilitation of inspections.

#### Utility Trench Testing

Testing will occur at the following locations at a minimum:

- One test within 30 feet of start.
- One test every 300 feet or at road intersections, whichever comes first.
- One test whenever soil conditions change, per the direction of the Owner.

The Contractor shall schedule with Owner for visual and probe review of earthwork activity. Contractor shall schedule with Owner and special inspection agency for nuclear densometer testing. Deliver test results to the Owner and to the roadway jurisdiction if different than the Owner.

## **2.10 SITE PREPARATION**

### **2.10.2 Clearing and Grubbing**

*[CSI 31 11 00]*

#### **Part 3 - Execution**

##### **Construction**

Clearing and grubbing shall be performed by the Contractor to remove and dispose of unwanted debris, vegetative matter, and other items noted on the Plans within the construction limits and shall conform to Section 2-01 of the Standard Specifications.

Protect trees and tree roots, structures and foundations, utilities, fences, and all other existing improvements not being removed regardless if shown to be protected on the Plans.

Remove and relocate permanent improvements that are within the construction limits, such as mailboxes and traffic signs. Locate mailboxes to preserve mail service during construction. Return facilities to original location, or plan location, at completion of local work.

Do not remove organic material including plants, grasses, trees, and native topsoil unless directed on the Plans. Where the Contractor is allowed to clear areas to facilitate construction but is not required to, restore any areas disturbed by construction to existing or better condition including matching surface restoration with seed, sod, or plantings as shown in adjacent areas required to be modified by the Plans. Restoration shall be completed at no additional cost to the Owner.

## **2.10.4 Dewatering**

*[CSI 31 23 19]*

### **Part 1 - General**

#### **Submittals**

The Contractor is to determine the scope, type, size, quantity, method of installation, operation, and removal of the dewatering system necessary to keep excavations de-watered to an elevation below the base of the excavation sufficient to stabilize the soils in the excavation and the surrounding areas, and to prevent flotation of partially completed structures. Prepare a detailed dewatering system plan and submit to the Owner for review prior to the installation of any dewatering system. This plan shall include, as a minimum, the scope, type, size, quantity, method of installation, operation, and removal of all dewatering systems.

### **Part 3 - Execution**

#### **Installation/Construction**

Dewatering systems must be positioned away from all building and utility construction so as to not become a part of the permanent facility.

Furnish, install, and operate all necessary machinery, appliances, and equipment to meet these water control requirements. De-water and dispose of the water so as not to cause injury to property or a nuisance to the public. Maintain sufficient pumping equipment and machinery in good working condition for all ordinary emergencies, including power outages, and have competent personnel available at all times to operate the equipment. The dewatering system shall not be shut down between shifts, on holidays, weekends, or during work stoppages.

#### **Field Quality Control**

The quality of all water discharged from the site shall meet all State and local requirements. Employ all means necessary to remove suspended solids, oils, trash, and other deleterious materials from water prior to discharging.

Control groundwater and surface water to prevent the softening of the bottom of excavations, or formation of quick conditions or boils during excavation. Lower ground water to 1 foot below the base of the excavation. The Owner will determine if soil conditions are unsuitable for supporting the improvements. The Contractor will determine soil conditions are unsuitable for performing work, placing materials, and proceeding with construction activities. When the dewatering system does not meet the specified requirements, and as a consequence there is a loosening or disturbance of the foundation soils, instability for the slopes, or damage to the foundation or structures occur, the Contractor shall at its own expense, supply all materials,

labor, and equipment, and perform all work required for the restoration of foundation soil, slopes, or structure to the satisfaction of the Owner.

### **Restoration**

Remove and backfill dewatering wells in accordance with applicable Federal and State regulations.

## **2.11 Earthwork Materials**

### **2.11.2 General Fill**

*[CSI 31 23 23.51]*

#### **Part 1 – General**

##### **Summary**

All fill not specifically defined as another type shall be “General Fill”.

##### **References**

Section 9-03.14(3) Common Borrow of the Standard Specifications.

#### **Part 2 – Products**

##### **Components**

General fill shall be soil free of organics, debris, and other deleterious materials, with no individual particles having a maximum dimension larger than 5 inches. The moisture content of the material and weather conditions at the time of placement will be used to determine the suitability of native materials for backfill as general fill.

#### **Part 3 – Execution**

##### **Installation/Construction**

Compact general fill in uniform layers not exceeding 12 inches in loose thickness and to at least 90 percent maximum dry density based on the ASTM D-1557 (modified) test procedure or 95 percent maximum dry density based on the ASTM D-698 (standard) test procedure.

### **2.11.4 Pipe Bedding**

*[CSI 31 23 23.53]*

#### **Part 1 – General**

##### **Summary**

Fill placed below and around buried utilities. The bedding material has been selected to support the weight of the utility by distributing the load so that the completed utility and backfill system does not weigh more than the native material. The grain size has been selected so that the bedding will not migrate into the bottom of the trench. Take care to maintain the integrity of the utility design by using the appropriate pipe bedding material where shown.

## References

Pipe bedding used around restrained joint pipe must be crushed surfacing or sand. Rounded gravels and pea gravel are not acceptable. Silty sands may be used with the Owner's approval but may require additional length of restrained joint pipe.

For ductile iron, steel, or concrete pipe larger than 4-inch diameter: Bedding material shall conform with Section 9-03.12(3) "Gravel Backfill for Pipe Zone Bedding" of the Standard Specifications except all shall pass a 1-inch sieve.

For PVC and HDPE water piping regardless of diameter: Bedding shall conform with Section 9-03.13 "Backfill for Sand Drains" of the Standard Specifications or as approved by the Owner.

For PVC sewer and storm piping, CPEP regardless of diameter, conduit, service lines, and all other piping 4-inch in diameter or less: Bedding shall conform with Section 9-03.13 "Backfill for Sand Drains" of the Standard Specifications or as approved by the Owner.

## Part 3 – Execution

### Installation/Construction

Bedding material shall surround the pipe and conduits to the limits shown on the Plans and provide uniform support along the entire length. Excavate bell holes to prevent concentrated loading at joints or bridging of the pipe. All bedding material shall bear on firm subgrade and be compacted to firm and unyielding condition.

### 2.11.5 Trench Backfill

*[CSI 31 23 23.54 or 31 23 33]*

#### Part 1 – General

##### Summary

All fill placed above the pipe bedding in a trench shall be "Trench Backfill". The trench backfill material has been selected to distribute surface loads over the utility. The grain size has been selected so that the trench backfill will not migrate into the pipe bedding or trench walls. Take particular care to maintain the integrity of the utility design by using the appropriate trench backfill material where shown.

##### References

Trench backfill shall consist of materials conforming to Section 9-03.19 "Bank Run Gravel for Trench Backfill" of the Standard Specifications or as approved by the Owner.

#### Part 3 – Execution

##### Installation/Construction

Trench backfill shall follow the requirements of WSDOT 7-09.3(10) and 7-09.3(11).

## 2.11.7 Gravel Base Course

*[CSI 32 11 23.10]*

### Part 1 – General

#### Summary

All fill placed directly under and against paving, foundations, and structures shall be “Gravel Base Course” unless otherwise called out on the Plans.

#### References

Aggregate for gravel base course under structures, and foundations shall conform to Section 9-03.10 Aggregate for Gravel Base or 9-03.9(3) Crushed Surfacing Base Course of the Standard Specifications.

Aggregate for gravel base course under roadways, paved areas, sidewalks, and for gravel areas shall conform to Section 9-03.9(3) Crushed Surfacing Base Course of the Standard Specifications.

## 2.11.8 Gravel Top Course

*[CSI 32 11 23.11]*

### Part 1 – General

#### Summary

Gravel travelled surfaces shown on the Plans shall be “Gravel Top Course”. Gravel top course may also be required directly under paving by the road jurisdiction or if shown on the plans.

#### References

Aggregate for gravel top course shall conform to Section 9-03.9(3) Crushed Surfacing Top Course and Keystone of the Standard Specifications.

## 2.12 Road Surfacing

*[CSI 32 10 00]*

### 2.12.3 Hot Mix Asphalt (HMA) / Asphalt Concrete Pavement (ACP)

*[CSI 32 12 16]*

### Part 1 – General

#### Definitions

The Plans and specifications may call out Hot Mix Asphalt (HMA) or Asphalt Concrete Pavement (ACP). The terms are synonymous.

## References

Hot Mix Asphalt for road paving and patching shall comply with the Jefferson County standard plans and/or specifications.

### **2.12.10 Pavement Marking/Striping**

*[CSI 32.17.23]*

#### **Part 1 – General**

##### **References**

Install pavement marking in accordance with 8-22 of the Standard Specifications and any Owner standards more stringent than the Standard Specifications.

#### **Part 3 – Execution**

##### **Repair/Restoration**

Replace pavement marking damaged or removed during construction. Cost is incidental to the contract unless a pay item is provided.

##### **Installation/Construction**

Provide markings on all new pavement per the local traffic agency's requirements.

Pavement marking shall match existing marking at the site unless noted otherwise on the Plans or within these specifications.

## **2.20 EARTH MOVING**

*[CSI 31 20 00]*

### **2.23 Excavation**

*[CSI 31 23 16]*

#### **Part 1 – General**

##### **Summary**

Excavate as necessary to construct the improvements shown.

#### **Part 2 – Products**

##### **Materials**

All excavated material below the organic layer can be re-used as backfill if it is properly protected from water saturation, meets the specification for the backfill purpose, and is approved by the Owner. Approval of material as backfill will be made the moment before placement of the material as backfill. Weather conditions may make previously approved material unsuitable for backfill requiring the material to be removed from the project site.

Excavated material that is not used as backfill shall be disposed off-site. All permits for the disposal of excavated material shall be obtained by the Contractor. A copy of all permits and

## **Part 3 – Execution**

### **Installation/Construction**

Excavation includes the digging, scraping, and removing existing native material, abandoned or interfering utilities, abandoned or interfering structures, and any other obstacles necessary for the construction of the improvements. Excavation includes utility excavation, structural excavation, and grading excavation.

Perform utility excavation to the depths necessary to complete the utility work shown.

Perform structural excavation to the limits shown and established by the Owner. Extend the base of the excavation laterally a minimum of 1 foot beyond the structure unless specified otherwise on Plans.

Excavated material may be stockpiled on-site. Temporary stockpiling of excavated material will not be permitted outside the construction limits at any time.

### **Examination**

The Owner will evaluate the base of the excavation to determine if it is suitable for backfilling. The Owner will evaluate the stability of the base of excavation by determining if all significant organic soils or other unsuitable materials have been removed.

### **Construction**

Perform excavation required by the Owner that is beyond the depth shown, per the direction of the Owner.

## **2.25 Temporary Erosion and Sedimentation Control**

*[CSI 01 57 13]*

### **2.25.3 Temporary Erosion and Sedimentation Control (No SWPPP)**

*[CSI 01 57 13.13]*

## **Part 1 – General**

### **Quality Assurance**

Contractor shall provide Temporary Erosion and Sedimentation Control (TESC) measures as necessary to meet the local/jurisdictional requirements and as required to meet anticipated site conditions. The Contractor shall add additional TESC facilities or processes as necessary to ensure that erosion and sedimentation problems do not occur. The Contractor shall inspect the TESC facilities daily and maintain the systems as necessary to prevent off-site damage.

## **Part 2 – Products**

### **Materials**

Straw or mulch shall be applied to exposed surfaces to minimize erosion and filter surface water runoff. Where straw or mulch is required for erosion control, apply to a minimum thickness of 2-inches. Straw shall not include Reed Canary grass.

## Part 3 – Execution

### Installation/Construction

All TESC systems including; fencing, earth berms, grasses, straw, mulch, culverts, drain pipe, outfalls, and other items required by for this project, must be installed prior to any clearing, grubbing, excavation, grading work, or other work that could result in off-site stormwater or material flows. TESC systems must remain in place throughout the duration of the construction activities. The systems may be relocated to complete construction activities if their location impedes the associated work. If the systems are relocated to complete any work, they must be reinstalled to protect the construction and surrounding areas prior to commencing work on other portions of the project.

Install systems such as mulch, plastic sheeting and hydroseed as soon as clearing, grading and excavation are complete if sites are 1-acre or less. Take care and diligence to minimize erosion exposure and provide TESC measures as shown on the Plans and required by construction practice.

Install stabilized construction entrances and wash pads at the beginning of construction activities and maintain for the duration of the project. Keep wash pads clean to prevent the transport of sediment onto adjoining roads.

Install earth berms as necessary to prevent surface water migration into excavations or off the project site. Route surface water intercepted by earth berms to an approved stormwater conveyance system. Ensure that the concentration of surface water at the earth berm does not erode the adjoining or downstream properties. Remove sediment deposited against the earth berm so surface water can flow freely. Do not remove the earth berm before the stabilization of the surface downhill from the berm.

### 2.25.4 Temporary Storm Water Pollution Control (No SWPPP)

*[CSI 01 57 23]*

## Part 3 – Execution

### Field Quality Control

The Contractor shall be responsible for meeting all construction stormwater discharge water quality requirements including State of Washington (WAC 173-220-020), Construction Stormwater Permit requirements and local requirements regardless of weather conditions.

If the project is fined by the permitting authority, that fine shall be paid by the Contractor at no additional cost to the Owner.

## 2.25.5 Filter Fabric Fence

*[CSI 01 57 13 or 01 57 23]*

### Part 2 – Products

#### Materials

Filter fabric per section 8-01.3(9)A2 and section 9-33.2(1), Table 6, of the WSDOT Standard Specifications.

### Part 3 – Execution

#### Installation/Construction

Install a filter fabric fence to allow the collection and passage of surface water through the fabric before discharge off site. When joints are necessary, splice filter fabric together at a support post with a minimum overlap of six inches. Secure both ends of the fabric to the post. Install the filter fabric fence following the contours of the existing grade where feasible. Drive the fence posts securely into the ground a minimum of 30-inches and spaced apart at a maximum of six feet. Fasten a wire mesh support fence securely to the uphill side of the posts using heavy-duty wire staples at least one inch long, tie wires, or wire rings. Extend the wire into the trench a minimum of four inches and not more than 36 inches above the existing surface. Excavate an 8-inch by 12-inch trench on the uphill side of the fence for securely burying the lower edge of the fabric fence. Extend at least 20 inches of the filter fabric fence continuously into the trench. Extend the filter fabric fence 36-inches above the existing grade. Secure the filter fabric placed in the trench with backfill material of three-quarter inch washed rock. Place the backfill material in the trench and on either side of the fence as shown on the construction Plans.

#### Field Quality Control

Inspect the filter fabric fence immediately after each rainfall and at least once daily during periods of prolonged rainfall. Repair or replace sections of the filter fabric fence that are not filtering surface water. The filter fabric fence may be removed after the threat of off-site contamination has passed.

## 2.50 EXCAVATION SUPPORT AND PROTECTION

*[CSI 31 50 00]*

### 2.51 Contractor Designed Shoring

*[CSI 31 50 10]*

#### Part 1 - General

##### Summary

Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it is the responsibility of the Contractor to design, furnish, place, maintain, and remove supports in accordance with applicable laws, codes, and safety requirements.

## References

Chapter 296-155 of WAC, “Safety Standards for Construction Work, Part N, Excavation, Trenching, and Shoring”.

OSHA

## Quality Assurance

Where the Contractor is required to provide the shoring design, it shall be prepared by a competent person as defined by WAC 296-155-650. Before beginning any excavation that is governed by the shoring requirements, the Contractor shall submit their stamped shoring plan and calculations to the Owner for approval. The stamp must be present on all Plans and calculations, and all submittals must be approved by the Owner prior to starting work.

## Part 3 - Execution

### Installation/Construction

Design, planning, installation, and removal of sheeting, shoring, sheet piling, lagging, and bracing shall maintain the undisturbed state of soil below and adjacent to excavation.

## 2.90 LANDSCAPING

*[CSI 32 90 00]*

### 2.90.2 Landscape Grading

*[CSI 32 91 19]*

#### Part 3 – Execution

##### Installation/Construction

Perform fine grading within Contract limits, including adjacent transition areas, to new elevations, levels, profiles and contours indicated. Provide subgrade surfaces parallel to finished surface grades, unless specified otherwise. Provide uniform levels and slopes between new elevations and existing grades. All fills required to achieve subgrades shall be compacted per requirements of the fill type as noted above. For landscaping areas, all fill shall be compacted between 80 to 85 percent of modified proctor (ASTM D-1557) unless noted otherwise on the Plans.

Perform grading, within branch spread of existing trees scheduled to remain, by hand methods to elevations indicated. Cut roots cleanly to depth 3 inches below proposed finish grade. Treat cut roots over 1-inch in diameter with asphaltic pruning paint.

## 2.90.3 Soil Amendments

### 2.90.10 Topsoil

*[32 91 19.20]*

#### Part 2 – Products

##### Materials

Protect existing topsoil in seeding/planting areas or remove and stockpile for later use. Existing topsoils that are contaminated or degraded due to the Contractor's activities shall be replaced by the Contractor at no cost to the Owner.

Import topsoil shall be naturally occurring surface soil with a maximum sand content of 60 percent. Topsoil shall have no evident rocks or debris over 1/2-inch. Acidity pH range shall be between 5.0 and 6.5. Organic matter content shall be 10 to 20 percent by dry weight. Add dolomite limestone, if required, to obtain pH. Limestone, if used, shall be finely ground, passing a minimum of 90 percent through the U.S. Standard No. 8 sieve and 20 percent through the U.S. Standard No. 100 sieve. Add approved nutrients, if required, to bring nutrients to a satisfactory level for planting as recommended by a qualified testing laboratory (exclude nitrogen, potassium, and phosphorus).

#### Part 3 – Execution

##### Installation

In planter areas, soil excavated shall be mixed with organic compost in a ratio of 1/3 organic compost to 2/3 sandy loam.

In seeding areas, place topsoil and rake or blade to a smooth, consistent surface. Do not compact. Install 2-inch depth topsoil unless specified otherwise on the plans or within the specific seeding/planting specification section.

Dispose of excess soil per the Owner's instructions.

### 2.90.11 Hydroseed

*[CSI 32 92 19.16]*

#### Part 1 – General

##### Related Sections

- Division 2.90.21 Erosion Control Matting

##### Scheduling

Apply hydroseed within the optimum seeding windows whenever possible. Hydroseed may be used for temporary erosion control only with the approval of the Owner. Time construction practices to minimize bare, cleared, and excavated areas so that surfaces are hydroseeded and seed germinates and grows stabilizing surfacing as soon as possible. The optimum seeding windows are April 1 through June 30 and September 1 through October 1. Seeding that occurs between July 1 and August 30 will require irrigation until 75 percent grass cover is established.

Seeding that occurs between October 1 and March 30 will require a mulch layer 2-inches thick until 75 percent grass cover is established.

**Maintenance**

Provide temporary irrigation, mulch or plastic sheeting (plastic sheeting for short term protection only, 7 days maximum) to hydroseeded areas as required for establishment and to protect the seed from construction activities at no additional cost to the Owner.

**Part 2 – Products**

**Materials**

Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. Mulch may be made up of 100-percent: cottonseed meal; fibers made of wood, recycled cellulose, hemp, and kenaf; compost; or blends thereof. Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide or polymers. Mulch or tackifier product used shall be installed per manufacturer’s instructions.

Areas that have seed applied by hand shall have a minimum 2-inch thick layer of compost-based mulch or 1-inch layer of topsoil. Slow-release fertilizers shall be used. Fertilizer shall not be agitated more than 20 minutes in the hydromulch machine before it is to be used.

On 2:1 slopes and less, Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products may be used in lieu of erosion control mat. BFM/MBFM products are applied with approximately 10 percent tackifier. BFM/MBFM shall be allowed to cure 24-36 hours before rainfall and shall not be installed on wet or saturated soils.

Western Washington Hydroseed Mix

Install seed, fertilizer, and mulch for hydroseed mix at the following application rates:

- Seed            180 pounds per acre
- Fertilizer      90 pounds per acre, 10-4-6 Nitrogen-Phosphorus-Potassium (N-P-K)
- Mulch           1,500 pounds per acre
- BFM/MBFM    3,000 pounds per acre (for 2:1 slopes and steeper)

<b>Ditch/Pond Seed Mix</b>			
<b>Name</b>	<b>Proportion by Weight</b>	<b>% Purity</b>	<b>% Germination</b>
Tall or Meadow Fescue	75-80%	98%	90%
Seaside/Creeping Bentgrass	10-15%	92%	85%
Redtop Bentgrass	5-10%	90%	80%
<b>All Other Areas Seed Mix</b>			
<b>Name</b>	<b>Proportion by Weight</b>	<b>% Purity</b>	<b>% Germination</b>
Redtop or Oregon Bentgrass	20%	92%	85%
Red fescue	70%	98%	90%
White Dutch Clover	10%	98%	90%

## **Part 3 – Execution**

### **Preparation**

The seedbed should be firm and rough. All soil should be roughened regardless of slope. If compaction is required, slopes must be track walked before seeding. Backblading or smoothing of slopes greater than 4:1 is not permitted if they are to be seeded.

### **Installation**

All disturbed surfaces within the project not otherwise covered by asphalt, gravel, quarry spalls, concrete, or other plant material/landscape items shall be hydroseeded, except ditches and swales may have seed applied by hand. Apply seed prior to installing erosion control blankets.

### **Field Quality Control**

These specifications are the minimum requirements for the anticipated conditions. The Contractor is responsible to ensure seeded areas establish ground cover and to provide any additional measures necessary to establish ground cover in seeded areas. Any seeded areas that fail to establish at least 75-percent cover (100-percent cover for areas that receive sheet or concentrated flows) shall be reseeded at no additional cost to the Owner.

Provide a temporary irrigation system until growth is established if hydroseeding is applied between April 1<sup>st</sup> and October 1<sup>st</sup> in Western Washington or Oregon, or for any work at any time in Eastern Washington. Remove temporary irrigation systems when no longer required.

## **2.92.30 Weed Control**

*[CSI 32 01 90.41]*

### **Part 1 – General**

#### **Definitions**

Weeds are defined as the common definition. An undesired plant.

Grasses (other than ornamental grasses) growing within planter areas shall also be considered a weed.

Weed Control means eradication of weeds by mechanical, chemical, or biological means that prevents regrowth for no less than 6 months.

#### **Performance Requirements**

Control weeds within the construction limits and any areas disturbed by construction activities.

#### **Submittals**

Submit on chemicals or biological processes proposed for weed control.

#### **Scheduling**

Intermittent weed control activities should be expected during construction. Final weed control shall occur after final site cleanup and prior to project acceptance.

### **Part 3 – Execution**

#### **Installers**

Products used that are not consumer-purchasable at public retail stores may only be applied by an applicator with a Commercial Applicator or Commercial Operator license.

#### **Field Quality Control**

The Contractor is responsible for confining weed control products to the site.

# Division 3

## Concrete

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### 3.00 GENERAL

Sections in these specifications titled “*Common Work for . . .*” apply to all following subsections whether directly referenced or not.

### 3.05 Common Work for Concrete

*[CSI 03 05 00]*

#### Part 1 - General

This division covers that work necessary for furnishing and installing all concrete as described in these specifications and as shown on the Plans.

#### References

Materials shall conform to the following standards:

- Cement - ASTM C150
- Coarse aggregate - ASTM C33
- Fine aggregate - ASTM C33
- Admixtures - ASTM C494
- Air-entraining admixtures – ASTM C260
- Fly Ash – ASTM C618

#### Submittals

Submittal information shall be provided to the Owner for the following items:

- Concrete mix design including aggregate gradation and substantiating strength data.
- Admixture Data
- Concrete anchors
- Grouts

Concrete mix designs shall be submitted to the engineer for approval a minimum of two weeks prior to placing any concrete. The mix design shall include the amounts of cement, fine and coarse aggregate, water and admixtures, as well as the water cement ratio, slump, concrete yield, aggregate gradation, and substantiating strength data in accordance with ACI 318, Chapter 5. A batch plant inspection may be required, the cost of which shall be paid by the Contractor. Review of mix submittals by the engineer of record indicates only that information presented conforms generally with contract documents. Contractor or supplier maintains full responsibility for specified performance.

