CONTRACT DOCUMENTS

AND

SPECIFICATIONS

FOR

PROJECT NO. TMUA-ES 2009-07, CONTRACT 2 PHASE 2 EAST 53RD STREET AND RIVERSIDE DRIVE: CHERRY CREEK LIFT STATION PUMP RESTORATION AND FORCE MAIN IMPROVEMENTS

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

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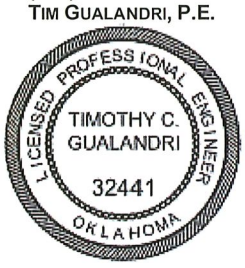

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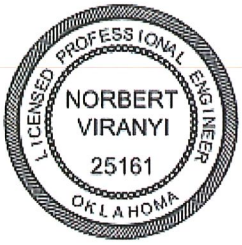

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VOLUME II - TECHNICAL SPECIFICATIONS

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CONTRACT DOCUMENTS

AND

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FOR

PROJECT NO. TMUA-ES 2009-07, CONTRACT 2 EAST 53RD STREET AND RIVERSIDE DRIVE: CHERRY CREEK LIFT STATION PUMP RESTORATION AND FORCE MAIN IMPROVEMENTS

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SECTION 00 0 10

TULSA MUNICIPAL UTILITIES AUTHORITY

PROJECT NO. TMUA-ES 2009-07, CONTRACT 2

EAST 53rd STREET AND RIVERSIDE DRIVE: CHERRY CREEK LIFT STATION PUMP RESTORATION AND FORCE MAIN IMPROVEMENTS

VOLUME II – TECHNICAL SPECIFICATIONS

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END OF SECTION

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description of Work

B. Constraints

C. Work By Others

D. CONTRACTOR's Use of Site

E. Work Sequence

F. Owner Occupancy

1.2 DESCRIPTION OF WORK

A. General: The Work to be done under this Contract consists of the construction of pump restoration improvements at the Cherry Creek Lift Station (C.C.L.S.) as shown and specified in Contract Documents entitled East 53rd Street and Riverside Drive: Cherry Creek Lift Station Pump Restoration and Force Main Improvements, TMUA Project Number: ES 2009-07, Contract 2. The Cherry Creek Lift Station is located at 4899 South Elwood Avenue in Tulsa, Oklahoma. The improvements include the following:

1. CCLS Pump Restoration Improvements (Base Bid)

a. Installation of four (4) 20-inch Pump Discharge Control Valves for pump startup and shutdown operations.
b. Installation of four (4) 20-inch or 19.38-inch pump impeller for each new NSY 100/150 Pump Rotating Assembly. Final size will be determined based on 90-Day Pilot Testing.
c. Replacement of (4) pump Rotating Assemblies, including two (2) new vibration sensors, one (1) new suction cover, and one (1) new suction cover wear ring for each existing 16x16x20 NSY Model 100/150 Centrifugal Pump.
d. 90-Day Pilot Testing of one (1) new NSY 100/150 Centrifugal Pump Rotating Assembly with one (1) new 20-inch diameter impeller for Pump No. 2. After completion of 90-Day Pilot Testing, and results demonstrate pump operations meet the Contract Requirements, the

remaining three (3) Pump Rotating Assemblies can be installed with a new 20-inch diameter impeller.

e. Installation of four (4) new self contained seal water support systems for each Pump.

f. Integration of eight (8) new vibration sensors for the new Pump rotating assemblies for vibration monitoring within the SCADA system.

g. Removal of four (4) Disc Accelerators within the existing 20-inch Surgebuster Check Valves for achieving performance similar to a Swing-Flex Check Valve.

h. Replacement of eight (8) existing Pump Suction and Discharge Pressure Gauges with new Differential Pressure Transmitters for trending pressure differential across the Pump within the SCADA system.

i. Integration of one (1) new Transient Pressure Monitoring System (TPMS) for local monitoring of transient pressure spikes across Pump No. 2 (Suction and Discharge) and its downstream Check Valve.

j. Replacement of four (4) existing 24-inch suction bell and piping within the CCLS Wet Well.

k. Removal of solids and grit within the Cherry Creek Lift Station Wet Well.

l. Replacement of existing Cherry Creek Lift Station Wet Well Cross Over Gate.

m. Inspection and repair of concrete surfaces on the top slab and within the Cherry Creek Wet Well.

n. Replacement of the existing odor control piping within the Cherry Creek Wet Well.

2. CCLS Force Main Improvements (Additive Alternates)

a. Removal and replacement of an existing 12-inch Drain Valve on the 36-Inch Cherry Creek Force Main's Blow-Off Line with a new Drain Valve Manhole.

b. Modification to existing Valve Vault No. 6, located at the SSWWTP, and construction of a new Valve Vault No. 8 where the 36-inch Cherry Creek Force Main and 24-inch 71st Street Force Main combine flow at the SSWWTP.

B. The Work includes:

1. Furnishing of all labor, material, superintendence, temporary pumping facilities, power, light, heat, fuel, water, tools, appliances, equipment, supplies, services and other means of construction necessary or proper for performing and completing the Work.

2. Maintaining the Work area and site in a clean and acceptable manner.

3. Maintaining existing facilities in service at all times except where specifically provided for otherwise herein.

4. Protection of finished and unfinished Work.

5. Repair and restoration of Work damaged during construction.

6. Furnishing as necessary proper equipment and machinery, of a sufficient capacity, to facilitate the Work and to handle all emergencies normally encountered in Work of this character.

7. Furnishing, installing, and protecting all necessary guides, track rails, bearing plates, anchor and attachment bolts, and all other appurtenances needed for the installation of the devices included in the equipment specified. Make anchor bolts of appropriate size, strength and material for the purpose intended. Furnish substantial templates and shop drawings for installation.

C. Implied and Normally Required Work: It is the intent of these Specifications to provide the OWNER with complete operable systems, subsystems and other items of Work. Any part or item of Work which is reasonably implied or normally required to make each installation satisfactorily and completely operable is deemed to be included in the Work and the Contract Amount. All miscellaneous appurtenances and other items of Work incidental to meeting the intent of these Specifications are included in the Work and the Contract Amount even though these appurtenances may not be specifically called for in these Specifications.

D. Quality of Work: Regard the apparent silence of the Contract Documents as to any detail, or the apparent omission from them of a detailed description concerning any Work to be done and materials to be furnished as meaning that only the best general practice is to prevail and that only materials and workmanship of the best quality are to be used. Interpretation of these specifications will be made upon this basis.

1.3 CONSTRAINTS

A. The Contract Documents are intended to allow the CONTRACTOR flexibility in construction of the Work, however the following constraints apply:

1. Prepare and submit a comprehensive schedule of proposed sequence of construction of the various parts of the lift station and force main improvements for approval in accordance with Section 01 32 16. Arrange the schedule to complete work in phases and permit operation by the OWNER of completed phases and parts thereof.