## **Part 2 - Products**

### **Components**

Nominal maximum size for aggregates is the smallest standard sieve opening through which the entire amount of aggregate is permitted to pass. Provide intermediate aggregate grades as required to achieve a well-graded mix.

All concrete surfaces exposed to weather or standing water shall be air entrained. Total air content shall be in accordance with IBC requirements unless specified otherwise herein. Air shall be measured at the truck, unless otherwise agreed to.

Water used in concrete shall be potable.

Fly ash may be substituted for up to 15 percent of the required cement, except where noted.

### **Mixes**

Concrete shall be mixed, conveyed, and proportioned in accordance with IBC section 1905.

The concrete mix shall include the amount of cement, fine and coarse aggregate, including aggregate gradations, water, and admixtures as well as water cement ratio, slump, concrete yield, and sustaining strength data in accordance with these specifications, the requirements of the International Building Code Section 1905, and the requirements of ACI 318.

### **Finishes**

Coat all aluminum in contact with concrete as specified in Division 9.

## **Part 3 - Execution**

### **Inspection**

Also comply with local building department and permit requirements for inspection and notification.

The Contractor shall repair, replace or modify, as appropriate, any items noted in the Special Inspector's inspection or the building department inspection.

### **Testing**

Concrete strength tests shall be performed per section 1905.6 of the IBC and per the requirements noted herein. The Owner will provide and pay all costs of concrete testing. The Engineer shall be furnished with copies of all inspection reports and test results.

Cylinders used for concrete strength tests shall be 6 by 12. Four by 8 cylinders may be used for mixes with maximum aggregates less than 1-inch, however the testing lab must apply a 0.94 multiplier to the compressive strength test results unless data acceptable to the Engineer is presented that would justify a higher multiplier. All mixes utilizing aggregates over 1 inch shall be tested using 6 by 12 cylinders.

When 4 by 8 cylinders are utilized AASHTO T23 requirements shall be followed, and the retainer used with neoprene pads when testing for compressive strength shall be constructed according to ASTM C1231.

The Contractor will coordinate all concrete testing with the testing agency. Costs will be paid by the Owner.

Give the Owner and testing agency 48-hour notice prior to concrete placement. If Contractor fails to provide the required notice, the Owner may elect to cancel the affected concrete placement. Contractor shall be responsible for costs and delays due to improper notification.

If the Contractor schedules a concrete placement and does not notify the Owner and testing agency of a cancellation within 24 hours of the scheduled placement, the Contractor shall pay the testing agency costs for an unnecessary trip. If the Contractor fails to provide the testing agency with adequate notification and testing agency cannot attend concrete placement, Contractor shall reschedule placement. Contractor shall be responsible for all associated delays.

The Contractor shall provide all assistance and cooperation necessary to testing personnel to obtain the required concrete tests. Contractor and Owner will have access to testing results as soon as they are available.

The testing agency shall take a minimum of four samples for every 50 yards of concrete placed (and a minimum of four per pour); one for a 7-day test, two for 28-day tests, and one for backup testing in case the other two samples do not meet design strength. Additional samples may be taken to verify strength prior to form removal at the Contractor's expense.

### **3.10 FORMING AND ACCESSORIES**

*[CSI 03 10 00]*

#### **3.11 Formwork**

*[CSI 03 11 00]*

##### **3.11.13 Structural Cast in Place Forming**

*[CSI 03 11 13]*

#### **Part 2 – Products**

##### **Materials**

Unless otherwise directed, coat contact surface of forms with colorless, non-staining, mineral oil that is free from kerosene, or other approved suitable material, to permit satisfactory removal of forms without concrete damage. Form-release agent for interior of potable water storage structures shall be National Sanitation Foundation Standard (NSF) No. 61 approved for use in direct contact with potable water.

Form construction for surfaces covered with backfill shall be made of steel, plywood, or dressed, matched lumber. Form construction for exposed surfaces shall be made of new plywood or steel without surface markings.

Form ties for use in liquid containment structures shall be standard plastic cone snap-ties with 3/4-inch diameter neoprene waterstop washer or removable taper ties. Use Greenstreak

X-plugs with removable taper ties or equal. Contractor shall submit to the Engineer form ties to be used for review prior to installation.

### **Part 3 - Execution**

#### **Installation/Construction**

Concrete forms shall be sufficiently tight to prevent leakage of concrete or mortar and shall be properly braced or tied together to maintain desired position and shape until removed.

Conduits, pipes and sleeves of any material not harmful to concrete and within the limitations of ACI 318, Section 6.3 are permitted to be embedded in concrete with approval of the Engineer. Provide a  $\frac{3}{4}$ -inch chamfer or radius at all exposed corners and edges, unless specifically stated otherwise on the Plans.

Forms shall remain in place until the concrete has developed sufficient strength to withstand imposed loads without damage or deflection. Wall and slab forms shall remain in place for a minimum of 24 hours after completion of the pour. Forms for beams and suspended slabs shall remain in place for a minimum of 14 days AND until concrete has developed 28-day design strength, unless approved by the Engineer. The Contractor shall coordinate with the testing lab to verify concrete strength prior to form removal.

Do not allow water to flow through areas where forms are to be placed. During form construction and prior to placement of concrete, keep footings and floor slab areas free of standing water.

#### **Field Quality Control**

Variations from plumb, specified grade, conspicuous lines, and walls shall not exceed plus or minus  $\frac{1}{4}$ -inch in any 10-foot length, and shall not exceed one inch over the entire length. Variations from dimensions shall not exceed plus or minus  $\frac{1}{2}$ -inch. Closer tolerances shall be achieved by the Contractor as necessary to accommodate equipment and other permanent materials.

### **3.15 Concrete Accessories**

*[CSI 03 15 00]*

### **3.20 REINFORCING**

*[CSI 03 20 00]*

### **3.21 Reinforcement Bars**

*[CSI 03 21 00]*

### 3.21.11 Plain Steel Reinforcement Bars

*[CSI 03 21 11]*

#### Part 1 - General

##### References

ACI – American Concrete Institute- latest edition

CRSI Manual of Standard Practice – latest edition

#### Part 2 - Products

##### Materials

Grade – ASTM A706, Grade 60

ASTM A615, Grade 60 shall be permitted if:

- (a) The actual yield strength based on mill tests does not exceed  $f_y$  by more than 18,000 psi; and,
- (b) The ratio of actual tensile strength to the actual yield strength is not less than 1.25.

Detailing - ACI 318 and ACI 315

Lap requirements - See schedule on Plans or as required by ACI 318

Tie wire - 16 gauge minimum

Bar supports shall conform to “Bar Support Specification” CRSI Manual of Standard Practice, MSP-1-80. Provide Class 1, plastic protected bar supports. Use pre-cast concrete blocks to support bars off ground. Bar supports in water holding and buried structures shall be non-metallic.

Bar supports for the bottom rebar mat of suspended slabs or beams in water holding structures must be point supports (chairs or dobbies), not continuous.

#### Part 3 - Execution

##### Installation

Reinforcing steel shall be detailed in accordance with ACI 315 and 318 and as shown on the Plans. Bend wire bar ties away from formwork to provide the same concrete clearance as shown on the Plans to the bars.

Welding of reinforcing steel shall not be performed unless specifically approved by the Engineer. If approved, Contractor will arrange and pay for all required Special Inspections associated with welding of reinforcing steel.

##### Field Quality Control

Reinforcing steel shall be free of rust and loose scale at time of concrete placement. Bars with kinks, improper bends, or reduced cross-section due to any cause will not be used. Bars shall not be field bent. Bars may not be tack-welded or otherwise heated.

If, within the project warranty period, rust spots appear on the concrete due to failure to achieve proper clearance on the rebar or wire ties, the Contractor shall grind out and patch the areas using a method satisfactory to the engineer.

### **3.30 CAST-IN-PLACE CONCRETE**

*[CSI 03 30 00]*

#### **3.30.05 Common Work for Cast in Place Concrete**

*[CSI 03 30 05]*

##### **Part 1 - General**

###### **Delivery**

Concrete shall be transported in a truck mixer to the jobsite and discharged within 1.5 hours after cement has been added to water or aggregates. Rejected concrete will be at Contractor's expense.

##### **Part 2 - Products**

###### **Components**

If allowed, curing materials shall conform to ASTM C171 and liquid membrane-forming compounds shall conform to ASTM C309. When concrete is to be coated or stained, use UV-dissipating form release and curing compounds.

##### **Part 3 - Execution**

###### **Preparation**

Do not place concrete during rain, sleet, or snow until water and freezing protection is provided.

Position embedded items accurately, and support against displacement or movement during placement.

Fill voids in sleeves, insets, anchor slots, etc., temporarily with readily removable materials to prevent entry of concrete into voids.

Before beginning placement of concrete, remove hardened concrete and foreign materials from inner surface of mixing and conveying equipment. Before depositing concrete, remove debris from space to be occupied by the concrete. Secure reinforcement in position to prevent movement during concrete placement.

At the beginning of the concrete pour for walls taller than 8 feet, place a 1½ to 2½-inch thick grout pad prior to placing the concrete for the wall. Grout mix shall consist of fine aggregates, concrete and water in the same ratios as used in the wall concrete. The placement of the concrete shall proceed immediately after the grout placement so as to prevent any cold joints.

At construction joints, thoroughly clean surface of existing concrete to remove laitance. Roughen existing concrete surface to expose aggregate uniformly and apply approved

bonding agent to existing concrete in accordance with manufacturer's recommendations. Prior to placing fresh concrete, dampen joint and coat with grout mixture in accordance with ACI 301, Section 8.5.

### **Installation**

Placement shall be in accordance with IBC, Section 1905.

Place no concrete when air temperature is below or expected to be below 40 degrees during the 28-day curing period unless a low temperature concrete mix has been approved by the Owner. Provide adequate equipment for heating materials and protecting concrete during freezing or near freezing weather. Keep materials, reinforcement, forms, and ground in contact with concrete free from frost at time of placement. Heat mixing water as required. Use no materials containing ice.

Place no concrete when air temperature exceeds or is expected to exceed 85 degrees during the 28-day curing period unless a high temperature placement plan has been approved, and unless adequate precautions are taken to protect work. Cool ingredients prior to mixing. Flake ice or crushed ice of a size that will melt completely during mixing may be substituted for all or part of water. Cool forms and reinforcing prior to placing concrete.

Handle concrete from mixer, ready-mixed truck, or from transporting vehicle to place of final deposit by methods which prevent separation or loss of ingredients. Under no circumstances shall concrete that has partially hardened be deposited.

Place concrete in maximum lifts of 3 feet. Deposit concrete continuously so that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams and planes of weakness within the section. If a section cannot be placed continuously, locate and reinforce construction joints at points as provided for in the Plans or as approved by the Owner. Maximum concrete drop shall be 5 feet.

Consolidate concrete by vibration, supplemented by hand spading, rodding, forking, or tamping. Thoroughly work concrete around reinforcement, around embedded items, and into corners of forms to eliminate air or rock pockets which may cause honeycombing, pitting, or planes of weakness. Insert and withdraw internal vibrators at points approximately 18 inches in each direction and extend into the lower concrete lifts. At each insertion, the duration shall be sufficient to consolidate the concrete; but not sufficient to cause segregation. Do not use vibrators to transport concrete within forms. Consolidate slabs by utilizing vibrating screeds, roller pipe screeds, internal vibrators, or other approved methods. Have a spare vibrator available at jobsite during concrete placing operations.

After removal of forms, cut out and patch defects in concrete surfaces. Remove form tie cones. Cut or snap off form ties to a depth of 3/4-inch. Chip out rock pockets, holes from form tie removal, and other defects to solid concrete. Repair defects in accordance with 3.01.30.71.

## **3.31 Structural Concrete**

*[CSI 03 31 13]*

### **3.31.30 Thrust Blocks, Driveways, Curb, Gutter, Sidewalks, Equipment Pads, and Fence Posts**

*[CSI 03 31 13.10]*

#### **Part 1 - General**

##### **Summary**

All concrete for non-structural applications including thrust blocks, driveways, sidewalks, equipment pads, and fence post foundations. Hydraulic or Structural Concrete may be substituted.

##### **Performance Requirements**

28-day compressive strength – 4,500 psi minimum

#### **Part 2 - Products**

##### **Mixes**

Water/cement ratio - 0.45 maximum

Nominal maximum aggregate size – ¾-inch (AASHTO Grading No. 67)

Entrained air ratio – 3.5 percent minimum to 6.5 percent maximum

### **3.34.13 Controlled Density Fill (CDF)**

*[CSI 03 34 13]*

#### **Part 1 - General**

##### **Submittals**

Revisions to the mix design shall be submitted to the Engineer for approval.

##### **Performance Requirements**

CDF as shown on the Plans or as directed by the Engineer shall be proportioned to be flowable, non-segregating, and excavatable, and shall conform to the following requirements:

- Maximum Compressive Strength 300 (psi).
- Minimum 28-day compressive strength 100 (psi).

#### **Part 2 - Products**

##### **Mixes**

- Pounds of cement per cubic yard (approx.) 50.
- Pounds of fly ash per cubic yard (approx.) 250.
- Pounds of dry aggregate per cubic yard (approx.) 3,200.

If air containing or water reducing admixture is used for flowability, total water and aggregates may be adjusted for yield. Weights may be adjusted for flowability and pumpability.

### **Part 3 - Execution**

#### **Field Quality Control**

Protect CDF for at least 24 hours after placement or for a duration as necessary to prevent displacement by construction equipment or traffic. CDF placing may be started if weather conditions are favorable, when the temperature is a minimum of 34 degrees Fahrenheit and rising. At the time of placement, CDF must have a temperature of at least 40 degrees Fahrenheit. Placing shall stop when the temperature is 38 degrees Fahrenheit or less and falling. CDF shall not be placed on frozen ground.

Cure CDF used for fill or pipe encasement for the following minimum durations prior to placement of any material directly over the CDF. If traffic must be restored prior to the duration stated, or the open excavation must be closed for safety, span the excavation with temporary plating appropriate for the anticipated loading. Cold weather may require more time. Curing accelerators may be used to reduce these times if approved by the Owner.

- Pipe encasement: 4 hours.
- Non-traffic: 24 hours.
- Vehicular traffic under 5,000 lbs per axle: 48 hours
- Vehicular traffic over 5,000 lbs per axle: 72 hours
- Permanent structures: 7 days.

### **3.34.16 Concrete Fill**

*[CSI 03 34 16]*

#### **Part 1 - General**

##### **Summary**

Use for all concrete shown on the Plans as Concrete Fill. Use water reducers as required for flowability.

##### **Performance Requirements**

Slump –as required for placement.

28-day compressive strength – 2,500 psi minimum

#### **Part 2 - Products**

##### **Mixes**

Water/cement ratio - 0.50 maximum

Nominal maximum aggregate size – 3/8-inch

Entrained air ratio – 5.0 percent minimum to 8.0 percent maximum

### **3.35 Concrete Finishing**

*[CSI 03 35 00]*

#### **3.35.05 Common Work for Surface Finishing**

*[CSI 03 35 05]*

##### **Part 2 - Products**

###### **Finishes**

Each concrete area that requires finishing shall conform to one of the following requirements:

- Floors – Floated or Light Brush as directed by Owner

##### **Part 3 - Execution**

###### **Preparation**

Do not place concrete which requires finishing until the materials, tools, and labor necessary for finishing the wet concrete are on the job and acceptable to the Owner. If rainfall is possible, tent the work area prior to the pour and maintain protection until the concrete is cured sufficiently to resist damage.

#### **3.35.54 Floated Finish**

*[CSI 03 35 54]*

##### **Part 3 - Execution**

###### **Construction**

Consolidate, strike off, and level concrete; but do not work further until ready for floating. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit floating operations. Consolidate surface with power-driven floats. Hand floating may be used if area is small or inaccessible to power units.

###### **Field Quality Control**

Check surface planeness during or after first floating. Cut down high spots and fill low spots to produce surface with tolerance of 1/4-inch in 10 feet in any direction. Refloat to a uniform, smooth, sandy texture immediately after leveling.

#### **3.35.56 Light Brush Finish**

*[CSI 03 35 56]*

##### **Part 2 – Products**

###### **Finish**

When concrete has appropriately set, finish with light soft broom finish. Brush perpendicular to slab slope.

## **Part 3 - Execution**

### **Construction**

Consolidate, strike off, and level concrete; but do not work further until ready for floating. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit floating operations. Consolidate surface with power-driven floats. Hand floating may be used if area is small or inaccessible to power units.

### **Field Quality Control**

Check surface planeness during or after first floating. Cut down high spots and fill low spots to produce surface with tolerance of 1/4-inch in 10 feet in any direction. Re-float to a uniform, smooth, sweat finish concrete.

## **3.40 PRE-CAST CONCRETE**

*[CSI 03 40 00]*

### **3.48 Pre-Cast Concrete Specialties**

*[CSI 03 48 00]*

#### **3.48.50 Utility Structures**

*[CSI 03 48 50, 33 05 61, 33 05 63]*

## **Part 3 - Execution**

### **Cleaning**

Fill picking holes with grout flush to the structure surface, including those in vault lids. Cut, remove, and grind smooth shipping lifting hooks on the vault interior, unless directed otherwise by the Engineer.

## **3.60 GROUTING**

*[CSI 03 60 00]*

### **3.62 Non-Shrink Grouting**

*[CSI 03 62 00]*

#### **3.62.13 Non-Metallic Non-Shrink Grout**

*[CSI 03 62 13]*

## **Part 1 - General**

### **Summary**

Use Precision Non-Shrink Grout for grouting all equipment base plates, pipe supports, and base plates for metalwork. Precision Non-Shrink grout may also be used for all other non-shrink grouting operations. General Purpose Non-Shrink grout may be used for any

applications other than those noted for Precision Non-shrink Grout. Non-shrink grout shall be used to seal all new pipe and conduit penetrations (watertight) into and out of all concrete and CMU block walled structures.

### **Storage and Handling**

Stockpile grout to prevent contamination from foreign materials and store admixtures to prevent contamination or damage from excess temperature change

## **Part 2 - Products**

### **Materials**

#### Precision Non-Shrink Grout:

Provide a high-precision, fluid, non-shrink, quartz or non-catalyzed metallic aggregate grouting material. Provide a ready-to-use grout that hardens free from bleeding, settlement, or drying shrinkage when mixed, placed and cured at any consistency – fluid, flowable, plastic or damp-pack.

Provide precision, non-shrink natural aggregate grout that when cured produces the following properties:

- A. Compressive Strength at fluid consistency (ASTM C109-Modified): 3500 psi (24 MPa) at 1 day, 7500 psi (52 MPa) at 28 days.
- B. Passes ASTM C1107 as a grade B grout when tested as temperature minimum and maximums of 45 degrees Fahrenheit to 90 degrees Fahrenheit (8 degrees Celsius to 32 degrees Celsius) at a working time of 30 minutes. Grout must be tested at a fluid consistency per ASTM C939 and remain fluid at temperature range minimum and maximums for the 30-minute working time. All materials including water must be mixed and tested at temperature minimum/maximums.
- C. Modulus of Elasticity at 28 days at fluid consistency (ASTM C469):  $3.0 \times 10^6$  psi (20.7 GPa) minimum,  $3.9 \times 10^6$  (27.0 GPa) maximum.
- D. Coefficient of Thermal Expansion for fluid consistency (ASTM C531):  $7.5 \times 10^{-6}$ /degrees Fahrenheit maximum ( $13.5 \times 10^{-6}$ /degrees Celsius).
- E. Flexural strength at 28 days for fluid consistency (ASTM C78): 1300 psi (7.9 MPa).
- F. Resistance to rapid freezing – thawing (ASTM C666, Procedure A): 300 cycles- min RDF 90 percent.
- G. Split tensile strength at 28 days at fluid consistency (ASTM C496): 450 psi (3.1 MPa).
- H. Pass 24-hour grout test under stated temperature, time and fluidity constraints. See MBT Protection and Repair 24-hour Grout Form.

Precision non-shrink grout shall be MasterFlow 928 or 885 Grout or approved equal.

#### General Purpose Non-Shrink Grout:

General Purpose Non-shrink grout shall meet the compressive strength and non-shrink requirements of CRD-C 621, Grades B and C; Corp of Engineers Specification for

Non-shrink grout; and ASTM C1107, Grades B and C. General Purpose Non-shrink grout shall be MasterFlow 713, Dayton Superior 1107 Advantage, or approved equal.

Provide curing compounds as recommended by the grout manufacturer.

Water to be used in mixing the grout shall be potable.

### **Mixes**

Comply with grout manufacturer's recommendations for mixing procedures.

Adjust water temperature to keep mixed grout temperature in the range of 45 degrees Fahrenheit (7 degrees Celsius) and 90 degrees Fahrenheit (32 degrees Celsius) minimum/maximum.

Use cold or iced water to extend working time in hot weather or in large placements.

Use warm water in cold conditions to achieve minimum as mixed temperatures.

## **Part 3 - Installation**

### **Preparation**

Mechanically remove unsound concrete within the limits of the grout placement.

Remove at least 1/4-inch (6mm) of existing concrete facing and continue removal as required to expose sound aggregate.

Thoroughly clean the roughened surface of dirt, loose chips, and dust. Maintain substrate in a saturated condition for 24 hours prior to grouting. Surface should be saturated surface dry at time of grouting.

Clean baseplates and other metal surfaces to be grouted to obtain maximum adhesion. Remove loose rust and scale by grinding or sanding.

Comply with grout manufacturer's recommendations for form construction. Construct forms to be liquid tight.

### **Installation**

Place grout mixture into prepared areas from one side to the other. Avoid placing grout from opposite sides in order to prevent voids. Work material firmly into the bottom and sides to assure good bond and to eliminate voids.

Ensure that foundation and baseplate are within maximum/minimum placement temperatures. Shade foundation from summer sunlight under hot conditions. Warm foundation when foundation temperature is below 45 degrees Fahrenheit (7 degrees Celsius).

Wet cure exposed shoulders for 48 hours followed by two coats of curing compound for best results. The minimal requirement is to wet cure until grout has reached final set, followed by two coats of curing compounds.

# Division 15

## Mechanical

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### 15.00 GENERAL

This division covers the work necessary for furnishing and installing mechanical appurtenances and accessories as described in these Specifications and shown on the Plans.

Sections in these specifications titled “*Common Work for . . .*” shall apply to all following subsections whether directly referenced or not.

### 15.05 Common Work for Mechanical

*[CSI 33 05 00]*

#### Part 1 - General

##### Summary

Provide the necessary piping, plumbing, fittings, and appurtenances to make all piping systems complete, tested, and ready for operation as specified herein and as shown on the Plans. Some fittings that are necessary for the complete piping system installation and operation may not have been shown. Provide fittings, pipe, and appurtenances necessary, whether shown on the Plans or not, to make all piping systems complete, tested, and ready for operation.

Some pipe supports, thrust blocking, and tie rods are not shown on the Plans. Provide pipe supports, thrust blocking, and tie rods for pipes as required by accepted design criteria to support and restrain the loads encountered.

##### Submittals

Submittal information shall be provided to the Owner for the following items:

- Copper pipe and fittings
- PVC pipe and fittings
- Floor drains and cleanouts
- Pressure gauges
- Other mechanical components listed in this division or required by the Engineer

### 15.10 BURIED PIPE INSTALLATION

*[CSI 33 05 05]*

#### Part 1 – General

##### Site Conditions

Existing soils are unclassified except where specifically identified on the Plans or specification.

## Part 3 - Execution

### Preparation

Pothole ahead of pipe-laying a sufficient distance at located utility crossings and where noted on the plans to allow room to make vertical adjustments as necessary to avoid existing utilities. Should the Contractor fail to pothole identified utility crossings, any subsequent adjustments necessary shall not be cause for cost or time claim. If the area potholed is in a travelled area and will be reopened to traffic more than one day in advance of pipelaying through the zone, the hole shall be patched with hot or cold mix, the cost of which shall be incidental.

Provide the results of potholing to the Owner no less than two working days in advance of utility installation. Provide a written record of size, materials, and locations for found utilities to an accuracy of 0.5 foot horizontal and 0.1 foot vertical. Failure to record locations clearly and legibly will result in non-payment.

### Installation

Install pipes to the depth shown on the trench detail, unless superseded by depth shown on the profile. Unless specified otherwise, install pipe to the following tolerances:

- Pressure pipes: 0.5 feet horizontal, 0.2 feet vertical. Regardless of vertical tolerance, do not create new high points not otherwise shown on the plans.

All non-metallic pipe, including service and air valve lines, shall include a tracer wire taped every 5 feet to the top of the pipe. Loop tracer wire to the surface in accessible locations such as valve boxes, meter vaults, or other surface access. If no access is available for more than 1,500 feet, provide a valve box specifically for the tracer wire. Wire shall be solid UF, 12AWG minimum for 2,000 foot runs and less, or 10AWG for runs longer than 2,000 feet.

Keep openings in pipe closed during the progress of work. Install plugs to prevent water and debris from entering pipe. No payment will be made to clean pipes.

## 15.11 Open Trench Pipe Installation

*[CSI 33 05 05]*

### 15.11.11 Pressure Pipe Installation

*[CSI 33 05 05]*

#### Part 1 - General

#### References

Use materials and installation methods in accordance with the latest edition of the Uniform Plumbing Code and local codes and regulations that are applicable.

## Part 3 - Execution

### Installation

Install pipes in accordance with the manufacturer's recommendations. Use types and sizes of pipes as specified herein and/or as shown on the Plans. Where small pipe sizes are omitted from the Plans and not mentioned in the specifications, use sizes corresponding to code requirements and as required by equipment and plumbing fixtures and appurtenances. Properly size any undesignated pipe sizes for the functions to be performed.

Lay pipe and supports at proper lines and grades. Follow the piping runs shown on the Plans as closely as possible, except for minor adjustments to avoid architectural and structural features. Make major relocations, if required, in a manner acceptable to the Owner.

Keep openings in pipes closed during progress of work.

Form thrust blocking so that bolts, joints, gaskets, and flanges of adjacent joints are clear of concrete allowing bolts and joints to be dismantled without removing concrete. All concrete blocking shall have a minimum compressive strength of 4,000 psi unless identified otherwise on the Plans.

Pipe passing through concrete walls or slabs shall be made watertight.

Trenches shall be excavated to a sufficient width to allow for pipe installation, compaction equipment, and shoring when necessary. Maximum trench width shall not exceed 36-inch plus OD for 4-inch and larger pipe, or 24-inch plus OD for 3-inch and smaller pipe for pay items or related materials including but limited to crushed surfacing, patching, import bedding, import backfill, and rock excavation.

Bedding shall be mechanically compacted in lifts no greater than 8-inches from base to springline and from springline to top of pipe using a jumping jack or sheepsfoot. Hoe-packs, sheepsfoots, and vibratory rollers shall not be used within 12-inches directly above the pipe. Compact trench backfill in lifts not exceeding 18-inches loose-thickness.

#### *Flanged Joint Assembly*

1. Bolt holes of flanges shall straddle the horizontal and vertical centerlines of the pipe. Clean flanges by wire brushing before assembling. Clean flange bolts and nuts by wire brushing; lubricate bolts with graphite or oil.
2. Insert the nuts and bolts (or studs), finger tighten, and progressively tighten diametrically opposite bolts uniformly around the flange to the proper tension. Bolts shall have minimum of two threads showing beyond the nut.
3. Tighten joints carefully to prevent strain upon valves, pumps, and other equipment.
4. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reset or replace the gasket, reinstall or re-tighten the bolts and nuts, and retest the joints. Replace the gasket if damaged.

## 15.11.50 Trench Patching

*[CSI 32 01 17]*

### Part 1 - General

#### Scheduling and Sequencing

The Contractor shall be required to patch all trenches installed within the existing pavement with Commercial Hot Mix Asphalt to the depth matching existing or as required by Jefferson County. Trench patches shall be installed no later than the second Friday following excavation for trenches parallel to the road, and no later than two days following excavation for trenches crossing the road and across intersections.

On trenches crossing the roadway or intersections, provide and maintain asphalt hot or cold mix until final patching is complete.

#### Maintenance

Crushed surfacing used for temporary patching shall be inspected and repaired continuously, including over weekends and other non-working periods. Temporary patching, regardless of material used, shall be incidental to the project cost. No additional payment will be made.

### Part 3 - Execution

#### Field Quality Control

Pavement patching that must be removed and replaced due to any failed testing will not warrant additional payment.

## 15.13 Above Grade Mechanical Installation

### 15.13.02 Exposed Piping Installation

*[CSI 40 05 05]*

#### Part 1 – General

##### Summary

This section is for exposed major pressure pipe systems such as booster stations, lift stations, treatment facilities, control valve vaults, etc. Testing of minor service plumbing systems shall follow the IPC/UPC.

#### Part 3 - Execution

##### Preparation

Provide all personnel and equipment required and complete all tests required to demonstrate the integrity of the finished installation for the approval of the Owner and all agencies having jurisdiction.

Secure the pipe and fittings to prevent movement under pressure. Furnish and install temporary blocking where permanent blocking is not required and remove it after testing.

All pumps, gauges, plugs, saddles, corporation stops, miscellaneous hose and piping, and other equipment necessary for performing the test shall be furnished and operated by the Contractor. Gauges used in the test may be required by the Owner to be certified for accuracy at a laboratory.

### **Tests/Inspection**

Visible leakage is unacceptable and shall be corrected.

Prior to calling out the Owner to witness the leak test, the Contractor shall have all equipment completely set up and ready for operation and shall have successfully performed the test to assure that the pipe is in a satisfactory condition. The Owner shall witness the test. If the test does not pass inspection for any reason, additional trips required to witness another test shall be done at the Contractor's expense.

Before applying the specified test pressure, expel air completely from the system.

## **15.18 Buried Piping Inspection and Testing**

*[CSI 33 05 05]*

### **15.18.02 Buried Pressure Pipe Inspection and Testing**

*[CSI 33 05 05, 33 05 05.31]*

#### **Part 3 - Execution**

##### **Preparation**

Provide all required personnel and equipment and complete all tests required to demonstrate the integrity of the finished installation for the approval of the Owner and all agencies having jurisdiction.

Backfill the pipeline trench sufficiently to prevent movement of the pipe under pressure. All thrust blocks shall be in place and sufficiently cured to reach design strength before testing. Furnish, install, and remove temporary blocking where permanent blocking is not required and remove it after testing.

##### **Tests/Inspection**

### **15.18.03 Valve Testing**

#### **Part 3 - Execution**

##### **Testing**

All valves shall be pressure tested. Do not exceed the rated working pressure of the valve when operating the valve. Bleed off test pressure prior to operating. Check all valve bonnet fasteners for tightness.

##### *Pre-Installation*

All buried valves shall be pressure tested outside the trench. Butterfly valves must be tested on both sides of the closed seat.

Valve clusters shall be pre-assembled and tested as a unit. Provide end plugs, blind flanges, assembly kits, and all appurtenances necessary for pressure testing. Valve testing shall use the following procedure.

1. Close the valve.
2. Install plug or flange (with test port).
3. Connect test apparatus and pump.
4. Pressurize to test pressure. 250 psi for butterfly valves, or manufacturer's listed test pressure if less.
5. There shall be zero drop in pressure or visible leakage for one minute. This includes leaking through the shaft packing.
6. If test fails, check for defects, correct, and retest. Valves that do not pass testing will be replaced by the Contractor at no additional cost to the Owner.

Operate all valves at least once from closed-to-open-to-closed positions while valve is under working (not test) pressure.

## **15.20 PIPE AND FITTINGS**

### **15.21 Common Work for Pipe and Fittings**

*[CSI 33 05 00 or 40 05]*

#### **Part 2 - Products**

##### **Components**

Under no circumstance shall the fasteners be of lesser strength or higher corrosive potential than the materials being connected. If dissimilar metals are adjacent (for example: stainless steel flange connecting to ductile iron flange) a dielectric insulation kit shall be used.

Fasteners for pipe and fittings: Per AWWA standards unless otherwise specified. All relevant subsections of AWWA C100, C200, and C500. All bolts and studs shall be long enough so that no less than two threads extend beyond the face of the nut. Non-submerged flange bolts to be ASTM A307 Grade A, zinc plated.

#### **Part 3 - Execution**

##### **Construction**

All piping and related equipment to be joined shall be connected as shown on the Plans, specifications, as recommended by the manufacturer or as required by standard industry practices if not otherwise specified.

Steel and stainless steel threads shall be protected against galling using steel thread sealing tape equal to Cobas steel thread sealing tape. Tape shall be specific to the steel type used.

## 15.21.02 Shackle (Threaded Rod) Restraints

[CSI 33 05 09.33]

### Part 1 - General

#### Definitions

Anchor fastener: The item which connects to the fitting and which the shackle rod passes through. Such as a 90° eye bolt or shackle plate.

Weathering steel: Steel alloy designed to resist corrosion. Often referred to using the genericized trade name Cor-Ten.

#### Submittals

Provide submittal for anchor fastener which includes strength rating in pounds. For shackle plates, include dimensional drawing.

For high strength rods (cold drawn or weathering steel), provide submittals showing rod material and yield strength.

### Part 2 - Products

#### Components

Anchor fasteners must be a steel alloy. Ductile iron, cast iron, or any material deemed brittle in the opinion of the Owner are not allowed.

Verify anchor fastener is appropriate for anchor location.

All buried shackled thrust restraint systems shall be stainless steel or weathering steel. Exposed shackles, such as in a vault or mechanical room, may be non-weathering steel but if so, must be coated with epoxy paint system. Clean rust prior to painting.

Material (* = weathering steel)	Yield Strength	Corrosion Resistant
Type 304/316 SS	Low (30 ksi)	Yes
ASTM A36	Low (36 ksi)	No
ASTM A588 *	Med (45 ksi)	Yes
ASTM A709 GR 50W *	Med (50 ksi)	Yes
ASTM A242 *	Med (50 ksi)	Yes
ASTM A307	High (60 ksi)	No
ASTM F3125 A325 Type 1	High (90 ksi)	No
ASTM F3125 A325 Type 3 *	High (90 ksi)	Yes

All components of any stainless steel or weathering steel system shall include only stainless steel or weathering steel components. Bolts, nuts, washers, rods, and other components shall be one material and not intermixed.

Shackle systems must provide a mechanism to prevent unthreading. Exposed shackles shall use double nuts. Buried shackle systems may use double nuts, single nut with tack weld, or single nut with center punch on outside rod thread.

Provided washers at anchor fasteners. Install anchor fasteners on the opposite side of the flange or mechanical joint from the rod.

### **Part 3 - Execution**

#### **Installation**

For standard elongation restraint, space shackles roughly equally around the pipe.

Nuts shall be finger tightened to snug, then tightened by wrench one full turn. Do not overtighten.

#### **Field Quality Control**

For high strength rod, labels from packaging showing rod material must be given to the Owner in the field. If package labels are not available, Owner has the right to assume rods are not high strength and may require installation of additional rods and field coating.

## **15.22 Metal Pipe and Fittings**

### **15.22.02 Ductile Iron Pipe and Fittings**

*[CSI 33 05 19 or 40 05 19]*

#### **Part 3 - Execution**

##### **Installation**

Install ductile iron water mains in accordance with AWWA C600. Provide tools and equipment, including any special tools required for installing each type of pipe used.

The amount of deflection at each pipe joint shall not exceed 3-degrees per joint (11 inches over 18 feet), or the manufacturer's printed recommended deflections, whichever is less.

### **15.22.03 Steel Pipe and Fittings**

*[CSI 33 05 24.23 or 40 05 24.23]*

#### **Part 3 - Execution**

##### **Installation**

Buried piping shall be bedded and backfilled per the plan details or manufacturer's recommendations utilizing an E' value for design check per AWWA M11 Chapter 6.

## Field Quality Control

The Contractor shall provide tools and equipment, including any special tools required for installing each particular type of pipe used. Pipe that is out-of-round shall be reshaped using methods provided by the pipe manufacturer. The Engineer reserves the right to reject pipe that is excessively out-of-round or damaged during reshaping.

### 15.22.06 Copper Pipe and Fittings

*[CSI 33 05 17 or 40 05 17]*

#### Part 1 - General

##### Design Requirements

Copper piping and tubing shall meet the requirements of ASTM B-88. Solder fittings shall meet the requirements of ANSI B16.22. Flared fittings per ANSI B16.26 and allowed only for working pressure less than 150 psi. Lead content of solder shall be no more than 0.2 percent.

#### Part 2 - Products

##### Materials

Exposed, interior:

Type K or L hard pipe with soldered fittings.

Soft pipe may be used only where approved by the Owner or shown on the plans.  
Soldered fittings for all sizes. Flared fittings only on 1/2-inch and smaller soft pipe.

#### Part 3 - Execution

##### Installation

Under structures, use unbroken pipe lengths to avoid fittings whenever possible.

Runs shall be parallel and perpendicular with floors and walls unless positive drainage is required. When Owner allows soft copper for exposed pipe, straighten any curved or bent pipe for straight sections longer than 6-inches.

### 15.22.08 Brass/Bronze Pipe and Fittings

*[CSI 33 05 12 or 40 05 12]*

#### Part 1 - General

##### References

Brass to be low-lead content in compliance with NSF/ANSI 372 to have no more than 0.25 percent lead content.

Brass nipples: ASTM B687

Brass fittings: ANSI/ASME B16.15 (threaded) Class 125 lb. (up to 200 psi water), 250 lb. (up to 400 psi water); B16.18 (soldered).

## **Part 2 - Products**

### **Materials**

Brass pipe, nipples, and fittings to have threaded ends.

## **15.23 Non-Metal Pipe and Fittings**

### **15.23.05 PVC Pipe and Fittings – Solvent Weld**

*[CSI 33 05 31.13 or 40 05 31.13]*

## **Part 2 - Products**

### **Materials**

Polyvinyl chloride (PVC) material for pipe fittings and couplings shall conform to ASTM D-1784, Type 1, Grade 1, with 2,000 psi design stress. Pipe shall be Schedule 40 or 80 in accordance with ASTM D-1785, as shown on the Plans.

There is no pipe color preference or requirement.

## **Part 3 - Execution**

### **Installation**

For exposed locations that will not be painted, primer and glue must be applied carefully and not allowed to run. Areas where primer/glue has run more than 1/4-inch past the joint will be cleaned, painted, or replaced by the Contractor at the discretion of the Owner.

## **15.30 VALVES**

### **15.31 Common Work for Valves**

*[CSI 40 05 51 or 33 14 19]*

## **Part 3 - Execution**

### **Installation**

Install valves in strict accordance with the manufacturer's instructions and as shown on the Plans. Verify alignment and adjustments after installation. Provide buried valves with all operators or valves boxes installed so that wrenches or operators perform freely and without binding or other interference. Bed and backfill buried valves according to the requirements of the pipe to which they are attached.

## 15.32 Isolation Valves

### 15.32.04 Butterfly Valves

*[CSI 40 05 64.17]*

#### Part 3 – Execution

##### Installation

All butterfly valves shall be test-operated prior to burial in the presence of the Owner's representative to prove full open and closing capability. Testing procedure: Close the valve prior to applying test pressure. Do not operate the valve under test pressure. Bleed off pressure to below the working pressure rating prior to operating the valve.

## 15.40 PIPING SPECIALTIES

### 15.40.03 Pipe, Valve, and Conduit Supports

*[CSI 40 05 07]*

#### Part 1 - General

##### Summary

This section includes providing pipe supports, hangers, guides, and anchors.

##### Related Sections

- Division 1.81.30 Seismic Restraint
- Division 5.05.23 Bolts and other Connectors

##### References

Pipe supports furnished under this section shall comply in all respects with the requirements of the following standards.

- ANSI/ASME B31.1      Power Piping
- ANSI/MSS SP-58      Pipe Hangers and Supports - Materials, Design and  
Manufacture
- ANSI/MSS SP-69      Pipe Hangers and Supports - Selection and Application

##### Performance Standards

Piping systems, including connections to equipment, shall be properly supported to prevent deflection and stresses. Supports shall comply with ANSI/ASME B31.1, except as otherwise indicated.

Size hanger rods, supports, clamps, anchors, brackets, and guides in accordance with ANSI/MSS SP 58 and SP 69.

Support plumbing drainage and vents in accordance with the Uniform Plumbing Code.

## Submittals

### Pipe Hanger/Support Design Calculations

Shop drawings of engineered pipe hangers/supports, including details of concrete inserts. Drawings shall include location plan showing location of the hanger/support in relation to the structure and/or equipment.

## Part 2 – Products

### Manufacturers

Pipe supports shall be equal to Standon Adjustable Model S92 Pipe Support manufactured by Material Resources, Hillsboro, Oregon.

### Components

Provide and install all equipment necessary for complete support systems including, but not limited to, base, riser pipe, anchor bolts, support cradle or clamp, and fasteners.

Except as otherwise noted, pipe support components shall comply with the types in ANSI/MSS SP-58.

### Finishes

Unless otherwise noted, all fabricated pipe supports, other than stainless steel or non-ferrous supports, shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM 123.

## Part 3 - Execution

### Installation

Piping shall be rigidly anchored to walls, slabs, and ceilings by means of suitable pipe supports, wall brackets, or pipe hangers.

Pipe supports, hangers, brackets, anchors, guides, and inserts shall be installed in accordance with the manufacturer's installation instructions and ANSI/ASME B31.1. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

Stand-on Pipe Support: Adjust support, secure to pipe and secure to floor as recommended by the manufacturer.

Riser Supports: Risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

Support Spacing: Pipe supports shall be placed to meet the following maximum spacing, unless otherwise noted or shown on the Plans: maximum vertical support spacing of 5 feet, and maximum horizontal support spacing of 10 feet. Support shall be provided at horizontal bends, base of risers (vertical bends), floor penetrations, connections to pumps, blowers, and other equipment, valves and appurtenances. Support spacing shall meet the local plumbing code where applicable. Support spacing may be increased from that noted above provided adequate calculations are provided supporting the change.

Support Anchorage: Concrete anchors shall be as specified in Division 3, Concrete Anchors. All channel strut type supports shall have a minimum of 2 anchors per support.

## Field Quality Control

Pipe supports shall be positioned in such a way as to produce an orderly, neat piping system.

Properly support, suspend or anchor exposed pipe, fittings, valves and appurtenances to prevent sagging, overstressing or movement of piping and to prevent thrusts or loads on or against connected pumps, blowers or other equipment.

### 15.40.04 Dielectric Fittings and Adapters

*[CSI 40 05 06.17]*

#### Part 3 - Execution

##### Installation

Metal	Connecting to
Bronze/brass	Copper or ductile iron
Ductile iron	Mild steel, bronze or brass

Provide dielectric adapters between dissimilar types of metal pipes, valves and fittings (e.g. copper to stainless steel). Flange isolating kits shall be used when dissimilar metal flanged pipe is connected. The following connections do NOT require dielectric isolators.

### 15.40.08 Valve Box – Cast Iron

*[CSI 33 05 81.23]*

#### Part 3 - Execution

##### Installation

Valve boxes shall be provided and installed for all buried valves. Install box plumb with surface and straight so that keys and operators do not bind.

### 15.40.11 Joint Restraints – Wedge Style

*[CSI 33 05 09.34]*

#### Part 3 - Execution

##### Preparation

Verify that the pipe surface where the restraints will affix is not damaged or corroded prior to installation. Any such damaged pipe shall be cut off and disposed of. Clean any dirt or debris from the surface of the pipe.

##### Installation/Construction

Install per the restraint manufacturer's instructions. Bolted style restraints shall be tightened in an alternating pattern in stages, do not tighten circumferentially. If bolted restraint does not come with break-off head bolts, a torque wrench must be used. If pipes require deflection at

the joints, perform the deflection prior to final tightening of the restraints. Do not exceed the manufacturer's maximum deflection recommendations.

Initial setting of wedges may use any commonly used hand tools until the wedge touches the pipe surface. Impact tools are not allowed for wedge engagement and final torquing.

Installation of restrained joint push-on pipe that will be deflected must be installed per the manufacturer's instructions. In general, this requires the pipe to be inserted into the bell at a straight alignment, but not pushed home. The pipe can then be deflected. If the manufacturer's instructions provide differing, or additional instructions, those instructions shall be followed.

Bedding material must be sands and/or angular gravels for proper soil-to-pipe adhesion and shall not be a clay, rounded gravel, pea gravel, washed rock, or other poorly graded material. Compaction of bedding around restrained pipe shall be performed in maximum 9-inch lifts using mechanical compaction equipment.

### Repair

If restraints are removed for any reason, the restraints shall be disposed of and not reused. The section of pipe to which the restraints were secured shall be cut off and disposed of.

## 15.40.12 Sacrificial Corrosion Control for Metal Pipe

*[CSI 13 47 13.13]*

### Part 1 – General

#### Description

This work consists of requirements for corrosion control materials and construction methods for water system piping. Provide the corrosion control system specified herein for transmission mains; and for pipe in vaults. *Impressed current corrosion protection systems are not covered.*

#### Abbreviations

mdft - Mils Dry Film Thickness, referring to coating applications.

NACE/AMPP - National Association of Corrosion Engineers/Association for Materials Protection and Performance

#### Definitions

**Casings and Sleeves** - Protective pipe or geomembrane through which the main or service is run.

**Distribution Mains** - Piping systems designed to distribute water to services.

**Exothermic Welding and Pin Brazing** - A specialized process used for electrical connections to the exterior of pipe and fittings.

**Pipe on Bridges** - Pipe, fittings, and appurtenances above ground and exposed, generally attached to bridge structures.

**Piping in Vaults and Facilities** - Pipe, fittings, and appurtenances enclosed inside vaults, pump stations, or other buildings.

**Services** - The piping between the distribution main and the water meter.

**Transmission Mains** - Piping systems with minimal service connection, includes conduits, interties, supply mains, and pump mains.

### **Submittals**

1. **Products** - Provide submittals for all products referenced in this section.
2. **Testing** - Submit written documentation of experience as a professional engineer regularly performing cathodic protection work or certification as a NACE/AMPP Cathodic Protection Specialist for all personnel performing field testing.
3. **Test reports** - Submit 3 copies of all field test reports.

## **Part 2 - Materials**

### **Exothermic Welds and Pin Brazing**

#### *Weld Materials*

Molds, cartridges, and all required materials for exothermic (copper) welding shall be as produced by "Cadweld", Erico Products, Inc., or approved equal. Provide molds and cartridges of a size and material as recommended in writing by the manufacturer. Molds for exothermic welding shall be graphite; ceramic molds are not acceptable.

1. Ductile Iron Pipe - For connection to ductile iron pipe, use "Cadweld" XF-19 alloy weld metal or approved equal.
2. Cast Iron Pipe - For connection to cast iron pipe, use "Cadweld" XF-19 alloy weld metal or approved equal.
3. Steel Pipe - For connection to steel pipe, use "Cadweld" F-33 alloy weld metal alloy or approved equal.