2. Maintain continuous operation of the existing lift station during construction. Any work which affects the existing lift station must be

carried out so that operation of the existing lift station will not be jeopardized or materially reduced in efficiency as a result of the work.

3. Provide and make as a part of work any temporary structures, connections, piping, and other work necessary to maintain service during the construction period.

4. Work on this Contract must be coordinated with the operation of the lift station. Notify the OWNER, with written notice, of the CONTRACTOR's planned procedures for each specific alteration or shutdown of existing facilities 30 calendar days before the alteration or shutdown begins. Do not commence with the alteration or shutdown until specific permission has been granted by the OWNER in each case. The OWNER will coordinate the CONTRACTOR's planned procedure with the operation of the lift station facility. The making of connections to existing facilities or other operations that interfere with the operation of the existing equipment must be completed as quickly as possible and with as little delay as possible. Prior to commencing with the work all required components, tools, and equipment are to be on-site. Work multiple or extended shifts to complete the work within the specified amount of time.

5. Any operational functions of the existing plant that are required to be done to facilitate the work of the CONTRACTOR will be performed by OWNER only as identified in approved planning.

6. If it is necessary for the proper operation or maintenance of the lift station, the CONTRACTOR must reschedule work to not conflict with necessary operation or maintenance of the lift station.

7. The OWNER will be the sole judge of when the CONTRACTOR's operations are causing interference with the lift stations operations, and the OWNER's orders and instructions must be carried out without delay.

B. In addition to the previously described general constraints, the following specific constraints apply:

1. Coordinate decommissioning and replacing of equipment, piping and appurtenances with the OWNER. Cause no more than one of four pumps and corresponding suction piping and discharge piping to be out of service at any time, except when performing replacement of existing suction piping, cross over gate and removal of solids and grit within the lift stations wet well for Contract Item 12.

2. Modify or connect to existing electrical facilities within the constraints shown on the Electrical Drawings. Limit temporary lift station shutdowns to the constraints specified. Combine electrical outages/shutdowns with piping outages/shutdowns where possible. Cause no outage of an individual piece

of equipment to exceed 2 hours unless a case is made for an outage of a longer period and such an extended outage can be accommodated by the OWNER.

3. Contractor to perform all work associated to Additive Alternate Contract Item 2 – New 12-Inch Force Main Drain Valve and Manhole between the months of September through February.

4. Contractor to perform all work associated with Contract Item 13 – Cherry Creek Wet Well Cross Over Gate between the months of September through February. OWNER to bypass all flow around the Cherry Creek Lift Station by means of the existing Mooser Creek sewer line. Contractor to coordinate this work 30 days in advance of performing the work to confirm approval by OWNER.

1.4 WORK BY OTHERS

A. Work on other projects, which may take place concurrently with this CONTRACT and which is excluded from this CONTRACT, is as follows:

1. Southside Wastewater Treatment Plant Peak Flow Optimization: Third River Crossing and Diversion Facilities

1.5 CONTRACTOR'S USE OF SITE

A. Limit use of site and premises for work and storage to allow for the following:

1. Coordination of the Work under this CONTRACT with the work of the other contractors where Work under this CONTRACT encroaches on the Work of other contractors.

2. OWNER occupancy and access to operate existing facilities.

3. Coordination of site use with ENGINEER.

4. Responsibility for protection and safekeeping of products under this CONTRACT.

5. Providing additional off-site storage at no additional cost to OWNER as needed.

1.6 WORK SEQUENCE

A. Construct Work in stages to accommodate OWNER's use of premises during construction period and in accordance with the limitations on the sequence of

construction specified. Coordinate construction schedules and operations with ENGINEER.

B. Coordinate Work of all subcontractors.

1.7 OWNER OCCUPANCY

A. OWNER will occupy premises during entire period of construction in order to maintain normal operations. Cooperate with OWNER's representative in all construction operations to minimize conflict, and to facilitate OWNER usage.

B. Conduct operations so as to inconvenience the general public in the least.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

A. Starting Work: Start Work within 10 days following the date stipulated in the written order from the Authority to proceed with the work and execute with such progress as may be required to prevent delay to other contractors or to the general completion of the project. Execute Work at such items and in or on such parts of the project, and with such forces, material and equipment, as to complete the Work in the time established by the Contract. At all times, schedule and direct the Work so that it provides an orderly progression to completion within the specified time for completion.

END OF SECTION

SECTION 01 26 00

CHANGE ORDER, WORK CHANGE DIRECTIVE AND FIELD ORDER PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Definitions

B. Change Orders

C. Work Change Directives

D. Field Orders

1.2 DEFINITIONS

A. Change Order: Refer to the Change Order definition in Article 1 of the General Conditions.

B. Work Change Directive: Refer to the Work Change Directive definition in Article 1 of the General Conditions.

C. Overhead: Overhead is defined as the cost of administration, field office and home office costs, general superintendence, office engineering and estimating costs, other required insurance, materials used in temporary structures (not including form work), additional premiums on the performance bond of the CONTRACTOR, the use of small tools, scheduling costs, and all other costs incidental to the performance of the change or the cost of doing business.

D. Field Orders: Refer to the Field Order definition in Article 1 of the General Conditions.

1.3 CHANGE ORDERS

A. Initiation of Proposals:

1. From time to time, the OWNER or the ENGINEER may issue a request for a Change Order proposal. The request will contain a description of the intended change with supplementary or revised Drawings and Specifications as applicable, and the projected time for accomplishing the change.

2. The CONTRACTOR may propose a change in the Work by submittal of a Change Order request to the ENGINEER describing the proposed change with a statement of the reason for the change and the effect on the Contract times and price, along with supporting documentation.

B. Execution of a request for a Change Order Proposal:

1. When a proposal is requested for changed work, submit proposal within 14 days following receipt of the request from OWNER or ENGINEER. State the increase or decrease, if any, in Contract Completion times and Contract Price.

2. Explain proposal in sufficient detail to permit review by OWNER.

3. For omitted work, the decrease in the Contract Price will be determined by the ENGINEER and will include appropriate amounts for profit and overhead.

4. The OWNER and ENGINEER will review the proposal and may request additional information and documentation. Provide these items upon request.

5. If the OWNER decides to proceed with the change, the OWNER will issue a Change Order for signature first by the CONTRACTOR and then by the OWNER.

6. The CONTRACTOR will promptly complete the approved change in the Work on receipt of the executed Change Order.

   a. Failure to sign the Change Order does not relieve the CONTRACTOR from performing the Work if the Change Order is signed by the OWNER.

C. Execution of a change order request:

1. The OWNER and ENGINEER will review the request and may request additional information and documentation. Provide these items upon request.

2. For omitted work, the decrease in the Contract Price will be determined by the ENGINEER and will include appropriate amounts for profit and overhead.

3. If the OWNER decides to proceed with the change, the OWNER will issue a Change Order for signature first by the CONTRACTOR and then by the OWNER.

4. The CONTRACTOR will promptly complete the approved change in the Work on receipt of the executed Change Order.

   a. Failure to sign the Change Order does not relieve the CONTRACTOR from performing the Work if the Change Order is signed by the OWNER.