#### *Terminals*

All wires used with exothermic welds shall have formed sleeve terminals and shall be welded using the reduced weld size and special weld mold for formed terminals, as specified in writing by the manufacturer. The formed terminals may be factory fabricated or may be field formed using sleeves and a hammer die. Connections to mortar coated steel or concrete cylinder pipe shall be exothermically welded to a 1/2-inch diameter steel rod preinstalled on the pipe by the pipe manufacturer.

#### *Pin Brazing*

Pin Brazing - Pins, studs, lugs and ferrules shall be as recommended in writing by the manufacturer for the wire size, pipe material, and pin braze machine settings. The wire crimp tool shall be the crimp tool recommended by the manufacturer in writing for the specific crimp connection,

#### *Weld Caps*

Furnish weld caps of high-density plastic, 10 mils (minimum) thickness Handy Cap IP, as manufactured by Royston Laboratories, or approved equal. Provide caps that incorporate a dome for the weld, a tunnel to contain the lead wire from the weld connection, and a base

plate to cover the prepared pipe surface. Weld caps shall be provided pre-filled with mastic/adhesive and have an integral primer for adhesion to the pipe or structure. Weld caps shall be sized for the exothermic weld or pin brazed connection.

### **Galvanic Anodes**

Supply galvanic anodes of the quantity, composition, dimensions, metal weight, and packaged backfill as shown or noted on the drawings.

### **Magnesium Anodes**

Provide magnesium anodes, nominal 20 inches long and nominal 30 pound bare metal weight. Magnesium anodes shall meet the requirements of ASTM B-843-M1C High Potential Magnesium Alloy and ASTM G97 with an open circuit potential of (-)1.7VDC to CSE and a current efficiency of 50%. The anodes shall be prepackaged in a permeable cloth bag containing the manufacturer's prescribed backfill and the packaged anode shall be a nominal of 2.5 times the bare anode weight. The anode lead wire shall be solid copper wire, AWG #12 or #10, with TW-, THHN-, or USE-type insulation, and the connection to the anode shall be silver soldered by the manufacturer and shall be of an un spliced length specific to the application but not less than 15 feet.

### **Ribbon Anodes**

Supply zinc ASTM B418 ribbon anodes, size 1/2 inch x 9/16 inch, 0.6 lb/ft with a 0.130 inch diameter core wire, Plattline standard size or equal.

### **Test Stations and Coupons**

Supply test stations of the quantity and type as shown or noted on the drawings.

#### **Test Station**

Flush-mounted test stations shall be cast iron valve boxes and cover for water.

#### **Cathodic Protection Monitoring Coupons**

Provide coupons, steel or ductile iron, to match the pipe material type. The coupon shall have 2 wires connected with a silver soldered potted connection, and with a minimum length of 10 feet. Provide MC Miller IR-Free coupons or approved equal. The coupon access drop tube shall be Schedule 40 PVC pipe, 2 inches in diameter.

#### **Wire**

Wire for test stations and joint bonds larger than AWG #10 shall be single-conductor, stranded copper, with USE-type insulation. Wire AWG #10 or smaller shall be solid not stranded, with TW-, THHN-, or USE-type insulation. Provide the wire size as specified or shown.

#### **Split Bolts and Insulation for Split Bolt Connections**

Provide bronze split bolts, sized for the wire to be joined; insulating putty, 3M Scotchfill or approved equal; and vinyl electrical tape, 3M Scotch Super 33 or approved equal.

## Ground Rods and Clamps

Provide hot-dipped galvanized ground rods, 5/8 inch diameter 8 foot length. Provide bronze clamps, and AWG #6 or #4 stranded copper wire with USE-type insulation for connections between pipe and ground rod.

## Insulation for Dielectric Isolation

### *Insulating Flange Joints*

See 15.40.04 above.

### *Insulating Flexible Couplings*

Flexible couplings size 12 inches in diameter or smaller shall be ductile iron and couplings larger than 12 inches in diameter shall be steel. All flexible couplings shall be fusion-bonded epoxy coated and furnished with high strength alloy bolts and nuts.

1. Insulating Boots - Provide insulating flexible couplings with two insulating boots that cover and prevent contact between pipe ends. Insulating flexible couplings shall be Romac Industries, Inc. style IC501 or IC400 or approved equal.
2. Reducing Couplings - Where couplings are for differing pipe sizes use reducing couplings with same size gaskets. Transition couplings with differing size gaskets are not acceptable. Couplings must meet AWWA C219 requirements. Couplings shall be specially ordered and sized for an insulating boot on one side and thrust restraint on the other side.

### *Insulating Copper Service Fittings*

Fittings shall have insulators integral to the body of the fitting, as manufactured by Mueller Company or approved equal. The design of the fitting shall include a mechanical restriction to prevent the copper tube from passing through the insulation.

### *Insulating Wall Seals*

Wall seals shall consist of compression disks and pressure plates made of dielectric materials. Insulating wall seals shall be Model C Insulating Type as manufactured by Link Seal or approved equal.

## Thin Film Coatings

### *Epoxy Coating for Buried Casing*

Provide coating materials per AWWA C210 and AWWA C213 except no coal tar epoxy will be allowed.

### *Epoxy Repair*

Provide 100% solids 2 component quick cure epoxy coating, NSF approved for potable water. Provide 3M Scotchkote 323 brush grade or approved equal.

### *Epoxy Coatings for Pipe on Bridges*

Provide epoxy primer and intermediate coats with an aliphatic polyurethane topcoat. Provide Pota-Pox epoxy primer and intermediate coats and an Endura-Shield polyurethane topcoat all by Tnemec or approved equal.

*Moisture Cured Urethane Coating for Pipe on Bridges*

Provide a zinc and micaceous iron oxide moisture-cured urethane system. Provide an MC-Miozinc primer, an MC Miomastic intermediate coat, and a Ferrox A topcoat all by Wasser High Tech Coatings or approved equal.

*Thixotropic Mastic Coating*

Provide a thixotropic mastic coating for field repair of existing coal-tar enamel that is not in contact with potable water. Provide Carboline Bitumastic 50 or approved equal.

*Leafting Aluminum Epoxy Coating*

Provide a leafing aluminum epoxy mastic for marginally prepared surfaces. Provide Carbomastic 15 LO by Carboline or approved equal.

*Galvanizing*

Galvanized items shall be per ASTM A123 & ASTM A153. Provide zinc base alloys for repair per ASTM A780. Hot stick method, zinc-rich paints are not acceptable.

*Silicate Concrete Coating*

Provide a water based silicate sealer for waterproofing the exterior surface of new concrete vaults.

*Mortar, Grout, Grout Band*

Mortar and grout shall be a chloride free Portland cement and sand mix with not less than 1 part cement to 3 parts sand or a proprietary cementitious chloride free mix approved in writing by the pipe manufacturer. The grout band shall physically contain the mortar/ grout and prevent moisture loss.

*Backfill*

Backfill in the pipe zone shall be aggregate or sand. Controlled density fill (CDF) and controlled low strength material (CLSM) are not acceptable. For tape wrapped pipe and polyethylene encased pipe, backfill shall be Crushed Surfacing Top Course.

**Miscellaneous**

*Pipe Hangers*

All pipe hangers shall be hot-dip galvanized after fabrication.

*Aluminum*

Aluminum in contact with concrete or stainless steel shall be paint coated in areas of contact with a non-alkyd based paint suitable for contact with concrete.

*Stainless Steel*

The exposed surface of stainless steel that is in contact with ductile iron shall be paint coated with a coal tar mastic or surface tolerant epoxy.

## Part 3 - Execution

### Corrosion Protection

#### *Transmission Mains*

Transmission mains are piping systems with minimal service connections including conduits, interties, supply mains, and pump mains. Transmission mains shall be made electrically continuous with welded joints or joint bonds, shall be dielectrically isolated at all connections, and shall be dielectrically isolated as shown on the plans.

1. Transmission mains crossing an electric rail track shall be cased under the track and for a minimum of 10 foot horizontal distance beyond the track slab.
2. Test stations shall be provided at dielectric isolation joints, casings, where transmission mains cross cathodically protected foreign lines, and as shown.
3. Transmission mains made of ductile iron pipe shall have polyethylene tube encasement and anodes. Steel transmission mains shall have tape wrap and anodes. Mortar-coated steel and concrete cylinder pipe (CCP) transmission mains shall have continuous mortar coating over all in-line valves, fittings, and special appurtenances, or when directed by Engineer, inline valves, fittings and special appurtenances shall be dielectrically coated and protected with anodes. All branch lines that are not mortar-coated shall be dielectrically isolated from the mortar coated main.

### Exothermic Welding and Underground Electrical Connections

Unless otherwise specified, all electrical connections to the pipe shall be by exothermic welding or pin brazing. Properly cover exothermic welds or pin brazed connections with weld caps or in the case of mortar coated steel or Concrete Cylinder pipe (CCP), tape the exposed copper of weld and wire with vinyl electric tape then encase in mortar. Provide sufficient space between adjacent exothermic welds or pin-brazed connections to install a full-sized weld cap on each connection. Repair all damaged pipe coating in accordance with the manufacturer's recommendations. Prior to coating, test all exothermic welds or pin brazed connections by striking with a hammer in a manner approved by the professional engineer or specialist in cathodic protection / corrosion.

### Pipe Joint Bonds

Provide pipe joint bonds to assure electrical continuity except where electrical isolation is specified. Connections to the pipe shall be by exothermic welding or by pin brazing. Bond wires shall be un-spliced wire with field connections made in the trench. Alternatively, "pig tails" can be pre-welded or pin brazed to the pipe; then the pigtails will be spliced together in the trench with split bolt connectors. Joint bonds with lug terminals can be field connected to pin brazed threaded studs. To permit inspection of the welds and pin brazing and to prevent damage to the weld caps, apply all protective coating after the joint is in place and complete. Insulate the split bolt and all exposed copper wire by encapsulating with electrical insulation putty, Scotchfill® Insulating Putty or approved equal, molding the connection smooth, and then wrapping the connection at 50% overlap with vinyl electrical tape, Scotch Super 33 or approved equal.

### *Joint Bond Configuration*

There shall be a minimum of 2 parallel joint bond wires, AWG #2, at each pipe joint. Valves and fittings may be bypassed by bond wires, but the valve or fitting must be made electrically continuous with the pipeline by a single wire, AWG #2 or AWG #4 that connects directly to a pipe section or connects to a joint bond wire (header run) with a split bolt connection. An assembly of valve and fittings may have a single bond wire (tap) from each component piece split bolt connected to a header run (AWG #2) that connects at each end, directly to a pipe section by exothermic weld, pin brazed connection, or by split-bolt connection to a joint bond wire.

### *Wiring*

All wiring is to be splice-free, except where splices are specified or shown or as approved. Coil or snake all buried wire with sufficient slack to prevent stress from backfill operations and earth settlement. Extend all wire at test stations a minimum of 30 inches above finished grade or install in rigid conduit. Repair any damage to the wire insulation with self adhering butyl rubber electrical tape, Scotch No. 130C or approved equal, and over wrap with vinyl electrical tape, Scotch No. 33 or approved equal. Spirally apply each layer at 50% overlap. This repair method is not applicable to repair of any wire in an impressed current system.

### *Split Bolt Connections*

Split bolt connections shall be limited to the connection of two wires. Three or more wires at one split bolt are not allowed. Connection of taps to header runs may be accomplished by stripping an appropriate length of insulation from the header without cutting the wire and connecting the tap at that point with a split bolt for each tap.

### *Ground Rods*

If the service is dielectrically isolated from the main, provide a ground rod, installed per National Electric Code, and connected to the customer side of the service.

## **Galvanic Anode Installation**

Unless specified otherwise, install anodes 5 feet below the pipe invert, positioned under the pipe or up to 3 feet perpendicular from the pipe edge. Do not place the anodes within 3 feet of a neighboring metallic structure. When anodes are distributed along the pipeline, alternate the perpendicular offset from one side of the pipe to the other.

### *Location*

Install the anode in clean, native backfill and not in the select bedding material. Locate anodes a minimum of 5 feet apart. Thoroughly soak the anode in water prior to installation. Compact the backfill to 95% of maximum density to 1 foot above the anode. Evenly distribute anodes along main and branch line installations. Anodes may be grouped at the ends of casings and short runs of pipe; maintain 5-foot minimum distance between anodes.

### *Connection*

The anode lead wire shall be exothermically welded to the pipe. Alternatively, the anode shall be connected to a joint bonding wire by using a split-bolt connection. Distances between anodes are nominal lengths and anode connections shall be made at pipe joints. Unless

otherwise specified, for ductile iron water mains and steel pipe and casings, provide anodes as shown.

### **Test Station Installation**

Locate test stations as follows.

#### *Isolation Joint Test Stations (TSIJ)*

Provide a test station at all buried insulated flanges and insulating couplings, except insulated connections on copper services. Provide a test station at the dielectric isolation between mortar coated steel or CCP lines and dielectrically isolated branch lines, unless the Engineer elects to not install test stations at these locations. Insulating Joint Test stations shall have (2) AWG #8 wires welded to each side of the dielectric joint, (4) wires total.

#### *Casing Test Stations (TSC)*

Provide one test station at each end of the casing. Casing Test Stations shall have (2) AWG #8 wires welded to the main and (2) AWG #8 wires welded to the casing, (4) wires total.

#### *Monitoring Test Stations (TSM)*

Provide a monitoring test station with cathodic protection monitoring coupons where water mains cross cathodically protected foreign lines and where water mains cross electric rail tracks. Monitoring Test Stations shall have (4) AWG #8 wires welded to the main, (2) cathodic protection monitoring coupons each with (2) AWG #12 wires, and (1) permanent reference cell with (1) AWG #12 wire; (9) wires total.

#### *Combination Test Stations (TSC/IJ)*

When (2) or more test stations on the same pipe are adjacent to each other (within 15 feet) they may be combined and the test wires run to a single flush mounted test station. A TSIJ near the end of a casing may be combined with the TSC into a single test station with (2) AWG #8 wires to the casing, (2) AWG #8 wires to the casing side of the dielectric joint and (2) AWG #8 wires to the far side of the dielectric joint, (6) wires total. A TSM can be included in the combined test station by providing (2) cathodic protection monitoring coupons without additional wires to the pipe or casing.

### **Dielectric Isolation**

Provide pipe isolation with insulating flange joints or insulating flexible couplings. Insulating joints shall be separate assemblies and not incorporated into joints with valves or other appurtenances with the exception of branch lines connected to Mortar Coated Steel Pipe (MCSP) or Concrete Cylinder Pipe. Where a branch line connects to a flange integral with a section of MCSP or CCP, a separate assembly is not required. Copper services shall be isolated with meter stops designed with integral insulation. Use insulating wall seals at all concrete wall penetrations.

### **Insulating joints**

Mechanical joint assemblies of flange coupling adapters may be assembled above grade complete with attached test wires. Tape the flange edge of insulating joints with PVC tape to prevent particle bridging across the flange faces. Insulating flexible couplings shall have an insulating boot on each pipe end. Reducing insulating flexible couplings shall have a boot on

one pipe end and restraining bolts on the other. Transition couplings are not acceptable. Use reducing couplings to accommodate differing pipe size. Joint restraint at flexible couplings shall only use hot-dip galvanized rod and nuts and shall be insulated from the non-cathodically protected side of a joint, or insulated from the mortar coated side of a joint, or insulated on one side of the joint if both sides are cathodically protected.

### **Polyethylene Encasement Sleeve Wrapped and Tape Wrapped**

#### *Polyethylene Encasement Installation*

Install polyethylene encasement, tube type, on all ductile iron pipe and appurtenances where shown or specified. Install one length of polyethylene tube encasement for each length of pipe in accordance with AWWA C105, Method A. Every 6 feet along the pipe, secure the polyethylene tube encasement with tape full circumference. The use of polyethylene sheets will not be allowed.

Install 40 mil geo-membrane around mechanical joints and similar connections where the polyethylene can be punctured or ripped. Tape the ends and seams of the geo-membrane with PVC tape and then cover the pipe joint with the adjoining polyethylene encasement.

#### *Sleeve Wrapped Installation*

Install geo-membrane when crossing a cathodically protected foreign line where the pipe configuration does not allow for a PVC pipe sleeve. Every 2 feet along the pipe, secure the geo-membrane with tape full circumference. Wrap shall overlap  $\frac{1}{4}$  circumference at crown of pipe with edges oriented down.

#### *Tape Wrapped Coating for Casings*

Apply tape wrapped coating on steel casing pipe in accordance with AWWA C203, AWWA C214, AWWA C216 for manufacturer applied tape wrap and AWWA C209 for minor field applications. For tape wrapped coating repairs and other coating holdback areas, apply repair tape system per manufacturer's requirements. Apply petrolatum wax tape per AWWA C217 with outer wrap only where directed.

#### *Tape Wrapped Coating for Copper Services*

Provide 20 mil PVC tape wrap and apply at 50% overlap, 40 mil total. Wrap the copper tube, and all fittings including corporation and meter stop.

#### *Mortar Coated Steel (MCSP) and Concrete Cylinder Pipe (CCP)*

Transmission mains shall have continuous mortar coating over all in-line valves, fittings, and other appurtenances, regardless of underlying coating, except when the application of a dielectric coating and installation of anodes at a valve, fitting or other appurtenance is allowed in lieu of mortar coating.

### **Thin Film Coatings**

#### *Paint for Buried Casings and Casing Welds*

Provide an epoxy coating per AWWA C210 and AWWA C213. Any angle iron, c-channels, lubricating or grout pipe, fins, or other appurtenances connected to the casing shall be epoxy coated on all sides. For field repairs, prepare the surface by power tool cleaning, SSPC SP3,

and repair with a 100% solids epoxy, one coat of 25 mil dry film thickness (mdft), or when permitted, coat the weld with a thixotropic coal tar mastic, one coat of 20 mdft.

#### *Paint Coating for Pipe in Vaults and Facilities*

Coat all piping except fittings and specials that are factory coated with fusion-bonded epoxy. Prepare the surface by power tool cleaning, SSPC-SP3, or shop abrasive brush blasting, SSPC-SP7. Use a needle gun or abrasive blast to disrupt the asphaltic coating on ductile iron pipe and fittings, but it is not necessary to remove all asphaltic coating. All work in vaults and facilities shall be done with HEPA filter equipment. Do not coat bolt areas such as flanges or restrained joint holdback areas until connection is complete. Coat with a leafing aluminum epoxy mastic, Carboline Carbomastic 15 or approved equal, 2 coats minimum with 6 mdft per coat, 12 mdft total.

Steel pipe, fittings and specials, 16 inches diameter and larger, shall be shop coated, except for hold backs, prior to installation. Surface preparation shall be near white abrasive blast SSPC-SP10 and the coating shall be a leafing aluminum epoxy mastic, 2 coats 6 mdft per coat, 12 mdft total.

#### *Paint Coating for Pipe on Bridges*

Shop blast and shop coat pipe except for hold back areas. Surface preparation and application of coatings shall be in accordance with manufacturer's written recommendations. Do not coat bolt areas such as flanges or restrained joint holdback areas until connection is complete.

1. Ductile Iron (DI) Pipe - For ductile iron pipe prepare the surface by power tool cleaning, SSPC-SP3, or shop abrasive brush blasting, SSPC- SP7. Use a needle gun or abrasive blast to disrupt the asphaltic coating on DI pipe and fittings, but it is not necessary to remove all asphaltic coating. Coat with a leafing aluminum epoxy mastic, Carboline Carbomastic 15 or approved equal, 2 coat minimum with 6 mdft per coat, 12 mdft total.
2. Steel Pipe - For steel pipe prepare the surface by near white abrasive blasting SSPC SP10. Coat with:
  - a. leafing aluminum epoxy mastic, 6 mdft per coat 12 mdft total, or
  - b. an epoxy coating system, 3 coats of 3-4 mdft per coat, 9-12 mdft total, or
  - c. a moisture-cured urethane system at 3 mdft prime coat, 3 mdft intermediate coat, and 2 mdft topcoat, 8 mdft total.

#### *Galvanizing*

Repair of galvanizing shall be per ASTM A780 using the zinc based alloys "hot stick" method. Zinc-rich paint is not permitted.

### **Testing and Verification**

#### *Quality Assurance*

The portion of the work that involves the installation and testing of the galvanic cathodic protection system shall be conducted by a professional engineer regularly performing cathodic protection work or by an individual who is registered or certified by AMPP/NACE as a cathodic protection specialist. Submit verification of registration or certification for written approval prior to the start of the work.

### *Field Verifications*

The professional engineer or specialist in cathodic protection / corrosion shall field verify the adequacy of the Contractor's personnel in handling and placing anodes and monitoring coupons, reference cells, exothermic welding, pin brazing, crimp connections, installing split bolt connectors, repairing coatings including weld caps, and measuring dielectric isolation and bonding.

The professional engineer or specialist in cathodic protection / corrosion shall at the start of the work provide a list of qualified Contractor personnel and only these listed individuals shall perform such work for the Contractor. Submit and review with contractor personnel the RH2 Exothermic Weld Inspection Reference handout and/or pin braze manufacturer's fault diagnoses of unsatisfactory pin brazes as applicable. The professional engineer or specialist in cathodic protection shall demonstrate to the contractor personnel a manner of hammer-striking the exothermic weld or pin brazed connection to verify the quality of installation without causing damage.

### *Testing During Construction*

Test all isolation joints after installation and prior to backfilling.

### *Continuity and Isolation Testing*

Perform testing as follows:

1. General - Test all sections of pipeline and appurtenances that are cathodically protected and dielectrically isolated for electrical continuity and dielectric isolation after all Contractor connections have been made.
2. Test Current Response - Measure the response of the pipe to the application of cathodic protection test current. If the application of the test current causes the pipe-to-soil potential to become more negative, electrical continuity of the pipeline, service runs, and appurtenances is indicated between that point and the point at which the test rectifier negative connection was made. The response of the potential shall be of a magnitude to demonstrate low resistance joint bonds. Electrical isolation across insulating fittings shall be indicated by the pipe-to-soil potential being more positive or only slightly negative in relation to the structure connected to the test rectifier.

### *Lack of Continuity or Isolation*

If electrical continuity or electrical isolation is not achieved, locate the deficiency and complete the necessary repairs. The Contractor's corrosion control specialist shall retest the system before final acceptance.

### *Repairs*

Make all repairs necessary to correct any deficiencies and repair any joint not passing the electrical continuity or isolation test at no cost to the City.

## **Final System Testing**

Final system testing shall be performed prior to the hydrostatic testing of each segment and prior to the substantial completion. Final testing shall be performed directly by the

professional engineer or specialist in cathodic protection / corrosion and witnessed by the Owner and shall include the following as a minimum:

1. Test and Service Locations - Provide pipe-to-soil potential measurements for all test stations and for all service connections. Include date of measurement taken.
2. Continuity and Isolation Measurements - Provide a report consisting of continuity and isolation measurements and other data for all cathodically protected sections of pipe, appurtenances, and for all service connections.
3. Documentation - Provide 3 copies of a report documenting all testing and installation of cathodic protection system. The cathodic protection specialist shall sign the report. Include the specialist's NACE/AMPP registration or certification number.

### **Warranty**

A 2-year warranty period specified in the Contract shall apply to the entire corrosion control system installed.

## **15.50 FLOW METERS**

*[CSI 33 19 00 or 40 71 00]*

### **15.50.05 Common Work for Flow Meters**

*[CSI 33 19 05 or 40 71 05]*

#### **Part 3 - Execution**

##### **Installation**

Install the meter in strict accordance with the manufacturer's recommendation.

##### **Testing**

If a meter approved by the Owner is not rated for the system test pressure, a temporary spool, flange(s), or cap(s) must be installed in place of the meter. A visual leak test will be performed under working pressure with the meter in place.

The Contractor shall prove correct meter and transmitter performance. Should performance not be acceptable, adjust or replace the unit at the Contractor's expense.