D. Compute the cost of both additive and deductive changes in the Work in accordance with Article 12 of the General Conditions and as follows:

1. Include the costs of labor crew foreman and general foreman performing or directly supervising the changed Work on the site. Include travel and subsistence, but only to the extent incurred.

2. To the labor cost add all net premium for Workman's Compensation, taxes pursuant to the Federal Social Security Act, and payments required under State and Federal unemployment laws.

3. Add necessary extra materials, delivered at the site.

4. Include rent for plant and equipment at unit rental costs for similar rentals from an independent firm (i.e. a firm which is not owned in whole or in part by the CONTRACTOR). If equipment is owned by CONTRACTOR or rented from a firm in which the CONTRACTOR has an interest, calculate the rent in accordance with the applicable provisions and terms of the current "Cost Reference Guide for Construction Equipment" published by Dataquest.

1.4 WORK CHANGE DIRECTIVES

A. Initiation by OWNER: OWNER may issue a Work Change Director with a Notice to Proceed without a prior request for a Change Order Proposal or the CONTRACTOR's signature.

B. Payment Determination: The OWNER will designate the method of determining the amount of compensation or credit, if any, based on one of the methods contained in Article 12 of the General Conditions.

C. Timing: Proceed with the change in the Work immediately upon receipt of the Work Change Directive.

D. Addition to Contract: The Work Change Directive Orders will be incorporated into the Contract Documents via a Change Order at a later date.

1.5 FIELD ORDERS

A. The ENGINEER may issue a written order at any time during the course of construction.

B. Field Orders serve as documentation of minor changes in the work not involving a change in the Contract Price or Times.

C. Proceed with the change described in the Field Order immediately upon receipt of the field order.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 29 00

PAYMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Schedule of Values

B. Application for Payment

1.2 SCHEDULE OF VALUES

A. Approval of Schedule: Submit for approval a Schedule of Values, in duplicate, for all of the Work. Submit schedule of Values within 15 calendar days after work has commenced. Prepare the schedule of values as a detailed breakdown of each and unit prices bid for each item of the Contract. The total of all items, so broken down, shall equal the total amount of the Contract. Submit such other information relating to bid prices as requested by the ENGINEER, and revise the Schedule of Values to a form acceptable to the ENGINEER. Following acceptance of the Schedule of Values, it may be used for checking CONTRACTOR'S applications for partial payments, but shall not be binding on the OWNER or ENGINEER for any purpose whatsoever. Be advised that no partial payment will be processed unless the Schedule of Values is submitted in accordance with the above requirements.

B. Format: Utilize a format similar to the Table of Contents of the Project Specifications. Identify each line item with number and title of the major specification section. Identify site mobilization, bonds and insurance. Include within each line item, a direct proportional amount of CONTRACTOR'S overhead and profit.

C. Revisions: With each Application for Payment revise schedule to list approved Change Orders.

1.3 APPLICATION FOR PAYMENT

A. Required Copies: Submit three copies of each application. Present required information in typewritten form or on electronic media printout. Present actual invoices for materials for direct payment by OWNER. Include a current summary of payment to date.

B. Execute certification by signature of authorized officer.

C. Use data from approved Schedule of Values.

D. Stored Materials: When payment for materials stored is permitted, submit a separate schedule for Materials Stored showing line item, description, previous value received, value incorporated into the Work and present value.

E. Change Orders: List each authorized Change Order as an extension on continuation sheet, listing Change Order number and dollar amount as for an original item of work.

F. Final Payment: Prepare Application for Final Payment as required in General Condition GC-29(2).

G. Submit an updated construction schedule with each Application for Payment. Revise schedule to show Work completed to date and remaining Work. Schedule remaining Work to achieve completion of all contract Work by the contract completion date.

H. Submit application for payment to ENGINEER on, or before, the first day of each month.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 29 50

CONTRACT ITEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract Items

1.2 CONTRACT ITEM 1 – MOBILIZATION AND DEMOBILIZATION

A. Description: Under the Contract Item for Mobilization and Demobilization, furnish all labor, materials, equipment, and services, and do all Work necessary to mobilize and subsequently demobilize the construction preparatory operations. The Work includes bonds, insurance, Contractor Construction Staking, movement in and out of personnel and equipment. A MAXIMUM OF 5 PERCENT OF THE TOTAL BID IS ALLOWED FOR MOBILIZATION AND DEMOBILIZATION IN THE BID PROPOSAL.

B. Payment: Mobilization and Demobilization will be paid by EACH in the following manner:

1. Payment for this item will be made in two installments unless the first estimate submitted is also the final estimate, in which case the total will be paid. The first payment of 50 percent of the Contract price will be included in the pay estimate which reflects fifty percent completion of the work.

2. An additional fifteen percent (15%) of the price bid for mobilization/demobilization may be included in the pay estimate which reflects fifty percent (50%) completion of the work.

THE FINAL TWENTY FIVE PERCENT (35 - 50%) OF THE PRICE BID FOR MOBILIZATION/DEMOBILIZATION MAY BE INCLUDED ON THE FINAL PAY ESTIMATE. NO ADDITIONAL PAYMENT WILL BE MADE FOR DEMOBILIZATION

1.3 CONTRACT ITEM 2 – 20-INCH PUMP DISCHARGE CONTROL VALVE

Description: Under Contract Item 2 furnish all labor, materials, equipment, and services, and do all Work for the installation of a new 20-inch Pump Discharge Control Valve for each of the four (4) existing pumps (S104-LFT1-RSP01, S104-LFT1-RSP02, S104-LFT1-RSP03, S104-LFT1-RSP04). The work includes modification of existing pump discharge line for installation of new 20-inch valve

with motor actuator, and all general, structural, mechanical, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

A. Payment: Payment for 20-inch Pump Discharge Control Valve Work will be made by EACH for Contract Item 2.

1.4 CONTRACT ITEM 3 – BACK PULLOUT/ROTATING ASSEMBLY WITHOUT IMPELLER FOR EXISTING 16X16X20 NSY MODEL 100/150 CENTRIFIGAL PUMP

Description: Under Contract Item 3 furnish all labor, materials, equipment, and services, and do all Work for the replacement of the existing back pullout/rotating assembly for all four (4) existing pumps (S104-LFT1-RSP01, S104-LFT1-RSP02, S104-LFT1-RSP03, S104-LFT1-RSP04). The Work includes removal of existing pump rotating assembly, installation of new NSY 100/150 centrifugal pump back pullout/rotating assembly, installation of pump vibration monitors integrated with new rotating assembly, reconnection of existing seal water and vibration switches, and all general, structural, mechanical, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

A. Payment: Payment for replacement of Back Pullout/Rotating Assembly Without Impeller Work will be made by EACH for Contract Item 3.