## **15.60 PRESSURE MEASUREMENT**

*[CSI 40 73 00]*

### **15.60.01 Common Work for Pressure Measurement**

*[CSI 40 73 05]*

#### **Part 1 – General**

##### **Related Sections**

- Division 17 - Electronic Pressure and Level Devices

## Design Requirements

Pressure and level measurement devices shall be scaled and rated for the application.

### Part 3 – Execution

#### Installation

All devices shall be installed to be field serviceable without taking the facility out of service. Readouts shall be positioned to be easily read from a standing position and central to the room, unless otherwise allowed by the Engineer.

### 15.61 Pressure Gauges

*[CSI 40 73 13]*

#### Part 1 – General

##### References

- ASME B40.100 (B40.1 Analog, B40.7 Digital)

##### Performance Requirements

Analog: Grade 2A ( $\pm 1$  percent of span) unless stated otherwise in the Products section.

Digital: Grade 2A ( $\pm 0.5$  percent of span) unless stated otherwise in the Products section.

##### Submittals

Provide catalog sheets showing dimensions, pressure range, accuracy and optional accessories.

#### Part 2 – Products

##### Manufacturers

Marsh, 3D Instruments, or approved equal.

##### Materials

Provide gauges per the table below. Gauges completely suitable for measuring potable water with wetted parts of brass, bronze, or stainless steel.

Location	Meter Manholes
Full Scale	0-300 psi
Normal Operating Range	200 psi
Analog or Digital	Analog
Surface or Stem Mount	Stem
Connection Size	0.25" or 0.5"
Accuracy Grade	See Perf. Req'ts
Glycerin fill or Dry	Glycerin
Face Size 2.5" or 4.5"	4.5"

For pressure gauges used in applications other than clean water, provide a diaphragm protector suitable for the contact fluid. Diaphragm equal to Marsh 13040, stainless steel with flushing port.

**Accessories**

Unless shown otherwise on the Plans, provide a block and bleed valve for each pressure gauge. Transcat 600/700 series, stainless steel, or approved equal. Do not use in chlorine rooms or chlorination systems.

**Part 3 - Execution**

**Installation**

Install gauges where shown on the Plans. Support gauges adequately. Tighten only with the connection hex nut, do not twist the case.

**Field Quality Control**

Where a new gauge is connected directly to the plumbing of a pressure transmitter, the gauge must read within its accuracy grade compared to the transmitter, unless the transmitter is proven faulty.

If the Engineer suspects any gauge is inaccurate, provide a calibrated gauge for comparison, or other method of verification acceptable to the Engineer.

Replace or calibrate gauges that do not meet the accuracy requirements.

## 15.70 PLUMBING

*[CSI 22 00 00]*

### 15.70.05 Common Work for Plumbing

*[CSI 22 05 00]*

#### Part 2 – Products

##### Components

###### Joints and Connections

- Steel and Brass: Use factory-cut pipe threads where possible; otherwise, cut pipe ends square, remove all fins and burrs, and cut full-depth tapered threads. Apply joint compound to male threads only and engage so that no more than three threads remain exposed.
- Copper: Make all joints in copper tubing with 95-5 tin-antimony solder applied in strict accordance with manufacturer's recommendations. Flared connections are only allowed in exposed locations.
- Hubless: Install a neoprene gasket and stainless steel clamp and shield coupling joint assemblies with bolts alternatively and incrementally tightened to a minimum 60 inch-pounds torque. Use a single set-point torque wrench manufactured specifically for this purpose. Do not use screwdrivers or other types of wrenches. Re-torque bolts after 24 hours.
- Solvent cement: Use solvent cement approved by pipe and fitting manufacturer and apply in accordance with the manufacturer's installation procedures.

###### Fixtures and Trim

Use chromium-plated brass bolts, nuts and washers where exposed; otherwise, use brass or bronze bolts, nuts and washers. Make connections gas-tight and water-tight. Do not use bulk material, including putty and plastics, for gaskets.

Trim shall match metal parts used with fixtures. Trim shall be stainless steel, except when provided with plumbing fitting by the manufacturer. Exposed trim shall have a satin type finish. Escutcheons shall be provided at each point where pipe or other fittings enter the wall.

#### Part 3 - Execution

##### Examination

Prior to work of this section, carefully inspect installed work of other trades and verify that such work is complete to the point where this installation may properly commence. Verify that plumbing may be installed in strict accordance with all pertinent codes and regulations. In the event of a discrepancy, do not proceed with the installation and immediately notify the Owner.

## Installation

Install and locate pipe, fittings and accessories as shown on the Plans.

Waste piping vents shall protrude through the roof. In framed walls, waste piping vents shall be concealed. Provide individual vents for each fixture.

Except for drain grates, do not embed plumbing in concrete or masonry, always surface mount. Where furring exists, conceal in furring unless shown otherwise on the plans. Where plumbing passes through concrete or masonry, provide a sleeve unless specifically shown otherwise on the plans.

Rigidly support wall hung fixtures by means of metal supporting members so that no stress is transmitted to connections.

Do not cut into or reduce the size of any load-carrying member without prior approval of the Engineer. Install pipes to clear all beams and obstructions.

Locate water hammer arresters in accordance with the manufacturer's recommendation.

Provide uniform pitch of at least  $\frac{1}{8}$ -inch per foot, or as otherwise noted, for all horizontal waste and drain piping within the building. Pitch all vents for proper drainage.

Cushion all traps and bearings to minimize transfer of sound; firmly anchor all pipes in position.

Vertical stacks shall be supported at floors with clamp anchors as required to relieve joint stresses.

Conceal all piping unless otherwise shown on the Plans.

Provide and conceal air chambers the same size as the branch line at each water connection to a plumbing fixture.

## Inspection

Test all plumbing fixtures for proper and smooth operation when in use.

Make sure fixtures are thoroughly clean and free of any foreign material.

## Part 3 – Execution

### Installation

Route copper or Sch 40 PVC tube from device to drain. Install so that water does not run over floors or other surfaces. For potable water source, provide an air gap between the outlet and the drain of no less than twice the pipe diameter.

## 15.75.16 Brass Ball Valves

*[CSI 40 05 63.34]*

### Part 1 – General

#### Performance Requirements

Ball valves rated for 250 psi W.O.G. minimum. Valve to be “full-port” style.

## **Part 2 – Products**

### **Manufactured Unit**

Ends to be threaded, unless specifically shown otherwise on the plans. Include ¼ turn lever handle. If available space does not allow handle to operate without interference, replace with tee handle.

### **15.75.20 Y-Strainers**

*[CSI 40 05 89.14]*

## **Part 2 – Products**

### **Manufacturers**

Y-strainers shall be equal to Chemtrol YS Series Y-strainers.

### **Manufactured Unit**

Provide Y-strainers fabricated from PVC Type 1, Grade 1 with viton seals. Provide filter screen fabricated from corrosion-resistant materials with an open area equivalent to twice the nominal pipe size. Y-strainers shall be rated for pressures as specified in the pressure rating section of this division.

### **15.75.21 Unions**

*[CSI 40 05 06]*

## **Part 2 – Products**

### **Manufactured Units**

As shown on the Plans, unions shall be water tight, capable of pressure forces of the pipe it is connected to, and allow a minimum of ¼-inch of play for installation and maintenance flexibility. Unions shall be threaded to match the pipe it connects and match the pipe material (copper, brass or PVC).

# Division 16

## Electrical

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### 16.00 GENERAL

The Contractor shall provide all labor, material, tools, equipment and services required to complete the furnishing, installation, wiring, connection, calibration, adjustment, testing and operation of all electrical equipment, devices and components as indicated and implied by the plans and specifications.

Sections in these specifications titled “*Common Work for . . .*” shall apply to all following sections whether directly referenced or not.

The Contractor shall reference Division 1.25 regarding substitutes and “or-equals”.

### 16.05 Common Work for Electrical

*[CSI 26 05 00]*

#### Part 1 - General

##### Summary

Plans are diagrammatic and indicate general arrangements of systems and equipment, except when specifically, dimensioned or detailed. The intention of the plans is to show size, capacity, approximated location, direction and general relationship of one work phase to another, but not exact detail or arrangement.

##### Regulatory Requirements

The Contractor shall coordinate and provide all permits, licenses, approvals, inspections by the authority having jurisdiction and other arrangements for work on this project and all fees shall be paid for by the Contractor. The Contractor shall include these fees in the bid price.

##### Related Sections

See the following sections for items that may be provided and/or installed with other electrical equipment.

- Division 15.51 Flow meter transmitters
- Division 17.50 Sensors and controls

##### Codes and Standards

Provide all electrical work in accordance with latest edition of National Electrical Code, National Electrical Safety Code, Washington State Electrical, and local ordinances. If any conflict occurs between government adopted code rules and these specifications, the codes are to govern. All electrical products shall bear a label from a certified testing laboratory recognized by the State of Washington. Recognized labels in the State of Washington are UL, ETL, and CSA-US.

##### Definitions

Dry Locations: All those indoor areas which do not fall within the definitions below for wet, damp, or corrosive locations and which are not otherwise designated on the Plans.

Wet Locations: All locations exposed to the weather, whether under a roof or not, unless otherwise designated on the Plans.

Damp Locations: All spaces wholly or partially underground, or having a wall or ceiling forming part of a channel or tank unless otherwise designated on the Plans.

The words “plans” and “drawings” are used interchangeably in this specification and in all cases shall be interpreted to mean “Plans”.

The word “provide” shall be interpreted to mean furnish and install.

## **Design Requirements**

Unless otherwise noted, provide enclosures as follows:

1. Outdoors and/or Wet Locations: NEMA Type 4X

## **Submittals**

Provide submittals of each item specified in this division to engineer for approval in accordance with Division 1 of these specifications. Submittals for motor control centers, motor control panels, control panels, instrumentation panels, and pump control panels shall include at a minimum: a wiring diagram or connection schematic, and an interconnection diagram.

### Wiring Diagram or Connection Schematic

1. Include all devices in a system and show their physical relationship to each other including terminals and interconnecting wiring in assembly. This diagram shall be in a form showing interconnecting wiring only by terminal designations (wireless diagram).

### Interconnection Diagram

1. Show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. Show references to all connection diagrams which interface to the interconnection diagrams. Interconnection diagrams shall be of the continuous line type. Show bundled wires on a single line with the direction of entry/exit of the individual wires clearly shown. Identify all devices and equipment. Show terminal blocks as actually installed and identified in the equipment complete with individual terminal identification. All jumpers, shielding and grounding termination details not shown on the equipment connection diagrams shall be shown on the interconnection diagrams. Show spare wires and cables.

Provide submittal information for the following items:

1. Conduit and Fittings
2. Outlet and Junction Boxes
3. Electrical Handholes and Vaults
4. Wire and Cables
5. Other Electrical Components listed in this Division and/or required by the Engineer.

## Construction Power

See Division 1.51

## Part 2 - Products

### Source Quality Control

Provide adequate space and fit for the electrical installation, including, but not limited to, determination of access-ways and doorways, shipping sections, wall and floor space, and space occupied by mechanical equipment. Provide electrical equipment that fits in the areas shown on the Plans. All equipment shall be readily accessible for maintenance, shall have electrical clearances in accordance with National Electric Code (NEC) and shall be installed in locations which will provide adequate cooling.

Do not use equipment exceeding dimensions indicated or equipment or arrangements that reduce required clearances or exceed specified maximum dimensions unless approved by the Owner.

### Identification of Listed Products

Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the inspection authority may require the product to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

### Materials

Use equipment, materials and wiring methods suitable for the types of locations in which they will be located, as defined in Definitions above.

All materials and equipment specified herein shall, within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.

### Components

Fasteners for securing equipment to walls, floors, and the like shall be either hot-dip galvanized after fabrication or stainless steel. Provide stainless steel fasteners in corrosive locations. When fastening to existing walls, floors, and the like, provide capsule anchors, not expansion shields. Size capsule anchors to meet load requirements. Minimum size capsule anchor bolt is  $\frac{3}{8}$ -inch.

### Accessories

#### Wire Identification

1. Identify each wire or cable at each termination and in each pull-box using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as approved by the Engineer. Identify each wire or cable in each pull-box

with plastic sleeves having permanent markings. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

### **Finishes**

Refer to each electrical equipment section of these specifications for painting requirements of equipment enclosures.

## **Part 3 - Execution**

### **Installation**

#### General

1. Complete the wiring, connection, adjustment, calibration, testing and operation of mechanical equipment having electrical motors and/or built-in or furnished electrical components in accordance with electrical code, UL listing requirements and manufacturer's instructions. Install electrical components that are furnished with mechanical equipment.
2. Provide the size, type and rating of motor control devices, equipment and wiring necessary to match the ratings of motors furnished with mechanical equipment.
3. Complete the procurement, installation, wiring, connection, calibration, adjustment, testing and operation of all electrical devices, components accessories and equipment which is not shown or specified but which is nonetheless required to make the systems shown and specified properly functional.

#### Workmanship

1. Assign a qualified representative who shall supervise the electrical construction work from beginning to completion and final acceptance.
2. Provide all labor using qualified craftsmen, who have had experience on similar projects.
3. Ensure that all equipment and materials fit properly in their installations.

#### Field Services

1. Provide field services of qualified technicians to supervise and check out the installation of the equipment, to supervise and check out interconnecting wiring, to conduct start-up and operation of the equipment, and to correct any problems which occur during testing and start-up.

#### Installing Equipment

1. Provide the required inserts, bolts and anchors, and securely attach all equipment and materials to their supports.
2. Install all floor-mounted equipment on 3½-inch high reinforced concrete pads.
3. Install all equipment and junction boxes to permit easy access for normal maintenance.

### Cutting, Drilling, and Welding

1. Provide any cutting, drilling, and welding that is required for the electrical construction work.
2. Structural members shall not be cut or drilled, except when approved by the Engineer. Use a core drill wherever it is necessary to drill through concrete or masonry. Perform patch work with the same materials as the surrounding area and finish to match.

### Metal Panels

1. Mount all metal panels, which are mounted on, or abutting concrete walls in damp locations or any outside walls 1/4-inch from the wall and paint the back side of the panels with a high build epoxy primer with the exception of stainless-steel panels. Film thickness shall be 10 Mils minimum.

### Load Balance

1. Balance electrical load between phases as nearly as possible on panelboards, motor control centers, and other equipment where balancing is required.
2. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

## **Field Quality Control**

### Minor Deviations

1. The electrical plans are diagrammatic in nature and the location of devices, fixtures, and equipment is approximate unless dimensioned. Based on this, the right is reserved by the owner to provide for minor adjustments and deviations from the locations shown on the Plans without any extra cost. Deviations from the Plans and/or specifications required by code shall also be done, subsequent to Owner's approval, without extra cost.
2. Plans indicate the general location and number of the electrical equipment items. When raceway, boxes, and ground connections are shown, they are shown diagrammatically only and indicate the general character and approximate location. Layout does not necessarily show the total number of raceways or boxes for the circuits required. Furnish, install, and place in satisfactory condition all raceways, boxes, conductors, and connections, and all of the materials required for the electrical systems shown or noted in the contract documents complete, fully operational, and fully tested upon the completion of the project.

### Project Record Plans

1. A set of Plans shall be maintained at the job site showing any deviations in the electrical systems from the original design. A set of electrical Plans, marked in red to indicate the routing of concealed conduit runs and any deviations from the original design, shall be submitted to the Owner for review prior to final acceptance.
2. After testing and acceptance of the project the Contractor shall furnish in the O&M manuals an accurate connection schematic and interconnection diagram for every service entrance panel, pump control panel, motor control center, and instrumentation panel provided this project.

## Cleanup and Equipment Protection

### Equipment Protection

1. Always exercise care after installation of equipment, motor control centers, control panels, etc., to keep out foreign matter, dust debris, and moisture. Use protective sheet metal covers, canvas, heat lamps, etc., as needed to ensure equipment protection.

### Cleaning Equipment

1. Thoroughly clean all soiled surfaces of installed equipment and materials upon completion of the project. Clean out and vacuum all construction debris from the bottom of all equipment enclosures.

### Painting

1. Repaint any electrical equipment or materials scratched or marred in shipment or installation, using paint furnished by the equipment manufacturer.

### Final Cleanup

1. Upon completion of the electrical work, remove all surplus materials, rubbish, and debris that accumulated during the construction work. Leave the entire area neat, clean and acceptable to the Owner.
2. Lamps and fluorescent tubes shall be cleaned, and defective units replaced at the time of final acceptance.

## 16.10 ELECTRICAL SITE WORK

### 16.10.1 Common Work for Electrical Site Work

*[CSI 33 71 19]*

#### Part 1 – General

##### Summary

The work included in this section consists of furnishing and installing conduit, fittings, handholes, pull vaults, warning tape, cables, wires, and related items, complete as specified herein and as indicated on the Plans for a complete and functional underground electrical system. Special vaults, grounding, trench backfill requirements may be specified with the particular equipment or electrical system involved.

##### Related Sections

Wire and cable per Section 16.60.

Raceways and conduit per Section 16.70.

##### Design Requirements

Materials and equipment shall conform to the respective specifications and standards; and to be the specifications herein. Electrical rating shall be as indicated on Plans.

## Part 3 – Execution

### Construction

Provide all excavation, trenching, backfill, and surface restoration required for the electrical work.

Excavate to depths as required by Code, particular installation, or as shown on the Plans. Trench width and length as required by the installation or as shown. Trench bottom shall be free of debris and graded smooth. Where trench bottom is rock or rocky or contains debris larger than 1 inch or material with sharp edges, over excavate 3 inches and fill with 3 inches of sand. Separation between new electrical utilities and other utilities shall be 12 inches horizontal and 6 inches vertical minimum, except gas line separation shall be 12 inches both vertical and horizontal. Cross concrete or asphalt only after surface material has been saw cut to required width and removed.

Backfill around raceways shall be 3-inches of pea gravel or sand for systems of 600 volt or less. Provide red marker tape over raceways below grade. Place backfill material to obtain a minimum degree of compaction of 95 percent of maximum density at optimum moisture content. Moisten backfill material as required to obtain proper compaction. Do not use broken pavement, concrete, sod, roots or debris for backfill.

### 16.10.2 Underground Marking Tape (Detectable Type)

*[CSI 33 05 97.23]*

### Part 2 – Products

#### Manufacturers

Tape shall be Brady “Detectable Identoline – Buried Underground Tape”, or equal.

#### Materials

Underground marking tape shall be for location and early warning protection of buried power and communication lines. Tape shall be detectable by a pipe/cable locator or metal detector from above the undisturbed ground. Tape shall be nominally 2 inches wide with a type B721 aluminum foil core laminated between two layers of 5 Mil thickness polyester plastic. The plastic color shall be red for electrical lines and orange for telephone lines.

### Part 3 – Execution

#### Installation

Unless noted otherwise on Plans, install approved underground marking tape 12 inches above and directly over the conduit or raceway in all trenches.

### 16.10.3 Handholes and Pull Boxes

*[CSI 33 71 19.13]*

#### Part 2 – Products

##### Manufacturers

Handholes and Pull boxes shall be Oldcastle or approved equal unless specified otherwise on the Plans.

##### Materials

Provide handholes of reinforced precast concrete, or injection molded composite plastic material. Handholes shall include a base, a body, extensions and a cover. Provide handholes with a perimeter of 10 feet or more (e.g., 3 feet by 2 feet) with both pulling irons and cable racks. All hardware shall be stainless steel, or hot-dip galvanized after fabrication; cable racking and hardware, however, shall be non-metallic and corrosion resistant. If no handhole size is shown on the Plans, size units per NEC or provide 12 inches by 24 inches by 18 inches deep, whichever is larger.

All handholes located in areas subject to vehicular traffic or where identified on Plans shall be ASSHTO, H-20 rated in accordance with ASTM C857.

The lids to all pull boxes and vaults shall be permanently marked for its intended use, “signal” for all signal and instrumentation handholes and “electrical” for all power handholes. Letter shall be a minimum of 3-inches high.

#### Part 3 – Execution

##### Installation

Conduits entering handholes shall have grounding bushings installed and the conduit ends shall be sealed with Permagem sealing compound. Where conduits enter through sides of handholes, the penetration shall be made watertight. Use a core drill wherever it is necessary to drill through concrete. Perform patch work with the same materials as the surrounding area and finish to match.

Pull boxes shall be provided at least every 150 feet on long straight runs. Spacing shall be reduced by 50 feet for each 90-degree bend.

Install handholes flush with finished grade in all paved areas, roadways and walkways. All handhole edges shall be flush with final surface.

### 16.15 Grounding and Bonding for Electrical Systems

*[CSI 26 05 26]*

#### Part 1 - General

##### References

Service and equipment grounding shall be per Article 250 of the NEC.

## Performance Requirements

Verify that a low-resistance ground path is provided for all circuits so an accidental contact to ground of any live conductor will instantly trip the circuit.

## Part 2 - Products

### Components

The grounding systems shall consist of the ground rods, grounding conductors, ground bus, ground fittings and clamps, and bonding conductors to water piping and structural steel as shown on the Plans.

System components shall be as allowed in the NEC unless specified otherwise below:

1. Ground Rods: Ground rods shall be cone pointed copper clad Grade 40 HS steel rods conforming to ASTM B228. The welded copper encased steel rod shall have a conductivity of not less than 27 percent of pure copper.
2. Ground Conductors: Buried conductors shall be medium-hard drawn bare copper; other conductors shall be soft drawn copper. Sizes over No. 6 AWG shall be stranded. Coat all ground connections except the exothermic welds with electrical joint compound, non-petroleum type, UL listed for copper and aluminum applications.
3. Ground Rod Boxes: Boxes shall be a 9-inch diameter precast concrete unit with hot-dip galvanized traffic cover. Boxes shall be 12-inches deep minimum. Covers shall be embossed with the wording "Ground Rod".

## Part 3 - Execution

### General Grounding Installation

When available a UFER ground per latest edition of NEC shall be provided as the primary means to ground the electrical system.

Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

Provide a ground rod box for each ground rod to permit ready access to facilitate testing.

Provide a ground wire in every conduit carrying a circuit of over 110 volts to ground.

Make embedded or buried ground connections, taps and splices with exothermic welds. Coat ground connections.

Bond metallic water piping at its entrance into each building.

### Vault and Handhole Grounding

Exposed noncurrent-carrying metal parts of equipment, conductor supports or racks, conduits, and other metal appurtenances, including any metal cover and its supporting ring, shall be bonded together and connected to a common ground. The size of the grounding

means shall be as prescribed in the NEC. Where the grounding means is exposed, the grounding conductor shall be not smaller than #8 AWG copper.

### **Ground Connections**

Above grade ground connections shall be exothermic weld, mechanical, or compression-type connectors; or brazing.

Below grade ground connections shall be exothermic weld.

Install all ground connections in strict accordance with connector manufacturer's recommendations and methods.

### **Testing**

Following completion of the grounding electrode system, if installed, measure ground resistance at each ground rod using the three-rod method. Submit results to engineer prior to final acceptance by the Owner.

Perform testing per NETA Standard ATS paragraph 7.13. Testing methods shall conform to NETA Standard ATS using the three-electrode method for large systems. Conduct tests only after a period of not less than 48 hours of dry weather.

Furnish to the Engineer a test report with recorded data of each ground rod location. See Division 16.95.4.

## **16.60 CONDUCTORS**

### **16.61 Low Voltage Wire and Cable**

*[CSI 26 05 19]*

#### **Part 1 - General**

##### **Design Requirements**

This section is for power and control conductors for 600 volts or less.

All conductors shall be copper. Wire or cable not shown on the Plans or specified, but required, shall be of the type and size required for the application and in conformance with the applicable code.

#### **Part 2 - Products**

##### **Materials**

###### Conductors

1. Solid and stranded copper wire shall be 600-volt Type THW, THWN, or THHW, Class B stranding, sizes #14 AWG, #12 AWG, and #10 AWG only. Use of THHN insulation shall not be allowed. Aluminum conductors shall not be allowed.
2. Stranded copper wire shall be 600-volt Type XHHW, Class B stranding, sizes #8 AWG and larger. Aluminum conductors shall not be allowed.