1.5 CONTRACT ITEM 4 – 20-INCH OR 19.38-INCH IMPELLER ASSEMBLY FOR THE 16X16X20 NSY MODEL 100/150 CENTRIFIGAL PUMP

Description: Under Contract Item 4 furnish all labor, materials, equipment, and services, and do all Work for the replacement of the existing 19.38-inch impeller assembly for all four (4) existing pumps (S104-LFT1-RSP01, S104-LFT1-RSP02, S104-LFT1-RSP03, S104-LFT1-RSP04). The Work includes removal of existing 19.38-inch pump impeller assemblies, installation of new 20-inch or 19.38-inch pump impeller assembly based on a 90-day Pilot Test. A 90-day pilot test shall be performed by the Contractor and Pump Manufacture with the 20-inch Impeller for Pump No. 2 (S104-LFT1-RSP02) prior to completing installation of the following three pumps impellers (S104-LFT1-RSP01, S104-LFT1-RSP03, S104-LFT1-RSP04), and all general, structural, mechanical, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items. A 90-Day Pilot Test shall consist of the Contractor and Pump Manufacture operating Pump No. 2 as the Lead Pump for 90 days while monitoring both vibration and Transient Pressure Spikes for startup sequence, shutdown sequences, and both average and nighttime flow operations with a 20-inch Impeller. Pumping to both the SSWWTP and FEBs shall be tested during the 90-Day Pilot. Vibrations shall be less than the alarm set point of 0.21 in/sec RMS and not exceed a transient

pressure spike of 8 psi above normal operating pressures. A final pumping demonstration test shall be conducted with both the OWNER and ENGINEER present for achieving final acceptance.

A. Payment: Payment for replacement of 20-inch or 19.38-inch Impeller Assembly Work will be made by EACH for Contract Item 4.

1.6 CONTRACT ITEM 5 – PRESSURE TRANSMITTERS

Description: Under Contract Item 5 furnish all labor, materials, equipment, and services, and do all Work for the installation of pressure transmitters for all four (4) existing pumps (S104-LFT1-RSP01, S104-LFT1-RSP02, S104-LFT1-RSP03, S104-LFT1-RSP04) on both the existing suction and discharge volutes. The Work includes removal of existing pressure gauges, installation of new pressure transmitters, and all general, structural, mechanical, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

A. Payment: Payment for installation of Pressure Transmitters Work will be made by EACH for Contract Item 5.

1.7 CONTRACT ITEM 6 – SELF CONTAINED SEAL WATER SUPPORT SYSTEM

Description: Under Contract Item 6 furnish all labor, materials, equipment, and services, and do all Work for the installation of a self contained seal water support system for all four (4) existing pumps (S104-LFT1-RSP01, S104-LFT1-RSP02, S104-LFT1-RSP03, S104-LFT1-RSP04). The Work includes installation of new seal water support system, and all general, structural, mechanical, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

A. Payment: Payment for installation of Pressure Transmitters Work will be made by EACH for Contract Item 6.

B.

1.8 CONTRACT ITEM 7 – TRANSIENT PRESSURE MONITORING SYSTEM

Description: Under Contract Item 7 furnish all labor, materials, equipment, and services, and do all Work for the installation of one (1) Transient Pressure Monitor System (TPMS) for Pump No. 2 (S104-LFT1-RSP02). The Work includes, installation of new transient pressure monitors, and all general, structural, mechanical, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

A. Payment: Payment for installation of Transient Pressure Monitoring System Work will be made by EACH for Contract Item 7.

1.9 CONTRACT ITEM 8 – REMOVAL OF DISC ACCELERATOR ON EXISTING CHECK VALVE

Description: Under Contract Item 8 furnish all labor, materials, equipment, and services, and do all Work for removal of four (4) Disc Accelerator on existing Check Valves located on each of the discharge lines for each existing pump. The Work includes removal of the Disc Accelerator on the existing Check Valves as shown and specified, replacement of existing check valve indicator, and all general, structural, mechanical, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

A. Payment: Payment for Removal of Disc Accelerators on Existing Check Valve Work will be made by EACH for Contract Item 8.

1.10 CONTRACT ITEM 9 – EQUIPMENT INTEGRATION AND COMMISSIONING

A. Description: Under Contract Item 9 furnish all labor, materials, equipment, and services, and do all Work for Integration and Commissioning of new equipment. The Work includes furnishing all labor, materials, equipment, and services, and do all general, instrumentation, and electrical Work complete and in place, together with all appurtenant Work for the integration and commissioning of Contract Items 2, 3, 5, and 6 as shown and specified, except for Work specifically included under the other Contract Items.

B. Payment: Payment for New Equipment Integration and Commissioning Work will be made by EACH for Contract Item 9.

1.11 CONTRACT ITEM 10 – PUMP CONTROL INTEGRATION AND COMMISIONING

A. Description: Under Contract Item 10 furnish all labor, materials, equipment, and services, and do all Work for the integration, testing and placing in trouble-free operation of pump controls for all four (4) existing pumps (S104-LFT1-RSP01, S104-LFT1-RSP02, S104-LFT1-RSP03, S104-LFT1-RSP04). The Work includes integration of pump controls for nighttime, average and peak flow conditions, and all general, instrumentation, and electrical Work complete and in place, together with all appurtenant Work as shown and specified, except for Work specifically included under the other Contract Items.

B. Payment: Payment for Pump Control Integration and Commissioning Work will be made by EACH for Contract Item 10.

1.12 CONTRACT ITEM 11 – 24-INCH SUCTION BELL AND PIPING

A. Description: Under Contract Item 11 furnish all labor, materials, equipment, and services, and do all Work for replacement of existing 24-inch suction bell and piping for all four (4) existing pumps (S104-LFT1-RSP01, S104-LFT1-RSP02, S104-LFT1-RSP03, S104-LFT1-RSP04). The Work includes replacement of the existing 24-inch suction bell and piping, fittings, couplings, and all general, structural, and mechanical Work complete and in place, together with all appurtenant Work as shown and specified.

B. Payment: Payment for 24-Inch Suction Bell and Piping will be made by EACH for Contract Item 11.

1.13 CONTRACT ITEM 12 –REMOVAL OF GRIT AND SOLIDS WITHIN C.C.L.S WET WELL AND VISUAL INSPECTION OF CONCRETE SURFACES

A. Description: Under Contract Item 12 furnish all labor, materials, equipment, and services, and do all Work for removal of grit and solids within each half of the C.C.L.S. Wet Well followed by a visual inspection of all concrete surfaces within the wet well. The Work includes removal of all grit and solids within the wet well, disposal of all removed grit and solids, power washing all concrete surfaces with 2.5 GPM at a minimum pressure of 2000 psi, taking photos and measuring all concrete surfaces which appear to be deteriorated, delaminated, or cracking on the surface of the concrete. All inspection efforts shall be documented in a Field Inspection Report and submitted to the OWNER, within 14 days of completing the work.

B. Payment: Payment for Removal of Grit and Solids Within C.C.L.S Wet Well and Visual Inspection of Concrete Surfaces Work will be made by EACH for Contract Item 12.

1.14 CONTRACT ITEM 13 – CHERRY CREEK WET WELL CROSS OVER GATE

A. Description: Under Contract Item 13 furnish all labor, materials, equipment, and services, and do all Work for replacement of the existing cross over gate for the Cherry Creek Wet Well. The Work includes replacement of the cross over gate, stem extension, handwheel, and all general, structural, and mechanical Work complete and in place, together with all appurtenant Work as shown and specified.

B. Payment: Payment for Cherry Creek Wet Well Cross Over Gate will be made by EACH for Contract Item 13.

1.15 CONTRACT ITEM 14 – CONDITION ASSESSMENT TESTING TOP SLAB OF CHERRY CREEK LIFT STATION WET WELL

A. Description: Under Contract Item 14 furnish all labor, materials, equipment, and services, and do all Work for conducting all condition assessment testing as

specified on Contract Drawing S07. The Work includes obtaining three (3) 6-inch diameter core samples of the Tank Room Floor Slab for Petrographic Analysis to evaluate depth and extent of delamination, cracking and microcracking, depth of carbonation, chemical analysis to determine chloride and sulfate content, and all general, structural, and mechanical Work complete and in place, together with all appurtenant Work as shown and specified.

B. Payment: Payment for Condition Assessment Testing Top Slab of Cherry Creek Lift Station Wet Well will be made by EACH for Contract Item 14.

1.16 CONTRACT ITEM 15 – SLAB REPAIR (PARTIAL DEPTH)

A. Description: Under the Contract Item for Slab Repair (Partial Depth), furnish all labor, materials, equipment and services necessary to repair structural slabs as shown for Structural Slab Repair Detail 1 on Contract Drawing S08 and specified. The Work includes saw cutting and removal of deteriorated concrete, preparation of surfaces, placement of sealant, and all other work necessary for a complete repair. Provide Work that meets the requirements of Division 3 and Repair Detail 1 on Contract Drawing S08.

B. Measurement for Payment: The quantity of Concrete Surface Repair that, in square feet, to be measured for payment under Contract Item 15 will be the total area of infilling computed as follows: disposal of materials, preparation and cleaning, shoring, bracing, forming, furnishing and placing of dowels and concrete materials where required, curing and finishing, and for all labor, tools, equipment and incidentals necessary to complete the Work. Unauthorized additional repairs will not be measured or paid for.

C. Payment: Payment for Slab Repair (Partial Depth) will be made at the Contract unit price per square foot for Contract Item 15.

1.17 CONTRACT ITEM 16 – VERTICAL SURFACE/WALL REPAIR (PARTIAL DEPTH)

A. Description: Under the Contract Item for Vertical Surface/Wall Repair (Partial Depth), furnish all labor, materials, equipment and services necessary to repair vertical surface/walls as shown for Repair Detail 2 on Contract Drawing S08 and specified. The Work includes saw cutting and removal of deteriorated concrete, preparation of surfaces, placement of sealant, and all other work necessary for a complete repair. Provide Work that meets the requirements of Division 3 and Repair Detail 2 on Contract Drawing S08.

B. Measurement for Payment: The quantity of Concrete Surface Repair that, in square feet, to be measured for payment under Contract Item 16 will be the total area of infilling computed as follows: disposal of materials, preparation and cleaning, shoring, bracing, forming, furnishing and placing of dowels and concrete materials where required, curing and finishing, and for all labor, tools, equipment and

incidentals necessary to complete the Work. Unauthorized additional repairs will not be measured or paid for.

C. Payment: Payment for Vertical Surface/Wall Repair (Partial Depth) will be made at the Contract unit price per square foot for Contract Item 16.

1.18 CONTRACT ITEM 17 – OWNER ALLOWANCE

A. Description: Under the Contract Item for OWNER Allowance provide all labor, material, equipment, and services to provide miscellaneous mechanical, electrical, plumbing, or other work that is not identified in the Construction Documents/Plans and which is authorized by the OWNER.

B. Payment: Payment of costs for labor, materials, equipment, services, and overhead and profit will be made in accordance with General Condition GC-26 Extra Work. Unauthorized additional OWNER work will not be measured or paid for.

1.19 ADDITIVE ALTERNATE CONTRACT ITEM 1 – MODIFIED VALVE VAULT NO. 6 AND NEW VALVE VAULT NO. 8

A. Description: The Work under Additive Alternate Contract Item 1 includes furnishing all labor, materials, equipment and services necessary for the completion of the Work. This includes: survey and control, exploratory excavation such as potholing to locate buried pipelines, structure excavation, subgrade preparation, structure bedding, concrete, reinforcing steel, piping, valves, equipment, backfilling and compaction, electrical work, surface restoration and all other work required to complete the modification of Valve Vault No. 6 and new Valve Vault No. 8 as shown and specified in the Contract Documents.

B. Measurement for Payment: Payment for this Contract Item will be based on a Schedule of Values submitted by the Contractor and approved by the Engineer.

C. Payment: Payment for these Contract Items will be made at the per each Contract price. Monthly progress payments will be made based upon Contractor's percent complete for this Contract Item as approved by the Engineer.

1.20 ADDITIVE ALTERNATE CONTRACT ITEM 2 – NEW 12-INCH FORCE MAIN DRAIN VALVE MANHOLE

A. Description: The Work under Additive Alternate Contract Item 2 includes furnishing all labor, materials, equipment and services necessary for the completion of the Work. This includes: survey and control, exploratory excavation such as potholing to locate buried pipelines, structure excavation including shoring system, hot tapping the existing line for preventing draining of the 36-inch Cherry Creek Force Main, subgrade preparation, structure bedding, concrete, reinforcing steel, piping, valves, equipment, backfilling and compaction, electrical work,

surface restoration and all other work required to complete the new 12-inch as shown and specified in the Contract Documents.

B. Measurement for Payment: Payment for this Contract Item will be based on a Schedule of Values submitted by the Contractor and approved by the Engineer.

C. Payment: Payment for these Contract Items will be made at the per each Contract price. Monthly progress payments will be made based upon Contractor's percent complete for this Contract Item as approved by the Engineer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 31 00

COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination

B. Preconstruction Conference

C. Progress Meetings

1.2 COORDINATION

A. General: Coordinate scheduling, submittals, and Contract work to assure efficient and orderly sequence of installation of interdependent construction elements.

B. Accessory Placement: Place conduits, saddles, boxes, cabinets, sleeves, inserts, foundation bolts, anchors and other like work in floors, roofs or walls of buildings and structures in conformity with the construction program.

1.3 PRECONSTRUCTION CONFERENCE

A. General: Prior to commencement of the Work, in accordance with the General Conditions, the OWNER will conduct a preconstruction conference to be held at a predetermined time and place.