### Splices

1. For Lighting Systems and Power Outlets: Wire nuts shall be twist-on type insulated connectors utilizing an outer insulating cover and a means for connecting and holding the conductors firmly.
2. All Equipment: Crimp type connectors shall be insulated type, suitable for the size and material of the wires and the number of wires to be spliced and for use with either solid or stranded conductors.
3. Division 16 Equipment and Power Conductors: Bolted pressure connectors shall be suitable for the size and material of the conductors to be spliced.
4. All Equipment: Epoxy splice kits shall include epoxy resin, hardener, mold, and shall be suitable for use in wet and hazardous locations.

### Terminations

1. Crimp type terminals shall be self-insulating sleeve type, with ring or rectangular type tongue, suitable for the size and material of the wire to be terminated, and for use with either solid or stranded conductors.
2. Terminal lugs shall be split bolt or bolted split sleeve type in which the bolt or set screw does not bear directly on the conductor.
3. Wire Markers shall be plastic sleeve type. Wire numbers shall be permanently imprinted on the markers.

### **Finishes**

Color Coding: Provide color coding for all circuit conductors. Insulation color shall be white for neutrals and green for grounding conductors. An isolated ground conductor shall be identified with an orange tracer in the green body. Ungrounded conductor colors shall be as follows:

1. 120/208 Volt, 3 Phase: Red, black and blue.
2. 277/480 Volt, 3 Phase: Yellow, brown and orange.
3. 120/240 Volt, 1 Phase: Red and black.

### **Part 3 – Execution**

#### **Location (Installation) Schedule**

Provide the following conductors for the following applications:

1. Use stranded copper conductors for all power and control circuits unless noted otherwise on plans or below. Size as noted on the Plans.
2. Contractor may use solid copper conductors for lighting and receptacle circuits using screw-type terminals. Size as noted on the Plans.
3. Size #14 AWG wire or smaller shall not be allowed on power circuits.

## Installation

### Conductor Splices

1. Splices: Install all conductors without splices unless necessary for installation, as determined by the Engineer. Splices when permitted shall be completed using an approved splice kit intended for the type of conductor and the application. The splice shall be in accordance with the splice kit manufacturer's instructions.
2. Underground Splices: All underground outdoor splices when approved by Engineer shall be completed in an accessible pullbox or handhole using an approved watertight epoxy resin splice kit rated for the application up to 600 volts. Splices will not be allowed to be direct buried.

### Conductor Identification

1. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pullbox, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule as favorably by the Engineer.
2. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

## Testing

Insulation Resistance Tests: For all circuits 150 volts to ground or more and for all motor circuits over ½ horsepower, test cables per NETA Paragraph 7.3.1. The insulation resistance shall be 20 megohms or more. Submit results to Engineer for review.

## 16.63 Signal Cable

*[CSI 27 15 00]*

### Part 2 - Products

#### Materials

##### Twisted Shielded Pairs (TSP)

1. Cable shall conform to IEEE 383, UL 13, and UL 83 and shall be type PLTC cable suitable for direct burial. Each TSP shall consist of two #16 AWG, 7-strand copper conductors per ASTM B8 with 15 Mils PVC insulation and individual conductor jacket of nylon. Conductors shall be twisted with 2-inch or shorter lay, with 100 percent foil shielding and tinned copper drain wires. The cable shall have an overall PVC jacket with a thickness of 35 Mils. The insulation system shall be rated at 90 degrees Celsius and for operation at 600 volts.

## Part 3 - Execution

### Installation

#### Cable Installation

1. Cables shall be continuous from initiation to termination without splices.
2. Cable shielding shall be grounded at one end of the cable only. Bonding shall be to a single ground point only. Bonding from cable to cable in multiple run installations shall not be permitted.
3. Install instrumentation cables in separate raceway systems with voltages not to exceed 30 volts DC.

#### Conductor Identification

1. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pullbox, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule as determined by the Engineer.
2. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

### Testing

Insulation Resistance Tests: Perform insulation resistance on all circuits. Make these tests before any equipment has been connected. Test the insulation with a 500 Vdc insulation resistance tester with a scale reading 100 mega ohms. The insulation resistance shall be 20 mega ohms or more. Submit results to Engineer for review.

## 16.70 RACEWAYS, BOXES, AND FITTINGS

*[CSI 26 05 33]*

### 16.71 Raceways

*[CSI 26 05 33.23]*

#### Part 1 – General

##### Design Requirements

Conduit sizes not noted on Plans shall be in accordance with NEC requirements for the quantities and sizes of wire installed therein.

Grounding of the raceway, junction boxes, fittings and any other boxes is the responsibility of the Contractor. Ground conductors, bushings, connections, clamps and other materials as

needed to ground the raceway system is the responsibility of the Contractor. All raceways shall be grounded in accordance with the NEC.

## Part 2 – Products

### Components

#### Conduit and Fittings

1. Galvanized Rigid Steel (GRS): Rigid conduit shall be steel, hot dipped galvanized inside and out. The GRS must meet USA Standards Institute C80-1 Underwriters Laboratories Standard UL6 and carry a UL label. Use cast threaded hub fittings and junction boxes for all rigid conduit except in locations not permitted by the NEC.
2. Nonmetallic Conduit: Nonmetallic Conduit shall be rigid PVC, Schedule 40 (PVC-40) or 80 (PVC-80). PVC conduit installed above grade shall be Schedule 80 extra heavy wall 90 degree Celsius. UL listed for aboveground use and UV resistant. Conduit shall be gray in color. Fittings shall be of the same material as the raceway and installed with solvent per the Manufacturer's instructions. Conduit, fittings, and solvent shall all be manufactured by the same Manufacturer.
3. Flexible Metal Conduit (Flex-LT): Flexible conduit shall be interlocking single strip, hot dipped galvanized and shall have a polyvinyl chloride jacket extruded over the outside to form a flexible watertight raceway. Flexible conduit shall be American Brass Company Sealtite Type VA, General Electric Type UA or equal.

#### Conduit and Cable Supports

1. Conduit Supports: Hot dipped galvanized framing channel shall be used to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required. Conduit support for PVC or PVC coated rigid steel shall be one-hole PVC or epoxy coated clamps or PVC conduit wall hangers.

#### Conduit Sealants

1. Moisture Barrier Types: Sealant shall be a non-toxic, non-shrink, non-hardening, putty type hand applied material providing an effective barrier under submerged conditions.
2. Fire Retardant Types: Fire stop material shall be a reusable, non-toxic, asbestos-free, expanding, putty type material with a 3-hour rating in accordance with UL 1479. Provide products indicated by the manufacturer to be suitable for the type and size of penetration.

## Part 3 - Installation

### Raceway Applications

Galvanized Rigid Steel (GRS) conduit shall be used in all locations unless noted otherwise below or on the Plans.

ABOVE GRADE CONDUITS shall be:

1. GRS for power and control wiring.
2. GRS for instrumentation and telecommunications wiring.

BELOW GRADE CONDUITS IN DIRECT EARTH (not under slabs-on-grade) shall be:

1. PVC-40 for power and control wiring.
  - a) Sweeps and risers for transition of PVC from below grade to above grade shall be GRS.
2. GRS for instrumentation and telecommunications wiring.

ALL CONNECTIONS TO VIBRATING EQUIPMENT shall be:

1. Liquidtight flexible metallic conduit for indoor, non-corrosive areas and all motor leads from VFDs.
2. Connection to equipment outdoors or in corrosive areas shall be with non-metallic liquidtight flexible conduit (except for motor leads from VFDs shall be flexible metallic.)

### **Installation**

All conduits shall be concealed in the floor, walls, ceiling slab, or beneath the floor slab. Surface mounted conduit will not be accepted unless noted otherwise on the construction Plans.

#### Size of Raceways:

1. Raceway sizes as shown on the Plans, if not shown on the Plans, then size in accordance with NFPA 70.
2. Unless specifically indicated otherwise, the minimum raceway size shall be:
  - a) Conduit:  $\frac{3}{4}$ -inch

All raceways shall contain a separate grounding conductor.

Spare conduits shall contain one  $\frac{3}{16}$ -inch diameter nylon pull rope.

Conduit routing is shown diagrammatic on the Plans. Contractor is responsible for routing the conduits in a neat manner, parallel and perpendicular to walls and ceilings.

Location of conduit ends are shown approximately. Contractor is responsible for ending conduits in location that will not conflict with electrical equipment. Route conduit ends to facilitate ease of equipment maintenance. Conduits extending from the floor to a device shall be located as close as possible to avoid creating a hazard.

Conduit shall not be routed on exterior of structures except as specifically indicated on the Plans.

Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

Securely fasten raceways at intervals and locations required by NEC, or the type of raceway employed.

Provide all required openings in walls, floors and ceilings for conduit penetration.

1. Do not install one (1) inch and larger raceways in or through structural members (beams, slabs, etc.) unless approved by Engineer.

2. New Construction: Avoid cutting openings, where possible, by setting sleeves or frames in masonry and concrete, and by requesting openings in advance.
3. Existing Construction: Core drill openings in masonry and concrete. Avoid structural members and rebar.

Conduit encasement or embedment in the earth shall be separated from the earth by at least 3-inches of concrete unless otherwise shown on the Plans. Plastic conduit spacers shall be located five feet on centers. The spacers shall be secured to the conduits by wire ties. The conduits shall be watertight.

Analog signal conduits shall be separated from power or control conduits. The separation shall be a minimum of 12-inches for metallic conduits and 24-inches for nonmetallic conduits.

Install explosion-proof seal-offs in hazardous areas shown on the Plans and as required by the NEC.

Plastic raceway joints shall be solvent cemented in accordance with recommendations of raceway manufacturer.

All conduit openings not encased in a panel shall be sealed with duct seal.

#### Wireway Installation

1. Straight sections and fittings shall be solidly bolted together to be mechanically rigid and electrically continuous. Dead ends shall be closed. Unused conduit openings shall be plugged.
2. Wireways shall be supported every 5 feet minimum.

## **16.72 Boxes and Enclosures**

### **16.72.2 Outlet and Junction Boxes**

*[CSI 26 05 33.16]*

#### **Part 1 – General**

##### **Design Requirements**

In corrosive areas, all junction boxes shall be NEMA 4X.

Outlet boxes and switch boxes shall be designed for mounting flush wiring devices.

Outlet boxes shall not be less than 4-inch square and 1½-inch deep. Ceiling boxes shall withstand a vertical force of 200 pounds for five minutes. Wall boxes shall withstand a vertical downward force of 50 pounds for five minutes.

#### **Part 2 – Products**

##### **Materials**

Use cast boxes with threaded hubs for all rigid and intermediate conduits. Steel boxes may be used with rigid and intermediate conduits where cast boxes are not allowed by the NEC. All boxes shall be of proper size to accommodate devices, connectors, and number of wires present in the box. Boxes shall be readily accessible.

Cast box bodies and cover shall be cast or malleable iron with a minimum wall thickness of 1/8-inch at every point, and not less than 1/4-inch at tapped holes for rigid conduit. Bosses are not acceptable. Mounting lugs shall be provided at the back or bottom corners of the body. Covers shall be secured to the box body with No. 6 or larger brass or bronze flathead screws. Boxes shall be provided with neoprene cover gaskets. Outlet boxes shall be of the FS types. Boxes shall conform to FS W-C-586C and UL 514.

Sheet metal boxes shall conform to UL 50, with a hot-dipped galvanized finish conforming to ASTM A123. Boxes and box extension rings shall be provided with knockouts. Boxes shall be formed in one piece from carbon-steel sheets.

Non-metallic boxes shall be hot-compressed fiberglass, one-piece, molded with reinforcing of polyester material, with a minimum wall thickness of 1/8-inch.

### **Finishes**

Where only cast aluminum is available for certain types of fixture boxes, an epoxy finish shall be provided.

## **16.72.3 Watertight Enclosures**

*[CSI 26 05 33.17]*

### **Part 2 – Products**

#### **Manufacturers**

The watertight enclosure shall be equal to Hoffman.

#### **Materials**

Watertight enclosures for vault electrical outlets shall be molded from fiberglass reinforced polyester material. A hinged cover shall be gasketed and opened with quick release latches. The conduit penetrations shall be sealed watertight.

### **Part 3 – Execution**

#### **Installation**

An epoxy plug shall be installed in the conduit to prevent the migration of water into the conduit. The enclosure shall be NEMA rated and installed per all applicable codes.

## **16.75 Wiring Devices**

*[CSI 26 27 26]*

## 16.75.1 Common Work for Wiring Devices

*[CSI 26 27 26]*

### Part 3 - Execution

#### Installation

##### Wiring Devices

1. Position of Outlets: All outlets shall be centered with regard to building lines, furring and trim, symmetrically arranged in the room or outside the structure. Device outlets shall be set plumb and shall extend flush to the finished surface of the wall, ceiling or floor without projecting beyond the same.
2. Unless otherwise noted, wall mounted outlet devices shall generally be 24-inches above the floor, 18 inches in architecturally treated areas, above process piping near process valve boards. Switches shall be 48 inches above the finished floor unless otherwise noted.

##### Installation of Wall Plates

1. Interior Dry Locations: Install plates so that all four edges are in continuous contact with the finished wall surfaces. Plaster filled will not be permitted. Do not use oversize plates or sectional plates.
2. Exterior and/or Wet Locations: Install plates with gaskets on wiring devices in such a manner as to provide a rain tight weatherproof installation. For receptacle devices, these plates shall maintain the weatherproof rating with an attachment plug inserted and be rated extra-duty. Cover type shall match box type.

#### Testing

After installation of receptacles, circuits shall be energized, and each receptacle tested for proper ground continuity, reversed polarity, and/or open neutral condition.

GFI receptacles shall be tested with the circuits energized. Devices shall be tested with a portable GFI receptacle tester capable of circulating 7.5 milliamperes of current, when plugged in, between the "hot" line and "ground" to produce tripping of the receptacle. Resetting and tripping shall be checked at least twice at each GFI receptacle.

Submit results of all field testing to the Engineer for review.

## 16.75.2 Receptacles

*[CSI 26 27 19]*

### Part 1 – General

#### Design Requirements

Receptacles shall be heavy duty, high abuse, grounding type conforming to NEMA configurations, NEMA WD1 and UL 514 Standards.

## Part 2 – Products

### Materials

#### Single and Duplex Receptacles

1. Outdoor, Process, or Corrosive Areas: Receptacles shall be duplex, 20 amp, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plug caps. Receptacle and plug caps shall be corrosion resistant, marine duty with lockable weatherproof lift covers.

## 16.95 Testing

*[CSI 26 08 00]*

### 16.95.1 Common Work for Testing

*[CSI 26 08 05]*

#### Part 1 - General

##### Submittals

Test reports shall be submitted to the Engineer prior to final acceptance in accordance with Division 1.33 of these specifications.

##### Scheduling and Coordination

The Contractor shall inform the Engineer in advance of testing in accordance with the requirements listed in Division 1 of these specifications.

Prior to scheduling the testing, the Contractor shall have satisfied themselves that the project area is properly cleaned up; all patching and painting deemed necessary properly completed; and all systems, equipment and controls are functioning as intended.

#### Part 2 - Products

##### Source Quality Control

Submit reports of factory tests and adjustments performed by equipment manufacturers to the Engineer prior to field testing and adjustment of equipment. These reports shall identify the equipment and show dates, results of test, measured values and final adjustment settings. Provide factory tests and adjustments for equipment where factory tests are specified in the equipment specifications. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. Provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory.

#### Part 3 – Execution

##### Site Testing

Test all circuits for continuity, freedom from ground, and proper operation during progress of the work.

Insulation Resistance, Continuity, and Rotation: Perform routine insulation resistance, continuity and rotation tests for all distribution and utilization equipment prior and in addition to tests performed by the testing laboratory specified herein.

Electric Motors: Perform voltage, current and resistance tests on all motors  $\frac{1}{2}$  horsepower and larger installed this project. Insulation resistance readings shall be taken with a 500-volt megger for 30 seconds with the circuit conductors connected to the motor. Verify that an overload condition does not exist.

Conduct special test as required for service and/or system ground.

### **Field Quality Control**

#### General

1. Conduct final test in the presence of Owner and/or their authorized representative. Contractor shall provide all testing instrumentation and labor required to demonstrate satisfactory operation of systems, equipment and controls.

#### Operational Tests

1. Operational test all circuits to demonstrate that the circuits and equipment have been properly installed, adjusted and are ready for full-time service. Demonstrate the proper functioning of circuits in all modes of operation, and including alarm conditions, and demonstrate satisfactory interfacing with the data acquisition and alarm systems.

### 16.95.3 Conductor Test Report

[CSI 26 08 13]

Conductor Test Report Page 1 of 1															
PROJECT:								OWNER:							
Contractor Co. Name:								Phone Number:							
Tested by:								Test Date:							
Race- way	V	C	Operating Load Voltage						Insulation Resistance - OHMS						
Label	(1)	(2)	(3)	VAB	VCB	VCA	VAN	VBN	VCN	A-B	B-C	C-A	A-G	B-G	C-G
A															
B															
C															
D															
E															
F															
G															

1. Refer to raceway and wire schedule and one-line diagram for description of feeder identified by label shown on this report
2. Visual Inspection – Check when completed
3. Continuity Test – Check when completed

## 16.95.4 Ground Electrode Resistance Test Report

*[CSI 26 08 15]*

Ground Electrode Resistance Test Report	
PROJECT:	OWNER:
Contractor Co. Name:	Phone Number:
Tested by:	Test Date:
Test Meter Type:	
Test Distance-D:	
Soil Conditions:	
Measured Resistance:	
DESCRIPTION OF TEST PROCEDURE, CONDITIONS, RESULTS:	

# Division 17

## Automatic Control

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### 17.00 GENERAL

This division covers all work necessary for furnishing, installing, adjusting, testing, documenting, and starting-up the Instrumentation and Control (I&C) and Telemetry System. Programmable logic controller (PLC) shall provide local, automatic monitoring of on-site instrumentation. Computer-based telemetry system will provide remote control, alarm presentation, and data logging activities at the Owner's headquarters location.

Sections in these specifications titled “*Common Work for . . .*” shall apply to all following related subsections whether directly referenced or not.

These specifications are an integral part of the contract documents for the I&C and Telemetry portion of this contract. The written descriptions of system performance contained herein are given to assist the Contractor in interpreting the contract plans but are not intended to be all-inclusive. The Contractor shall be aware that all automatic control systems do not require the same components and accessories for complete system operation. Therefore, these specifications do not include all accessories and appurtenances required for a complete system. The Contractor shall, however, provide all accessories and appurtenances to result in a completely operational system as required to meet the functional requirements of these documents. Where specific equipment specifications are given, they are used to represent the level of quality required by these documents.

### 17.05 Common Work for Automatic Control

*[CSI 40 60 05]*

#### Part 1 - General

##### Summary

The work under this division covers construction specifically described in these specifications. Project Plans will be provided for this project. All work incidental and necessary to the completion of the project described herein shall be completed under the bid item listed in the bid proposal, and no other compensation will be allowed. The work generally consists of the following:

- Detailed system layout and design for the particular equipment bid in accordance with these functional specifications.
- Furnishing of I&C equipment including delivery, storage, software, programming, installation, testing, startup, and documentation.
- Providing operator maintenance manuals for all equipment and devices provided by this Contract.
- Providing system training to the operators of the proposed equipment.

## Related Sections

- Division 16 Electrical

## References

The project Plans are based on Instrument Society of America (ISA) standards numbers S5.1, S5.2, S5.3, and S5.4. The Contractor is encouraged to be familiar with these standards since the project plans do not contain wiring or ladder diagrams, but are based on the functional requirements of the ISA format.

All equipment and materials shall conform to the latest revised editions of applicable standards published by the following organizations:

- American National Standards Institute (ANSI).
- Institute of Electrical and Electronic Engineers (IEEE).
- National Electrical Manufacturers Association (NEMA).
- Underwriters' Laboratories (U/L).
- Instrument Society of America (ISA)

All equipment and materials, and the design, construction, installation, and application thereof shall comply with all applicable provisions of the National Electrical Code (NEC), the Occupational Safety and Health Act (OSHA), and any applicable Federal, State, and local ordinances, rules and regulations. All materials and equipment specified herein shall be within the scope of Underwriter's Laboratory (UL) examination services, be approved by the UL for the purpose for which they are used and shall bear the UL label.

All control panels shall bear a label by UL or by an approved testing authority for the completed assembled panel.

## Definitions

**Contractor:** The Contractor, as distinct from the Control System Integrator, shall install panels and other materials furnished by the Control System Integrator and provide all materials and work necessary and thereby, satisfy all requirements that are within the scope of this section.

**Control System Integrator:** A single firm preselected by the Owner, who shall design and furnish the system, provide the instrument panels; provide the PLCs, RTU, assemble and test the control panel equipment, and program PLCs, computers, and other instrument components and provide start-up and training services under a separate contract. The Control System Integrator for this contract shall be: Quality Controls Corporation (Lynnwood, WA).

## Submittals

All submittals shall be complete, neat, orderly and indexed. Partial submittals will not be accepted. Submittal information shall be provided to the Owner for the following items:

- Telemetry Panel
- Liquid Level Switch
- Pressure Transmitter

- Intrusion Alarm Switch
- Operation and Maintenance Manuals per Division 1.79.2 and Division 17.94
- Full size nameplate wording schedules, in lettering style proposed for use.

In addition to the requirements of Division 1.33, the Contractor shall develop and submit the following information provided by the Control System Integrator.

#### Hardware Submittals

Before any components are fabricated, and/or integrated into assemblies, or shipped to the site, the Contractor shall prepare a complete hardware submittal. The Engineer shall require five (5) sets, including fully detailed shop drawing, catalog cuts, wiring connections, and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these Specifications. The decision of the Engineer, upon the acceptability of any submittal, shall be final. Catalog information shall be submitted for all components and equipment, regardless of whether or not it is of the same manufacture as that listed in the Specifications.

#### System Plan Submittals

Following approval of the hardware submittal, the Control System Integrator shall prepare complete system interconnect wiring diagrams and panel layout plans for approval.

#### Plans

The Control System Integrator shall develop all shop drawings required for design, fabrication, assembly and installation of the control system. Shop drawings shall include all plans required in manufacture of specialized components and for assembly and installation of them.

Plans shall be prepared with a CAD program capable of exporting to AutoCAD format, and printed on 11-inch by 17-inch media. Plans shall have borders and title blocks identifying the project system, revisions to the plans, and type of plan. Each revision of a plan shall carry a date and brief description of the revisions. Diagrams shall carry a date and brief description of the revisions. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel work wiring. Additionally, one set of electronic .DWG files shall be provided to the Owner.

#### Elementary Diagrams

The Contractor shall provide elementary diagrams for all discrete loops. Loop diagrams shall be prepared in compliance with ISA S5.4 and shall be provided for all analog loops. Elementary diagrams and loop diagrams shall show circuits and devices of a system. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system. Elementary and loop diagrams shall also show wire numbers, wire color codes, signal polarities, and terminal block numbers.

#### Panel Fabrication and Arrangements Plans

The Contractor shall provide arrangement plans of all panel front- and internal-mounted instruments, switches, devices, and equipment indicated. All panel mounting details shall be

shown. Outer dimensions of all panels shall be included on the plan. Deviations from approved arrangements require approval prior to installation.

Arrangement plans shall be drawn to scale using standard Architectural or Engineering scales.

### **Site Conditions**

Specified instrumentation and control equipment shall be modified, if necessary, to make it suitable for operation in the ambient conditions specified in Division 16.

### **Warranty**

In addition to any other warranties required by the specifications, the entire PLC system will be warranted against defects in materials, workmanship, and software functions for a period of one (1) calendar year following the successful completion of the Functional Acceptance Test (FAT). The Contractor or designated service organization will be available on 24-hour notice to correct any system problems without charge to the Owner during the warranty period. In addition, the Contractor will provide four 2-day site visits during the warranty period to perform inspection and calibration of the equipment or other work at the request of the Owner.

### **Extra Materials**

The Control System Integrator shall supply sufficient spare parts, components, and assemblies to replace *any* defective or malfunctioning control component provided in this system. Control components are considered any device or combination of devices without which normal automatic control as outlined in this specification cannot be accomplished, and includes:

1. Two (2) spares of each part, component, or assembly, if more than ten (10) of those components are normally in use in the system.
2. One (1) box of each fuse type provided on this project. If ten (10) or more of a fuse type is provided for the project, then two (2) spare boxes shall be provided.
3. One (1) spare circuit breaker of each rating type provided on this project.
4. One (1) spare relay of each rating type provided on this project.
5. One (1) spare DC power supply.
6. One (1) spare of each type of PLC module and processor.

Spare part components shall be packaged for ease of field installation by non-trained personnel, so that no soldering or special skills are required for installation. All spare parts shall be delivered in a hinged plastic box that is purposefully made for this contract. The box shall have a parts list permanently attached to the inside lid which lists all parts and refers to them by numbered code visible on the outside of the package. Fragile components shall be adequately protected with cut foam. Electronic components shall be wrapped in ultra-violet inhibiting film. The exterior of the box shall be labeled "Telemetry Spare Parts – Water Department." Provide the box with lifting handles.

## **Part 2 – Products**

### **Components**

These Specifications list major instruments required to provide the process instrumentation system. All instrument functions specified on this list shall be provided by the Control System Integrator. Any additional instruments required to complete the instrument loops because of certain characteristics of the particular equipment selected by the Control System Integrator shall be provided. Such additional instruments shall be provided and included in the original contract price even though not specified in the instrument index or on the Plans.

### **Accessories**

Provide all accessories required to furnish a complete control system that meets the requirements of the Plans and Specifications.

### **Source Quality Control**

Material shall be new, free from defects, and of the quality specified. All equipment and materials utilized in the system shall be the products of Manufacturers with at least five (5) years of experience in the manufacture of similar equipment. Similar items in the system shall be the products of the same Manufacturer. All equipment shall be of industrial grade and of standard construction, shall be capable of long, reliable, trouble-free service, and shall be specifically intended for control and monitoring of operation of motor-driven pumps and equipment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing.

## **Part 3 - Execution**

### **Installers**

Installation shall be performed by the workers who are skilled and experienced in the installation of I&C and Telemetry systems.

### **Installation**

Installation and testing procedures shall be as specified in these and subsequent sections of this division.

The control system shall be installed in accordance with the installation plans and instructions prepared by the Control System Integrator.

Installation shall include all elements and components of control system and all conduit and interconnecting wiring between all elements, components, sensors, and valve operators.

Equipment shall be located so that it is readily accessible for operation and maintenance.

### **Field Equipment**

Equipment shall be provided as specified on the Plans such that ports and adjustments are accessible for in-place testing and calibration. Where possible, equipment shall be located between 48 inches and 60 inches, unless specified otherwise on the Plans, above the floor or a permanent work platform. Instrumentation equipment shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Equipment shall be mounted where shock or vibration will not impair its operation. Support systems shall not be attached to handrails,

process piping or mechanical equipment except for measuring elements and valve positioners. Instruments and cabinets supported directly by concrete or concrete block walls shall be spaced out not less than  $\frac{5}{8}$ -inch by framing channel between instrument and wall.

Steel used for support of equipment shall be hot-dip galvanized after fabrication. Support systems including panels shall be designed in accordance with the Seismic Restraint and Anchorage section of Division 1.81 of these specifications and to prevent deformation greater than  $\frac{1}{8}$ -inch under the attached equipment load and an external load of 200 pounds in any direction.

#### Electrical Power Connection

Electric power wiring and equipment shall be in compliance with Division 16. Power disconnect switches shall be provided within sight of equipment and shall be labeled to indicate opened and closed positions and specific equipment served. "Within sight of" is defined as having a clear unobstructed view from the equipment served and within 50 feet of the equipment served. Disconnect switches shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location is such that the above requirements cannot be met by a single disconnect switch, two switches, one at the equipment and one at the work platform, shall be provided.

#### Signal Connection

Electrical signal connections to equipment shall be made on terminal blocks or by locking plug and receptacle assemblies. Jacketed flexible conduit shall be used between equipment and rigid raceway systems except that flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 2 feet. Flexible cable, receptacle and plug assemblies shall be used only where specified.

## **17.06 Control System Integrator**

*[CSI 40 61 13]*

### **Part 1 - General**

#### **Division of Responsibility**

All instrumentation and industrial electronic systems shall be provided under the supervision of a single Control System Integrator, chosen by the Owner, which is regularly engaged in the design and installation of such systems of similar scope and complexity. The assignment of specific responsibilities herein to the Control System Integrator shall not, in any way and under any conditions, diminish the Contractor's full and complete responsibility for all work performed and all materials installed under the contract.

The assignment of a Control System Integrator that is an equipment supplier shall not be acceptable.

#### Control System Integrator's Responsibility

The Control System Integrator shall be solely and completely responsible for the final design and assembly of the entire control system. Responsibilities include:

- Provision and detailed design of custom control panels. The plans show general layout of the control panels. The Integrator shall provide detailed scaled design of all components on and in the control panels and determine specific requirements.
- The design of all interconnecting wiring of control equipment including remote control panels, packaged equipment panels, mechanical equipment with control components, etc.
- Testing of the control panels in the Control System Integrator's shop.
- Coordinate with the Contractor for specific requirements and locations of raceway penetrations and field wiring in control panels.
- The Control System Integrator shall supply the Contractor with all necessary detailed installation plans and/or written instruction for installation of all control components and sensing devices for proper system operation.
- Develop an assembly and testing schedule, with the Engineer and Owner to allow for testing of all new programs in the Control System Integrator's shop.
- Provide installation assistance.
- Programming of the PLC's.
- Programming of the graphical touch screen operator interfaces (OI) on the control panels.
- MTU and Human Machine Interface (HMI) programming at the Owners Headquarters.
- Provide Startup and Training Services.

#### General and Electrical Contractor's Responsibilities

The General and Electrical Contractor shall be responsible for the following equipment and services:

- Review of the Control System Integrator's submittals and wiring diagrams for coordination with space requirements, raceway requirements of field wiring, etc.
- Supply the Integrator with submittals of equipment related to the control system that the Integrator must include in their submittals and integrate. Such as meters, packaged control panels that the Integrator does not build, etc.
- Installation of the control panels provided by the Control System Integrator.
- Installation of the interconnecting wiring in accordance with these documents and the Control System Integrators wiring diagrams.
- Installation of I&C and Telemetry System components in accordance with these documents and plans or instructions of the Control System Integrator.

## Part 3 – Execution

### Installers

The Control System shall be designed, constructed, programmed and commissioned by full time employees with a minimum of 5 years of experience (minimum of 1 year with Integrator).

#### Integrators List

The Control System Integrator shall be:

- Quality Control Corporation (QCC) – Lynnwood, Washington

## 17.08 System Description

*[CSI 40 61 96]*

### Part 1 – General

#### Summary

The I&C and Telemetry system functions required are specified on the Plans and in subsequent sections of this Division.

#### Design and Performance Requirements

The system shall be designed to provide the control capabilities and functions indicated and implied by the Plans and these Specifications and to provide trouble-free operation with minimum maintenance. The system shall readily enable manual operation of any and all functions in the event of failure of any one component.

The control system shall be designed and assembled by the Control System Integrator to provide:

- Control of meters, equipment, and processes.
- Monitoring of operation of meters, equipment, and processes.
- Indication of operating status of meters, equipment, and processes.
- Monitoring and indication of pressures and flows, as indicated and implied by the Plans and Specifications.
- The capabilities indicated and implied by the Plans and Specifications.

The I&C and Telemetry System shall be designed and assembled by the Control System Integrator to be an integrated system composed completely of components which are specifically designed and used for and in conjunction with control and operation of motor-driven pumps and process control equipment. The Control System Integrator shall supply all interfacing equipment, appurtenances and accessories and all such devices that may be required for proper interfacing as part of the control system.

## Project Conditions

The control system for the facility shall be a Remote Telemetry Unit (RTU) based system that consists of a new RTU linked to the existing Master Telemetry Unit (MTU) via cellular communications.

RTU sites included in this project are:

1. Flow Meter Telemetry Panel

## Part 2 – Products

### Manufacturers

The telemetry components of the RTU shall be manufactured by Allen-Bradley to be consistent with the Owner's existing system.

### Components

The I&C and Telemetry System shall include the instruments, control devices, Remote Telemetry Unit, Human Machine Interface, input and output devices, sensors, interfacing devices, cabinets, enclosures and other components indicated and implied by the Plans and Specifications.

The following is a list of the RTUs, Control Panels, Pressure Transmitter, and other components to be provided by the Control System Integrator:

- Telemetry Panel

## Part 3 – Execution

### Preparation

The Control System Integrator shall be responsible for the coordination and integration of control system with the meters and other related equipment. The Control System Integrator shall communicate directly with the Manufacturer(s) and Supplier(s) of all related equipment to determine all details of the equipment, which may influence or affect the control system. The Control System Integrator shall determine all requirements for and shall cause integration of the control system into a unified operating system. The Control System Integrator shall define all requirements for all interfacing equipment and shall supply all appurtenances, accessories and all such devices, which may be required for proper interfacing as part of the control system.

The Control System Integrator shall be responsible to obtain submittal information on equipment supplied by other disciplines and to integrate them into the control system to form a complete working package as outlined by the contract documents.

### Installation

The system shall be completely assembled in the shop by the Control System Integrator. All components and equipment shall be prewired to the maximum extent possible.

All Process Control shall be done within the control panels unless specifically listed on the Plans as other.

## 17.10 PANELS (PROVIDED BY CONTROL SYSTEM INTEGRATOR)

*[CSI 40 67 00]*

### 17.12 Equipment Panels

*[CSI 40 67 16, 40 67 19]*

#### Part 1 – General

##### Related Sections

Division 10.14.23 Panel Signage. All panels shall be labeled.

##### References

Panels shall meet the requirements of UL-508 for water systems. All panels shall bear the appropriate label. The provider of the panels shall be a UL-508A certified facility. All field modifications shall be in conformance with UL-508.

##### Design Requirements

Control equipment panels shall be enclosures conforming to the requirements of the National Electrical Manufacturers Association (NEMA) and shall be NEMA 4X Stainless Steel for outdoor use.

#### Part 2 – Products

##### Components

- Enclosure shall be constructed of stainless steel.
- Minimal metal thickness shall be 14-gauge.
- All doors shall be rubber-gasketed with continuous hinge and key locking latch mechanism.
- Wherever practical, enclosures shall be a manufactured item.
- All doors shall be provided with quick-release latches to secure cover.
- Panels shall be sized to adequately dissipate heat generated by equipment mounted in or on the panel.
- Enclosure shall include a backpan.
- Enclosure shall be finished in ANSI 61 gray polyester powder coating inside and out over phosphatized surfaces.
- The enclosure shall be oversized to accommodate future racks and auxiliary devices as required.
- All outdoor enclosures shall be provided with a control panel heater and ventilation fan and filter with built-in thermostat to provide adequate climate control.

## **Fabrication**

Panels should be completely fabricated, and instruments installed and wired in the manufacturer's factory (where possible). All wiring shall be completed and tested prior to shipment. All external connections shall be by way of numbered terminal blocks. Panel cutouts for instruments and devices shall be cut, punched or drilled and smoothly finished with rounded edges.

## **17.20 PANEL COMPONENTS (PROVIDED BY CONTROL SYSTEM INTEGRATOR)**

*[CSI 40 78 00]*

### **Part 1 - General**

#### **Design Requirements**

All components shall be suitable for installation inside the I&C and Telemetry system panel enclosure.

### **17.20.3 Terminal Blocks**

*[CSI 40 78 71]*

#### **Part 1 - General**

#### **Design Requirements**

Terminal blocks shall be one-piece molded plastic blocks with screw-type terminals and barriers rated for 600 volts. Terminals shall be double-sided and supplied with removable covers to prevent accidental contact with live circuits. Terminals shall have permanent, legible identification, and be clearly visible with the protective cover removed.

Fusible terminal blocks shall be provided with a LED blown fuse indicator for each terminal.

#### **Part 3 - Execution**

#### **Installation**

All wires between panel-mounted equipment and other equipment shall be terminated at terminal blocks. Switches shall be terminated at the terminal blocks with crimp-type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for their terminal block screws and for the number and size of the wires terminated.

## 17.21 Power Supply and Protection

### 17.21.2 Normal Power Supply

*[CSI 40 78 59]*

#### Part 1 - General

##### Design Requirements

All equipment panels shall be provided with 120-volt, 60-Hz power. Make provisions for conduit entry and provide a terminal block for termination of the circuit wires. All electronic control panel components shall require a 120 VAC-24 VDC power supply. DC power supply shall be sized to provide at least 50 percent more current than the peak current demands of the control panel. DC power supply shall have UPS backup power capabilities as identified in Section 17.21.3. Protection equipment shall consist of circuit breakers and fuses to protect electrical circuits from short circuits and overloads.

#### Part 2 – Products

##### Manufacturers

DC power supplies shall be Puls Inc., Sola Inc., Allen-Bradley, or approved equal.

Fuses shall be Bussmann Manufacturing Model ABC or MDA rated for Branch circuit, or approved equal.

Circuit Breakers shall be Allen-Bradley rated for Branch circuit, or approved equal.

#### Part 3 – Execution

##### Construction

Branch circuits shall be individually fused with an indication of fuse opening. All fuse holders for the panel shall be grouped on a single sub-panel. They shall be so situated that when the panel door is opened there is a clear view of the indicators and clear access for replacement of the fuses.

Provide DC power supplies as required to power instruments requiring external DC power of the appropriate voltages, with sufficient voltage regulation and ripple control to assure that the instruments being supplied can operate within their required tolerances. The power supplies at all RTUs shall include batteries for a backup power supply and charging equipment.

### 17.21.3 Backup Power Supply

*[CSI 40 67 63]*

#### Part 1 - General

##### Design Requirements

All equipment panels shall have an Uninterruptable DC Power Module that interfaces with the Normal DC Power Supply. The Uninterruptable DC Power Module shall be capable of powering the control panel equipment for a period of not less than 24 hours after normal

power failure. Transfer shall be a non-mechanical, non-interruptible, smooth transfer to battery backup.

Remote equipment batteries shall be sealed lead-acid batteries of sufficient ampere hour capacity to meet the above requirements.

### **Performance Requirements**

The master console shall display power failure, and also a low battery condition alarm for the new equipment. A power failure alarm shall occur in the format currently used by the system. A low battery condition alarm shall cause the alarm indicator to flash but will not sound the audible alarm. The indicating light shall go off when the alarm condition is clear.

## **Part 3 – Execution**

### **Installation**

Batteries, battery chargers, and necessary wiring shall be installed to meet the above specifications.

## **17.21.5 Line Protection Units – Low Current**

*[CSI 40 78 56.15]*

### **Part 1 - General**

#### **Design Requirements**

The line protection unit shall isolate and protect the I&C electronics from current and voltage surges in the transmission lines. Each protection unit shall have:

- An isolation transformer with a minimum of 1,500 volts AC isolation, primary to secondary, and a minimum saturation current of 100 milliamps (ma) S.C. or as required to protect the I&C equipment from damage.
- Separate line-side and equipment-side terminal blocks.
- Two clip-mounted, replaceable gas discharge tubes rated at 90 volts striking voltage and 5,000 ampere peak pulse current capacity and suitable ground strap.

### **Part 2 - Products**

#### **Manufactured Units**

The line protection unit shall be a complete unit, mounted on a separate chassis, and be field replaceable without soldering. The chassis shall be a 1/4-inch thick plate.

## 17.21.6 Line Protection Units – High Current

*[CSI 40 78 56.17]*

### Part 1 - General

#### Design Requirements

The line protection unit shall isolate and protect the I&C electronics from current and voltage surges in the transmission lines. Each protection unit shall have:

- A minimum continuous operating current rating of 30 amps or larger as required to protect the telemetry equipment from damage.
- A minimum peak surge current rating of 80 KA.
- Separate line-side and equipment-side terminal blocks.
- LED indicator for circuit diagnostics.
- A response time less than or equal to 1 nanosecond.

The line protection unit shall be a complete unit available as a surface mount or DIN rail.

### Part 2 - Products

#### Manufacturers

The line protector shall be an Allen-Bradley Model 4983-DC120-20 or equal.

## 17.22 Wire and Cable

*[CSI 40 67 33]*

### 17.22.2 Wiring

*[CSI 40 67 33]*

#### Part 1 - General

#### References

All electrical wiring shall be in accordance with the NEC.

#### Design Requirements

Wires shall be 600-volt class, PVC insulated, stranded copper and shall be the sizes required for the current to be carried but not less than No. 14 AWG conductor size.

Wires for signal circuits shall be twisted shielded pairs not smaller than No. 18 AWG.

### Part 3 – Execution

#### Installation

All power wiring shall be supported on a sheet metal raceway or enclosed in a plastic wiring duct. Wiring for signal circuits shall be separated at least 6-inch from any power wiring.

### 17.22.3 Cables

*[CSI 40 67 33]*

#### Part 1 - General

##### Design Requirements

Cables and connectors shall be industry standard, shielded, and shall be provided to connect all peripherals and equipment.

### 17.24 Switches and Relays

*[CSI 40 78 19, 40 78 53]*

#### 17.24.2 Selector Switch

*[CSI 40 78 19.21]*

##### Part 2 – Products

##### Manufacturers

*Heavy-Duty, Watertight, and Corrosion-Resistant Type:* Eaton/Cutler-Hammer, Type E34; Square D Co., Type SK; Allen Bradley, Type 800H; General Electric Co., Type CR 104P.

##### Manufactured Units

Selector switches shall be NEMA type 4/4X/13, corrosion-resistant/watertight/oil-tight, type selector switches with contacts rated for 10 amperes continuous at proper operating voltage. Operators shall be black knob type. Units shall have the number of positions and contact arrangements and spring return function (if any) as shown on Plans. Units shall be single-hole mounting, accommodating panel thicknesses from  $\frac{1}{16}$ -inch minimums to  $\frac{1}{4}$ -inch maximum.

### 17.24.3 Pushbuttons

*[CSI 40 78 19.23]*

##### Part 2 – Products

##### Manufacturers

*Heavy-Duty, Watertight, and Corrosion-Resistant Type:* Eaton/Cutler-Hammer, Type E34; Square D Co., Type SK; Allen Bradley, Type 800H; General Electric Co., Type CR 104P.

##### Manufactured Units

Pushbuttons shall be NEMA type 4/4X/13, corrosion-resistant/watertight/oil-tight, type push buttons with momentary contacts rated for 10-ampere continuous at proper operating voltage. Button color shall be as specified in control panels and shall have a full guard. Pushbutton contact arrangements shall be as shown on Plans. Size of pushbuttons as indicated on the Plans.

## Special Functions

Pushbutton for “Emergency Help” applications shall have maintained contacts and red mushroom head operators.

### 17.24.4 Panel Relays

*[CSI 40 78 53]*

#### Part 1 – General

##### Design Criteria

Relays shall be provided as necessary to perform switching functions required of control panels and other control circuits as shown on the Plans and described in the technical specifications. Appropriate relay type and associated contacts shall be selected based on the application from the control wiring diagrams or the functional description. Where timing relays and control relays require additional contacts, provide auxiliary control relays properly sized for the application.

All contacts and relays shall be NEMA rated and UL recognized.

The electrical life expectancy for the relay shall be over 500,000 operations at 120V AC, 10 amps; (over 200,000 operations at 120V AC, 10 amp for SPDT, 3PDT, and 4PDT). The mechanical life expectancy for the relay shall be over 50,000,000 operations.

#### Part 2 – Products

##### Manufacturers

###### Control Relays

Square D Class 8501, Type K or R; Allen Bradley 700 Type HA or HB; IDEC RH Series; or equal.

##### Manufactured Units

###### Control Relays

Relays for general purpose use shall be DPDT or 3PDT, 10 amp contacts with the appropriate coil voltage for the application. Relays shall be plug-in type with matching socket. All relays shall have LED indicators to signal when the coil is energized. Relay coils shall be rated for continuous duty.

#### Part 3 – Execution

##### Installation

Provide adjustable time relays on all alarm and shut down circuits to prevent nuisance tripping of other alarm points. Time delay relays for these functions may not be shown on the Plans; however, provide as required on all circuits.

Provide additional form C contacts over and above the number indicated on the Plans for all relays provided.

120 VAC relays shall not be interchangeable with other voltages to prevent a hazardous interchange of relay voltages.

Provide DIN mounted or panel mounted type depending on application.

## **17.25 Indicating Lights and Readouts**

*[CSI 40 78 13, 40 78 16]*

### **17.25.2 Pilot Lights**

*[CSI 40 78 16.21]*

#### **Part 2 – Products**

##### **Manufacturers**

*Heavy-Duty, Watertight, and Corrosion-Resistant Type:* Eaton/Cutler-Hammer, Type E34; Square D Co., Type SK; Allen Bradley, Type 800H; General Electric Co., Type CR 104P.

##### **Manufactured Units**

Indicating lights shall be NEMA type 4/4X/13, corrosion resistant, water-tight, oil-tight, full voltage, push-to-test, high visibility 28 chips LED type. Pilot lights shall be rated for the proper operating voltage. Appropriate lens caps shall be provided as shown on Plans.

## **17.30 INTELLIGENT CONTROL UNITS (PROVIDED BY CONTROL SYSTEM INTEGRATOR)**

### **17.31.2 Programmable Logic Controller (PLC) System**

*[CSI 40 63 43]*

#### **Part 1 - General**

##### **Summary**

Work involved in this contract includes providing new PLC equipment and programming to provide the functions shown on the Plans and described herein.

##### **Performance and Design Requirements**

- The PLC system modifications shall accomplish the control requirements of the loop descriptions, Plans, and Specifications.
- The design application and installation of the PLCs shall conform to NEMA ICS 1.1.
- PLC programming shall be documented.
- All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per ANSI/IEEE C37.90.2.

## Part 2 – Products

### Manufacturers

PLC components added to this Contract shall be Allen-Bradley. No substitution.

Refer to project Telemetry Panel plans for specific Allen-Bradley component numbers and quantities.

### Components

#### Input/Output (I/O) Modules

- a) Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
- b) Provide I/O system with:
  1. I/O solid state boards with status lights indicating I/O status and board failure.
  2. Electric isolation between logic and field device.
  3. Interchangeable boards for similar I/O type to allow substitution of operating boards for failed units by the operator.
  4. Capability of withstanding low energy common mode transient to 1500 V without failure.
  5. Incorporate noise suppression design.
  6. Capable of meeting or exceeding surge-withstand capability tests, per ANSI/IEEE C37.90.1.
  7. Capable of meeting or exceeding electrical noise tests, NEMA ICS1-109.60-109.66.
- c) Discrete I/O modules:
  1. Interface to ON/OFF devices.
  2. I/O status indicator on module front.
  3. Voltage rating to match circuit voltage.
  4. Output module current rating:
    - a. Match maximum circuit current draw.
    - b. Minimum 1.5 A/point for 120 V AC applications.
  5. Isolated modules for applications where one module interfaces with devices utilizing different sources of power.
  6. Individually fused outputs with blown fuse indication.
- d) Analog I/O modules:
  1. Input modules to accept signals indicated on Plans or Specifications.
  2. 12-bit minimum resolution.