B. Delineation of Responsibilities: The purpose of the conference is to designate responsible personnel, to establish a working relationship among the parties and to identify the responsibilities of the OWNER, ENGINEER and the CONTRACTOR. Matters requiring coordination will be discussed and procedures for handling such matters, established. The agenda will include:

1. Submittal procedures

2. Partial Payment procedures

3. Maintenance of Records

4. Schedules, sequences and maintenance of facility operations

5. Safety and First Aid responsibilities

6. Change Orders

7. Use of site

8. Housekeeping

9. Equipment delivery

C. Attendees: The preconstruction conference is to be attended by the representatives of the CONTRACTOR, the OWNER and the ENGINEER who will be associated with the project. Representatives of regulatory agencies, subcontractors, and principal suppliers may also attend when appropriate.

D. Chair and Minutes: The preconstruction conference will be chaired by the OWNER who will also arrange for the keeping and distribution of minutes to all attendees.

1.4 PROGRESS MEETINGS

A. Meeting Frequency and Format: Schedule progress meetings on at least a monthly basis or more frequently as warranted by the complexity of the Project, to review the Work, discuss changes in schedules, maintain coordination and resolve potential problems. Invite OWNER, ENGINEER and all subcontractors. Suppliers may be invited as appropriate. Meeting notes will be prepared by ENGINEER who will distribute the notes to attendees within 10 calendar days after each meeting. Meeting notes will summarize meeting highlights.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 32 16

PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Form of Schedules

B. Content of Schedules: Submit for approval, a preliminary progress schedule in duplicate, in accordance with the General Conditions.

C. Schedule Revisions

D. Submittal Requirements

1.2 FORM OF SCHEDULES

A. Prepare schedules in form of a horizontal bar chart.

1. Provide separate horizontal bar for each trade or operation.

2. Utilize a horizontal time scale and identify first work day of each week.

3. Utilize scale and spacings to allow space for notations and future revisions.

B. Utilize a listing format which chronologically indicates the order of start of each item of work.

C. Identify each listing by major specification section numbers.

1.3 CONTENT OF SCHEDULES

A. Completion Dates: Show the beginning and ending contract dates stated in documents. Schedules showing completion prior to the contract completion date will be accepted but in no event will they be considered basis for a claim for delay against the OWNER by the CONTRACTOR for the period between the early completion date and the completion date provided in the Contract Documents.

B. Show complete sequence of construction by activity. Coordinate CONTRACTORS project schedule with the final accepted schedule of values.

C. Show dates for beginning and completion of each major element of construction and installation dates for major items of equipment. Elements shall include, but not be limited to, the following:

1. Shop drawing receipt from supplier/manufacturer submitted to ENGINEER, review and return to supplier/manufacturer

2. Material and equipment order, manufacturer, delivery, installation, and checkouts

3. Performance tests and supervisory services activity

4. Demolition

5. Excavation, sheeting, shoring, dewatering

6. Construction of various facilities

7. Piping and equipment installation

8. Warranty Log

9. Electrical work activity

10. Heating, ventilating, and air conditioning work activity

11. Plumbing work activity

12. Miscellaneous concrete placement

13. Subcontractor's items of work

14. Backfilling, grading, seeding, sodding, landscaping, fence construction, and paving

15. Final cleanup

16. Allowance for inclement weather

17. Coordination with concurrent Work on site

D. Show projected percentage of completion for each item as of first day of each month.

1.4 SCHEDULE REVISIONS

A. As a minimum, revise construction schedule every 30 calendar days to reflect changes in progress of Work for duration of Contract.

B. Indicate progress of each activity at date of submittal.

C. Show changes occurring since previous submittal of schedule.

1. Major change in scope
2. Activities modified since previous submittal
3. Revised projections of progress and completion
4. Other identifiable changes

D. Provide a written report as needed to define:

1. Problem areas, anticipated delays, and impact on schedule
2. Corrective action recommended and its effect
3. Effect of changes on schedules of other Contractors

1.5 SUBMITTAL REQUIREMENTS

A. Schedule: Submit final progress schedule in accordance with "General Conditions".

B. For preliminary and final submittal of construction progress schedule and subsequent revisions thereof, furnish three copies to ENGINEER.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 33 00

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description

B. Definitions

C. Submittal Procedures

D. ENGINEER'S Actions on Submittals

E. Repetitive Reviews

F. Example Format for CONTRACTOR's Approval and Certification Stamp

G. CONTRACTOR's Submittal Transmittal Form

1.2 DESCRIPTION

A. This Section specifies procedural requirements for submittals made by the CONTRACTOR to the ENGINEER. Specific submittals required for individual elements of the Work are specified in the associated, individual Specification Sections. Except as otherwise indicated in other Specification Sections, comply with the requirements specified herein for each type of submittal.

1.3 DEFINITIONS

A. Shop Drawings: The term "Shop Drawings", as used in the General Conditions includes all "Action Submittals" and "Information Submittals" as defined below.

B. Action Submittals: The following submittals require approval by the ENGINEER as described in Subsection 3.2 of this Section:

1. Manufacturer's Documents: Technical data, detailed drawings and other similar information specially prepared for this Project by product manufacturers and suppliers, including fabrication and installation drawings, diagrams, actual performance curves, data sheets, schedules, templates, patterns, reports, instructions, design mix formulas, measurements, and similar information not in standard printed form.

2. Product Data: Stock or standard printed information on materials and equipment that has not been specially prepared for this Project, including specifications, installation instructions, catalog cuts, wiring diagrams, and color charts.

3. Working Drawings: Technical data, drawings and other similar information specially prepared for this Project by the CONTRACTOR or Subcontractors, including fabrication and installation drawings, diagrams, and other similar information.

4. Samples: Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

5. Mock-Ups: Special types of samples that are too large or otherwise inconvenient for handling in the manner specified for transmittal of sample submittals.

6. "Or Equal" or Substitution Requests: Wherever a proprietary item is identified by the product, manufacturer or supplier name and/or model number, an "Or Equal" ("equal to" or "equivalent") item may be submitted unless the description of the item contains a prohibition against an "Or Equal".

   a. An item may be determined "Or Equal" only at the sole discretion of the ENGINEER, based upon the following criteria:

      (1) The item is equal in quality, durability, appearance, strength, and design characteristics.

      (2) The item will perform to meet the design concept.

      (3) No changes to other work will be required to accommodate the item.

      (4) No addition to the Contract Price or Contract Times will be required as a result of the use of the item.

      (5) OWNER will not incur any additional cost as a result of the use of the item.

   a. If the ENGINEER, at its sole discretion, determines that a proposed item is not an "Or Equal", the proposed item may be considered as a "Substitute" item.

C. Information Submittals: The following submittals require acknowledgement by the ENGINEER as described in Subsection 3.2 of this Section:

1. CONTRACTOR's Licensed Professional Submittals: Certificates and other documents required by the Contract Documents to be prepared and submitted by the CONTRACTOR's Licensed Professionals.

2. Inspection and Test Reports

3. Mill reports

4. Guarantees

5. Warranties - Prior to the warranty start date of each piece of equipment, provide the OWNER with a Warranty Log (see sample form) including actual dates of the manufacturer's start up services, Operations and Maintenance manual approval, request for approval and approval receipt. On a monthly basis, furnish to the OWNER an updated Warranty Log. Distribute copies at Progress Meetings.

6. Certifications, including letter from manufacture certifying the installer as qualified to install the manufacturer's products.

7. Experience records

8. Maintenance agreements

9. Operation and maintenance manuals

10. Survey data and reports: property surveys, building or structure condition surveys, field measurements, quantitative records of actual Work, damage surveys, photographs, and similar data required by Specification sections.

11. Physical work records

12. Quality testing and certifying reports

13. Industry standards

14. Record drawings

D. Other Submittals: For submittals concerning the following refer to the indicated Contract Document Section:

1. Listing of manufacturers – Section 01 60 00

2. Suppliers, and subcontractors -Article 6.06 of the General and Supplementary Conditions

3. Construction progress schedule – Section 01 32 16 or 01 32 17

4. Warranty Log – Section 01 33 00

5. Schedule of shop drawing submissions - Article 2.05 of the General and Supplementary Conditions.

6. Bonds – Article 12 of the General and Supplementary Conditions

7. Schedule of values – Section 01 29 00

8. Payment applications– Section 01 29 00

9. Insurance certificates - Article 12 of the General and Supplementary Conditions

E. Clarifications and Interpretations: Refer to the General Conditions

1. The CONTRACTOR is responsible to review the Contract Documents, determine the type and extent of the Work and make all necessary field measurements before starting the Work. If any conflict, error, ambiguity, or discrepancy is discovered the CONTRACTOR is to submit a written request for interpretation or clarification from ENGINEER. The ENGINEER will issue a written clarification or interpretation of the requirements of the Contract Documents as ENGINEER may determine necessary, consistent with the intent of and reasonably inferable from the Contract Documents. Such written clarifications and interpretations will be binding on the CONTRACTOR.

2. If the CONTRACTOR submits a written request for information that does not, in the sole discretion of the ENGINEER, require clarification or interpretation of the Contract Documents, ENGINEER will notify CONTRACTOR that such information is contained (or could otherwise be reasonably determined) in the Contract Documents. The CONTRACTOR shall reimburse OWNER for ENGINEER's charges for evaluating and responding to such a request for information.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 SUBMITTAL PROCEDURES

A. Scheduling:

1. Submit, for approval by the ENGINEER, a preliminary schedule of submittals, in duplicate, within 15 calendar days after the starting date of the contract. ENGINEER will review no submittals until an acceptable schedule of submittals has been submitted. If the CONTRACTOR intends to request a substitute(s) for the materials or equipment specified, schedule substitution request(s), along with any related, subsequent submittals, in the schedule of submittals and submit as scheduled.

2. Schedule, prepare and transmit each submittal to ENGINEER sufficiently in advance of scheduled performance of related Work and other applicable activities.

B. Coordination:

1. Coordinate the preparation and processing of submittals with the performance of the Work. Coordinate each submittal with other submittals and related activities, such as substitution requests, testing, purchasing, fabrication, delivery, and similar activities that require sequential performance. Coordinate submissions for different items of interrelated work so that one submittal will not be delayed by ENGINEER's need to review a related submittal.

2. ENGINEER may return any submittal requiring coordination with other submittals without review and marked "Revise and Resubmit". This type of returned submittal will be counted as a submittal subject to the provisions of 3.3 –REPETITIVE REVIEWS of this Section.

3. The ENGINEER will not hold a submittal awaiting additional information from the CONTRACTOR.

C. Submittal Preparation:

1. All Submittals: Review each submittal to determine, as applicable, that:

a. The submittal is required by the Contract Documents. The ENGINEER will only review submittals required by the Contract Documents.

b. The materials and equipment depicted in the submittal are intended for incorporation into the Work.

c. The submittal is complete and in sufficient detail to allow ready determination of compliance with the Contract Documents.

d. The items depicted in the submittal will fit in the space available.

e. The information in the submittal has been coordinated with the requirements of the Contract Documents; work to be performed by all trades involved; field measurements and other requirements of the Work.

f. The submittal does not contain standard printed information unless full identification of the project-specific portions and any project-specific supplementary information is shown thereon in ink or typewritten form.

g. The submittal does not encompass more than one Section of the Specifications.

h. The submittal presents, where applicable, such data as dimensions, weights, and performance characteristics on drawings for mechanical and electrical equipment. Show conformance with the performance characteristics and other criteria included in the Contract Documents.

i. Variations from the Contract Documents have been specifically noted on the Submittal Transmittal Form and highlighted on all relative documents within the submittal that are affected by the variation.

(1) At the time of each submittal, CONTRACTOR shall give ENGINEER specific written notice of such variations, if any, that the Shop Drawing or Sample submitted may have from the requirements of the Contract Documents, such notice to be in a written communication separate from the submittal; and, in addition, shall cause a specific notation to be made on each Shop Drawing and Sample submitted to ENGINEER for review and approval of each such variation.

(2) ENGINEER's review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to each such variation at the time of each submittal as required by paragraph (1) above and ENGINEER has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample approval; nor will any approval by ENGINEER relieve CONTRACTOR from

responsibility for complying with the requirements of the Contract.

j. The submittal is in compliance with the Contract Documents and a completed approval and certification stamp has been placed on each submittal document. Use a rubber stamp containing the information shown in the sample stamp at the end of this section. ENGINEER will rely upon CONTRACTOR's certification of compliance that the CONTRACTOR has reviewed and approved the submittal and has confirmed that the submittal conforms to all the requirements of the Contract Documents except for variations specifically noted on the Submittal Transmittal Form and all attached documents. Submittals will be returned to CONTRACTOR without action if certification is not provided and the submittal will be counted as a submittal subject to the provisions of 3.3 –REPETITIVE REVIEWS of this Section.

2. Manufacturer's Documents and Working Drawing submittals:

a. Accurately and distinctly present the following:

(1) Graphical information at accurate scale

(2) Name, address and telephone number of manufacturer or supplier

(3) Materials and equipment that are to be included in the Work

(4) Compliance with standards

(5) All dimensions, clearly identifying those dimensions based on field measurement

(6) Arrangements and sectional views

(7) Necessary details, including complete information on making connections between Work in this project, work in other related projects and existing facilities

(8) Electrical wiring connections between all equipment provided including all internal wiring between internal components of equipment

(9) Kinds of materials and finishes

(10) Parts list and descriptions thereof

(11) Spare parts, lubricants or special tools required by the Contract Documents

b. Include the following on each drawing or page:

(1) Preparation date and revision dates

(2) Project name

(3) Specification Section number and page number

(4) Identification of equipment or materials

(5) Name of CONTRACTOR (and Subcontractor if applicable)

(6) Name of Supplier and/or Manufacturer

(7) Field dimensions, clearly identified

(8) Standards or industry specification references

(9) Identification of variations from the Contract Document requirements

(10) Physical location and location relative to other facilities that the Work-related equipment or materials are to be installed adjacent to or connected with

(11) Provide 8-inch wide by 3-inch high blank space for CONTRACTOR's and ENGINEER's stamps

c. Transmit all submittals electronically in pdf format, unless specifically requested for prints. Submittals will be returned with review comments electronically.