3. I/O chassis supplied power for powering connected field devices.
4. Isolated (differential) inputs and outputs.
5. User configurable for desired fault-response state.
6. Provide output signals as indicated on Plans and Specifications.
7. Individual D/A converter for each output module.
8. Individual A/D converter for each input module.

#### Data Highway Communications

1. All PLC controllers shall be capable of EtherNet/IP communications. Any additional industrial protocols shall be provided through protocol converters.

#### PLC Peripheral Devices

1. PLC Peripheral Devices

##### Graphical Operator Interface

- a. The data entry and display module shall consist of a 6.5-inch color screen display.
- b. The unit shall be capable of reading PLC data table register values and pre-defined messages and writing into PLC memory to modify register values.
- c. The readout module will be used as a local operator interface device for entering operational parameters and reading out process data including display of all alarms by tag number.
- d. A complete index of parameters and corresponding memory locations and a complete cross reference of alarms will be permanently attached to each PLC enclosure.
- e. The unit will be self-contained, 24 VDC powered and rated minimum NEMA 12 suitable for panel mounting.
- f. Communications will be direct with the Ethernet Switch via shielded CAT 5E Ethernet Cable.
- g. The touch screen panel shall be an Allen-Bradley PanelView Plus 7 Standard Terminal, 6.5-inch Color Display, Part Number 2711P-T7C21D8S, No Substitutions.

### **Part 3 - Execution**

#### **Installers**

Control System Integrator and programmers shall have had experience in design, installation, and start-up of at least three similar installations using the proposed hardware and software.

#### **Installation**

Provide a completely integrated distributed programmable controller system capable of analog and sequential control, data acquisition and display, alarm annunciation and communications

using the PLC system. I/O cards and memory shall be added as necessary to complete work shown on the Plans and described in the specifications.

The system shall provide true distributed control wherein each PLC is an intelligent stand-alone controller programmed for the specific functions required at its respective location. Certain information in the form of control commands, interlocks and data will be passed directly between the PLCs for use in executing the local control programs.

#### Input/Output Connection Requirements

1. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
2. Prewire I/O modules to terminal blocks.
3. Provide terminal blocks with continuous marking strip.
4. Size terminals to accommodate all active data base points and spares.
5. Provide terminals for individual termination of each signal shield.
6. Field wiring shall not be disturbed when removing or replacing an I/O module.

#### PLC Installment

1. Component placement:
  - a. Mount all components according to manufacturer's instructions.
  - b. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
  - c. If items such as magnetic starters, contactors, relays and other electromagnetic devices are located within the same enclosure as the PLC system components, provide at least 6 inches of separation between the magnetic area and the control area.
  - d. Oversize enclosure to accommodate future racks and auxiliary devices as required.
2. Provide enclosure with a single quick disconnect of incoming power. Mount disconnect switch or breaker on enclosure exterior and label.
3. Enclosures shall comply with these specifications.
4. Enclosures shall be equipped with H2S inhibitor(s) suitable for the enclosed volume.

## 17.33 Network Equipment and Computers (Provided by Control System Integrator)

### 17.33.1 Industrial Network Equipment

*[CSI 40 66 13]*

#### Part 1 – General

##### Design Requirements

All specified “industrial network equipment” shall comply with the following minimum specifications:

1. Rated for a 5-30VDC power supply.
2. UL listed.
3. Designed for an industrial environment.
4. Operating temperature of -40 degrees Fahrenheit to 176 degrees Fahrenheit.
5. IP66 rated water and dust resistant.
6. Control network device shall be capable of remote monitoring using OPC protocol.
7. All devices on fiber backbone shall have a minimum of two sets of transmit/receive ports.
8. Twisted pair network speed shall be a minimum of 100Base-TX.
9. Fiber optic network speed shall be a minimum of 100Base-FX.

These requirements do not apply to non-industrial network equipment.

#### Part 2 - Products

##### Control Network Equipment

Data highway communications shall be accomplished on a control network consisting of nodes, one at each PLC or computer workstation and a physical link layer consisting of cables and all interfacing hardware. Control Network equipment shall consist of the following devices.

##### Unmanaged Ethernet Switch

One (1) N-Tron 308TX Ethernet Switch, or equal.

#### Part 3 – Execution

##### Installation

All network equipment in Control Panels shall be installed as per Plans, specifications and product installation instructions. All components shall be suitable for installation in the environment where installed. All devices shall be installed as specified by the manufacturer. All devices shall be installed to be field serviceable without taking the facility out of service. Device displays shall be positioned to be easily read when viewing directly into control panels.

## **17.50 SENSORS AND CONTROLS (PROVIDED BY CONTROL SYSTEM INTEGRATOR)**

*[CSI 40 70 00]*

### **17.50.1 Common Work for Sensors and Controls**

*[CSI 40 70 05]*

#### **Part 1 – General**

##### **Design Requirements**

Provide sensors and controls scaled and rated for their intended application.

#### **Part 3 – Execution**

##### **Installation**

All devices shall be installed to be field serviceable without taking the facility out of service. Readouts shall be positioned to be easily read from a standing position, central to the room unless allowed otherwise by the Engineer.

## **17.51 Emergency Sensors and Controls**

### **17.51.4 Intrusion Alarm Switch**

*[CSI 28 31 11.23]*

#### **Part 1 – General**

##### **Design Requirements**

The switch shall be two-pole side plunger type switch with one normally open and one normally closed set of contacts. The switch shall be a Type C and NEMA rated.

#### **Part 2 – Products**

##### **Manufacturers**

Intrusion switches shall be as specified on the Plans, or equal.

##### **Components**

Provide with a standard box plug-in and connecting cable of significant length to reach a junction box located near the switch.

#### **Part 3 – Execution**

##### **Installation**

The Contractor shall install intrusion alarm switches on all entrance doors and access hatches as shown on the Plans. All components shall be suitable for installation in the environment where installed.

Mount the switch as shown on the Plans to detect the opening of each entrance door and access hatch identified on the Plans. Connect to the normally open contacts so that the switch is closed when the door is closed and open when the door is open. A factory provided cord shall be of significant length to reach from the device to a junction box.

## 17.52 Pressure and Level Sensors and Controls

*[CSI 40 72 00, 40 73 00]*

### 17.52.2 Flood Liquid Level Switches

*[CSI 40 72 83]*

#### Design Requirements

The switch shall be SPST rated for 20VA. The float shall be constructed on Buna-N material and the stem shall be constructed from brass.

#### Part 2 – Products

##### Manufacturers

Switches shall be Omega, LVN-20 or equal.

#### Part 3 – Execution

##### Installation

The Contractor shall install a liquid level switch as shown on the Plans. Mount the switch to the end of 1/2-inch PVC Coated GRS, depending on the area classification. Provide threaded busing as necessary to provide a complete assembly. Secure pipe to wall with a minimum of two galvanized conduit hangers. Mount the liquid level assembly 1/2-inch above the finished floor.

### 17.52.10 Gauge Pressure Transmitter

*[CSI 40 73 26]*

#### Part 1 – General

##### Design Requirements

Provide transmitter with 1/4-inch or 1/2-inch process connections or as shown on the plans if different, and completely suitable for measuring pressure in potable water. Select ranges to provide a system that utilizes the largest percentage of available span for each transmitter. Transmitter shall transmit in pounds per square inch displayed at the device screen and through the 4-20mA output.

Location	Low end of range	High end of range (minimum)	High end of range (maximum)
Meter Manholes	0 psi	200 psi	300 psi

## **Part 2 – Products**

### **Manufacturers**

Pressure transmitter shall be Foxboro IGP10, Endress+Hauser Cerabar S PMP71, Siemens Sitrans P DS III, or equal.

### **Manufactured Units**

Pressure transmitters shall be all solid state with a 4-20ma output. All wetted parts shall be stainless steel. Transmitter shall be hermetically sealed to withstand submergence or an operating environment of 100 percent humidity for an indefinite period of time. Total error band shall not exceed 0.25 percent of full scale over a temperature range of 0-100 degrees Celsius. Voltage input shall be 9 to 20 VDC without more than a 0.12 percent change in output. Volumetric displacement of bridge from 0 psi to max-rated pressure shall be less than 0.01 cubic inches. Provide electronics with built-in protection against AC line transients and lightning spikes, and an R/F filter to reject external electrical and internal noise. Zero and span adjustments shall be non-interacting.

A digital indicator with on-board pushbuttons shall be provided to display the measurement with a choice of units. The pushbuttons shall allow zero and span adjustments and local configuration without the need for a hand-held terminal.

## **Part 3 – Execution**

### **Installation**

Transmitter installations shall be equipped with drain and bleed and isolation valves to remove air from transmitter diaphragm. Control System Integrator shall be completely responsible for proper operation and interface of transmitter with other electronics provided on the project.

## **17.90 TESTING, STARTUP, AND TRAINING**

### **17.90.1 Common Work for Testing, Startup, and Training**

*[CSI 40 61 21, 40 61 26, 40 80 00]*

#### **Part 1 – General**

##### **Summary**

Total system hardware start-up is the responsibility of the Control System Integrator.

##### **Maintenance**

The Control System Integrator shall be solely and completely responsible for all hardware maintenance of the system from time of start-up to the date of acceptance, by formal action of the Owner, of all work under the contract. The Control System Integrator shall perform all such work required or considered to be required by the Owner to cause and maintain proper operation of the system and to properly maintain the system.

## Warranty

The Control System Integrator shall begin all repairs, replacements, modifications and adjustments within twenty-four (24) hours of notification by telephone by the Owner and shall complete such repairs, replacements, modifications and adjustments within forty-eight (48) hours of notification. Should the Control System Integrator fail to begin the work within 24 hours or complete the work within 48 hours, the Owner may proceed to undertake or complete the work.

## Part 3 – Execution

### Field Quality Control

#### Equipment Manufacturer's Support

1. The Control System Integrator shall pay for services of equipment manufacturer's field service representative(s) to:
  - a. Inspect equipment covered by these Specifications.
  - b. Supervise adjustments and installation checks.
  - c. Conduct start-up of equipment and perform operational checks.
  - d. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

## Repairs

The Control System Integrator shall correct all deficiencies and defects and make any and all repairs, replacements, modifications, and adjustments as malfunctions or failures occur.

The Contractor and the Control System Integrator shall anticipate that the Owner may delay acceptance of all work under the contract if, in the judgment of the Owner, malfunctions or failures in operation of the control system repeatedly occur after start-up. Both the Contractor and the Control System Integrator shall not be entitled to an extension of time or to any claim for damages because of hindrances, delays or complications caused by or resulting from delay by the Owner in accepting the work because of malfunctions or failures in operation of the control system.

## 17.91 Tests and Inspections

*[CSI 40 61 21, 40 80 13]*

### Part 1 - General

#### Summary

Materials, equipment, and construction included under this specification shall be inspected in accordance with the specifications. Testing shall be performed by the Control System Integrator in accordance with Division 16, and this and subsequent sections of this division. Testing shall be required to determine if installed equipment and system(s) will operate in the manner in which they are intended to operate. The decision of the Owner upon the acceptability of the test procedures and conformance shall be final. The work will not be accepted until all testing has been satisfactorily performed.

## Scheduling

The Control System Integrator shall prepare factory and field test procedures to demonstrate conformance of the complete system to this specification. The Contractor shall submit the detailed test procedures within four weeks after the notice to proceed for the Engineer's review and approval.

The Contractor shall furnish all labor, materials, tools, equipment, instruments and services necessary to perform all specific functional testing of all installed equipment and systems at no additional cost.

The Control System Integrator and Contractor shall notify the Owner and Engineer of the factory testing date 30 days before testing.

The Contractor and Control System Integrator shall include in the schedule 10 consecutive working days as part of the factory testing with the hardware supplied by the Control System Integrator at the Control System Integrator's shop.

The Control System Integrator and Contractor shall submit to the Engineer a detailed field testing schedule identifying each day that the Control System Integrator will need to be on site for field testing of equipment. A preliminary schedule shall be submitted to the Engineer for review 60 days before testing. A final schedule shall be submitted to the Engineer for review 30 days before testing.

Startup shall not proceed until the software field testing is complete.

## Part 2 – Products

### Factory Testing

All factory testing of control panels and computer systems shall be performed at the Control System Integrator's shop.

The completed control system shall be tested in the shop by the Control System Integrator. All motor control centers and VFD's supplied by the Control System Integrator shall be interconnected with the control system and powered with rated incoming voltage. Testing shall be conducted in two phases. The initial hardware testing shall include, but not be limited to, operation of all input and output (I/O) points, control devices and motor controllers.

The initial hardware testing of the control system shall include the following:

1. The entire assembled panels shall be meggered and tested to be free from grounds and shorts.
2. Energize each discrete input and output and simulating each analog input and output using a loop simulator and calibrator. Circuits not energized shall be tested for continuity. Discrete input signals shall be tested in both the "on" and "off" state. Analog signals shall be tested at a minimum of three values (4 mA, 12 mA, and 20 mA). The test results shall be documented by the Control System Integrator in checklist format. The final test results shall be signed by both the Engineer and Control System Integrator prior to shipment of equipment to the job site.
3. Provide signal generators, multimeters, and other test equipment as required to verify proper operation of the assembled panels.

4. Control panels shall initially be hardware tested in one group. The Control System Integrator shall interconnect the equipment with Ethernet cables and analog and discrete wiring as shown on the Plans. The equipment shall remain connected for the remainder of the factory testing period.
5. Correct, replace, or repair control panel, and/or components until testing demonstrates proper operation. Control panels shall not be shipped to the job site until testing has demonstrated complete operation of the panels.
6. Provide updated and complete as-built drawings for the control panels at the time of final factory testing. The Engineer shall review the drawings against the panel construction at the time of final factory testing. Drawings which do not reflect the actual construction of the panel shall be revised and reviewed again by the Engineer. As-built drawings that require revisions shall be submitted to the Engineer for review prior to shipment of equipment to the job site. This review process shall be repeated as necessary so that as-built drawings reflect the actual construction of the at the time of shipment. Panels shall not be shipped to the job site until the as-built drawings are updated, complete, and reflect the actual as-shipped status of the equipment.

Upon completion of the initial hardware testing, Control System Integrator shall conduct software testing for final inspection by the Owner. All control functions and all status and alarm monitoring and indication shall be demonstrated under simulated operating conditions. Simulating equipment shall be provided and wired into the control system for this testing. Testing shall be continued for the time period required by the Owner to observe and verify any revisions and as described above in the scheduling portion of this specification.

### **Part 3 – Execution**

#### **Field Quality Control**

Following installation by the Contractor, the Control System Integrator will verify the correctness of the interconnecting wiring and energize all control equipment in the field. Each point at the controller(s) shall be checked for proper functional operation through communication with the central computer.

#### **Field Tests**

The Control System Integrator in conjunction with the Contractor shall conduct field tests of all panels and instrumentation in the presence of the Engineer after installation of the equipment at the site. Testing shall be conducted by physically actuating signaling devices, installing temporary jumpers, or artificially imposing signals on the field wiring. This shall be done to establish proper operation of the field devices, the integrity of the field wiring, and the proper connection of field devices to the panels. The Contractor and Control System Integrator shall coordinate with the Engineer to provide for as complete testing of the control system as is practical prior to placing the equipment on line for actual control and monitoring. The Contractor and Control System Integrator shall make corrections or repairs to the wiring and/or devices as necessary to provide proper operation of the system.

After the initial testing is complete, commissioning shall be accomplished by the Control Systems Integrator and Contractor, with the Owner and Engineer present. Commissioning

shall include operation and verification of all control components and features of the entire control system. Each function shall be demonstrated to the satisfaction of the Owner.

### **Repairs**

Should any part of the system fail during the test, the test shall be rescheduled and repeated to the satisfaction of the Owner after repairs.

## **17.92 Startup**

*[CSI 40 80 15]*

### **Part 1 – General**

#### **Summary**

All testing, startup and operation shall not be cause for claims for delay by the Contractor, and all expenses accruing therefrom shall be deemed to be incidental to this contract. The Contractor shall make arrangement for all materials, supplies and labor necessary to efficiently complete the testing, startup and operation.

Startup shall consist of testing, by a simulated operation, all operational equipment and controls. The purpose of these tests shall be to check that all equipment will function under operating conditions, that all interlocking controls and sequences are properly set, and that the facility will function as an operating unit.

#### **Scheduling**

Factory representatives of all major units shall be present for the startup phase. The test shall continue until it is demonstrated that all functions of controls and machinery are correct.

### **Part 3 - Execution**

#### **Field Quality Control**

When the installation of the Control System is substantially complete, the Contractor shall commence with calibration and field testing. Testing shall determine that all system components connect up correctly to each other so that the system works as designed. Refer to section 17.91 for field testing requirements.

All components of the control system shall be calibrated by the Control System Integrator after completion of installation. Each component shall be adjusted to be within the Manufacturer's required range and for the specific application.

Components that cannot be properly calibrated or that are found to exceed the Manufacturer's specified range or accuracy shall be removed and replaced at no additional cost to the Owner.

The control system shall be placed into operation by the Control Systems Integrator.

The Control System Integrator shall calibrate all instruments, indicators, recorders, loops, etc. and shall provide a five-point calibration test results sheet for each calibrated instrument supplied by the Control System Integrator. The five-point calibration shall include one point at: Minimum input range value, Maximum input range value, Midrange input value, no other point less than 25 percent of span to any other point. Test forms shall identify each instrument

tested, input conditions vs. output signal results in tabulated form, and shall be submitted to the Engineer prior to final commissioning.

### **Repairs**

All deficiencies observed during the start-up will be corrected by the Contractor and Control System Integrator.

## **17.93 Training**

*[CSI 40 61 26]*

### **Part 1 – General**

#### **Submittals**

Submit index of all training offered by PLC system equipment manufacturers including operation and maintenance.

The Control System Integrator shall prepare and assemble specific instruction materials for each training session and shall supply such materials to the Owner at least 2 weeks prior to the time of the training.

### **Part 3 – Execution**

#### **Hands-On Training**

The Control System Integrator shall conduct specifically organized training sessions in operation and maintenance of the control system for personnel employed by the Owner. The training sessions shall be conducted to educate and train the personnel in maintenance and operation of all components of the control system. Training shall include, but not be limited to, the following:

1. Preventative maintenance procedures
2. Trouble-shooting
3. Calibration
4. Testing
5. Replacement of components

At least one training sessions, at least 2 hours in duration, shall be conducted at the facility after start-up of the system.

## **17.94 Documentation**

### **17.94.2 Operations and Maintenance Manuals**

*[CSI 40 80 23]*

#### **Part 1 – General**

##### **Summary**

Two types of operation and maintenance manuals (O&M) will be required for the contract:

1. General manuals for use by the Water Department staff for daily operation, maintenance and troubleshooting.
2. Technical manuals for use by trained electronics technicians for technical and “board level” maintenance and repair.

### **Submittals**

Prior to the receipt of payment for more than 50 percent of the work, the Contractor shall deliver to the Owner two sets of acceptable manufacturer's operating and maintenance instructions covering each piece of mechanical and electrical equipment, or equipment assembly, furnished under this contract. Each set of instructions shall be bound into multiple volumes; each volume to be complete with and index and bound in a suitable hard-cover binder. Manuals shall be assembled and indexed so that information on each piece of equipment can be readily found.

### **Quality Assurance**

Manuals shall be purposefully made for this installation, and general manuals which are vague or have limited applicability will not be accepted. The manuals shall be written in a non-technical format suitable for reading by water system operators with no previous automatic control equipment experience. The decision of the Owner on the acceptability of the manual shall be final.

## **Part 2 – Products**

### **Materials**

The Control System Integrator shall prepare and assemble detailed operation and maintenance manuals in accordance with the project general requirements. The manuals shall include, but not be limited to, the following:

1. Name, location and phone number of nearest supplier and spare part warehouse.
2. Step by step operating procedures.
3. Narrative of overall system performance and operation.
4. Listing of all equipment setpoints.
5. Preventative maintenance procedures
6. Trouble-shooting of master and remote equipment.
7. Calibration
8. Testing
9. Replacement of components
10. System schematics / shop drawings
11. As-built elementary and one-line diagrams
12. Catalog data and complete parts list for all equipment and control devices
13. Listing of recommended spare parts.

14. Listing of recommended maintenance tools and equipment.
15. Warranties.
16. Disassembly and reassembly instructions.
17. Program documentation printout with tag numbers and descriptive comments.
18. Backup program on CD-ROM or flash drive.

All plans shall be provided on hard copy and in electronic form on disk. Electronic drawing files shall be provided in PDF and AutoCAD .DWG format with all “xrefs” bound. If “xrefs” are not bound, all “xref”.DWG files shall be provided unlinked with instructions to reestablish the links. Files shall be in AutoCAD 2010 or later format.

# Division 18

## Measurement and Payment

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### 18.0 GENERAL

It is the intention of these specifications that performance of work under bid items shall result in complete construction, in proper operating condition, of improvements identified in these written specifications and accompanying plans. Work and material not specifically listed herein but required according to the plans and specifications and general practice shall be included in Contractor's bid price.

#### **Bid Item 1 – Mobilization, Demobilization, Site Preparation, and Cleanup**

Lump sum price covers complete cost of furnishing, installing and testing, complete and in-place, all work and materials necessary to: move and organize equipment and personnel onto the job site; secure job site; obtain all necessary permits and licenses; prepare site for construction operations; maintain site and surrounding areas during construction; move all personnel and equipment off site after contract completion, and accomplish all other items of work not specifically listed in other divisions.

No more than 80-percent of bid amount for this item will be paid before final payment request, and this bid amount may not be more than 10-percent of value of total contract.

#### **Bid Item 2 – Water Supply Metering Improvements**

Lump sum price shown shall cover the complete cost of furnishing, installing, and testing, complete and in-place, all work and materials necessary to construct the Water Supply Metering Improvements project. Work includes, but is not limited to:

- Provide all site work relating to construction of improvements, including: structure excavation, backfill, and compaction; site grading; temporary construction fencing; temporary erosion and sedimentation control; disposal of excess material; control of water; landscaping; trenching; excavation; removal of unsuitable materials; select bedding; backfill; appurtenances; dewatering; restoration for underground utilities; and all other work necessary for a complete installation of all site work;
- Provide all materials, equipment, and labor necessary for traffic control;
- Provide all materials, equipment, and labor necessary for construction of the underground utilities, including: trenching, trench shoring, and stabilization; disposal of excess material; select bedding; backfill; compaction; materials and appurtenances for telemetry, electrical, and other underground utilities; and all other work necessary for a complete installation of all underground utilities;
- Provide all materials, equipment, and labor necessary for the mechanical work shown on the Plans and detailed in the contract specifications, including: installation of the City-procured major mechanical components; and procurement and installation of all other mechanical materials and equipment not provided by the City or listed in other bid items;

- Provide all materials, equipment, and labor necessary for the structural work as shown on the Plans and detailed in the contract specifications, including: installation of the City-procured pre-cast concrete manholes; and procurement and installation of all other structural materials and equipment not provided by the City or listed in other bid items;
- Provide all materials, equipment, and labor necessary for the electrical work shown on the Plans and detailed in the contract specifications, including: installation of the City-procured electric meter load center; and procurement and installation of all other electrical materials and equipment not provided by the City or listed in other bid items;
- Provide all materials, equipment, and labor necessary for the automatic control system as shown on the Plans and detailed in the contract specifications, including: installation of the City-procured SCADA control panel; and procurement and installation of all other automatic control system materials and equipment not provided by the City or listed in other bid items; and
- Provide as-built data; cleanup site prior to final acceptance; and accomplish all other items of work not specifically listed in other divisions.

### **Bid Item 3 – Force Account**

The unit price shown shall cover the complete cost of performing work not shown or described in the contract documents but directed by the Owner. Work authorized by the Owner will be paid using the Force Account methodology described in section 1-09.6 of the Standard Specifications. The bid includes a fixed amount for all bidders and may not represent the actual amount performed during the project.