3. Product Data:

a. Assemble all data into a single submittal for each element of work or system. Where product data has been printed to include information on several similar products, some of which are not required for use on the subject Project, clearly mark copies to show such information is not applicable.

b. Where data must be specially prepared for required materials or equipment because standard printed data are not suitable for use, submit the data as a Manufacturer's Document and not as Product Data.

c. Submit product data with appropriate Manufacturer's Document or Working Drawing, when applicable.

d. Submit an electronic copy.

4. Samples:

a. Whenever possible, provide samples physically identical with the materials proposed for incorporation into the Work. Where variations in color, pattern or texture and the like are inherent in materials represented by samples, submit multiple samples (not less than 3) showing the approximate range of variations.

b. Submit samples for visual review of generic kind, color, pattern, texture, and for a final check of coordination of these characteristics with other related elements of the Work and existing facilities.

c. Include information with each sample to provide a generic description of the item, and its name, manufacturer, limitations, and compliance with standards.

d. Submit 3 sets of samples, where specifications indicate selection of color, pattern, texture or similar characteristics from manufacturer's range of standard choices is necessary.

5. Mock-Ups:

a. Mock-ups and similar samples are recognized as special types of samples. Comply with samples submittal requirements to the greatest extent possible. Process Submittal Transmittal Forms to provide a record of activity.

6. Requests for "Or Equal" or Substitution

a. ENGINEER will, at its sole discretion, determine if the item is "Or Equal" or an acceptable Substitution. Prepare submittals as described above. CONTRACTOR shall reimburse OWNER for ENGINEER's Charges for evaluating a proposed "Or Equal" submittal that receives a negative determination. CONTRACTOR shall reimburse OWNER for ENGINEER's charges for evaluating a proposed Substitution, whether or not a positive determination is made or the CONTRACTOR withdraws the request for Substitution, and for changes resulting from an approved Substitution.

b. For Substitution Requests submit sufficient written information including the following:

(1) Certify that the proposed Substitution is functionally equivalent to the specified item and its performance characteristics, when it is incorporated into the Work, will be equivalent to the specified item.

(2) State the extent, if any, to which the use of the proposed Substitution will affect the performance of the construction work and/or the characteristics of the completed work.

(3) Describe all differences between the proposed Substitution and the specified item.

(4) Describe the sources of supplies, replacement parts, repair services and technical support.

(5) Provide an itemized estimate of all costs or credits directly or indirectly attributable to the use of such Substitution, including redesign engineering, construction and energy costs.

(6) Furnish additional information as requested by the ENGINEER.

(7) CONTRACTOR may be required to furnish a guarantee or other surety for any Substitution at no addition to the Contract Time or Price.

c. Substitute means, methods, techniques, sequences, or procedures of construction may be used in place of those required by the Contract Documents if approved by ENGINEER, at ENGINEER's sole discretion. Follow the procedure described in b. above, submitting appropriate information.

d. Provide sufficient time for ENGINEER to evaluate each "Or Equal" and Substitution Request. Do not order, install or utilize any "Or-Equal" or Substitution until ENGINEER's determination is complete. ENGINEER's approval will be in the form of an approved submittal for an "Or Equal" item or in the form of a Change Order for a Substitution. CONTRACTOR will be advised in writing of any negative determination.

e. Provide all information and documents in support of any proposed "Or-Equal" or Substitution at no addition to the Contract Times or Price.

7. CONTRACTOR's Licensed Professional Submittals

a. Submit electronic copies of certificates and other documents required by the Contract Documents to be prepared and submitted by the CONTRACTOR's Licensed Professionals.

8. Inspection and Test Reports:

   a. Identify each inspection and test report as either specially prepared for the Project or a standard publication of workmanship control testing at point of production. Submit electronic copy in accordance with the requirements for Manufacturer's Documents or Product Data, respectively as described in this Section.

9. Mill Test Reports, Experience Records, Physical Work Records, Guarantees, Warranties, and Maintenance Agreements:

   a. Refer to the Contract Documents sections for specific requirements.

10. Survey Data:

    a. Refer to the various Contract Documents for specific requirements. Furnish electronic copies. Provide electronic copies of final property survey (if any).

11. Certifications, Quality Testing and Certifying Reports:

    a. Refer to Specification sections for specific requirements on submittal of certifications. Submit electronic copies. Certifications are submitted for review of conformance with specified requirements and information. Submittal is final when reviewed and returned by ENGINEER with no further action required.

12. Closeout Submittals:

    a. Refer to Specification sections and Section 01 78 00 for specific requirements on submittal of closeout information, materials, tools, and similar items such as:

       (1) Warranties and Bonds

       (2) Record Drawings

       (3) Special Tools

13. Operation and Maintenance Manuals:

    a. Submit Operation and Maintenance Manuals in accordance with Section 01 78 23

D. Submittal Transmittal Form: Use the Submittal Transmittal Form found at the end of this Section to forward each specific submittal package to the ENGINEER. Provide all the information indicated on the Form and answer each question. Submittals with incomplete information on the Submittal Transmittal Form will be returned to the CONTRACTOR marked "Revise and Resubmit" and will be counted as a submittal subject to the provisions of 3.3 –REPETITIVE REVIEWS of this Section.

E. Submittal Numbering:

1. Number all submittals as follows:

(A) - (B)

Where:
(A) = Specification Section Number
(B) = Consecutive submittal number for the Specification Section Number listed in (A), with an alphabetic suffix indicating the sequential version of the submittal.

Examples: 01 13 00-001A indicates the initial version of submittal number 001 for Specification Section 01 13 00.
01 13 00-001B indicates the second version of submittal number 001 for Specification Section 01 13 00.
01 13 00-002A indicates the initial version of submittal number 002 for Specification Section 01 13 00.

2. When a document(s) is resubmitted for any reason, use a new Submittal Transmittal Form with the same submittal number and a new, sequential alphabetic suffix.

F. Resubmittal Preparation:

1. Comply with the requirements described in the Submittal Preparation subsection above. In addition:

a. Identify on the Submittal Transmittal Form that submittal is a resubmission.

b. Make and clearly identify any corrections or changes required by ENGINEER's notations on the previous, returned submittal.

c. Respond to ENGINEER's notations:

(1) On the Submittal Transmittal Form or on a separate page(s) attached to the Submittal Transmittal Form, answer or acknowledge, in writing, all notations or questions indicated by ENGINEER on the ENGINEER's response to the previous submittal.

(2) Identify each response by the corresponding question or notation number established by ENGINEER.

(3) If CONTRACTOR does not respond to each notation or question, the ENGINEER will return the resubmission without action. Additional resubmittals will be required until the CONTRACTOR provides a written response to all of the ENGINEER's notations or questions.

d. Indicate CONTRACTOR initiated revisions or variations:

(1) On the Submittal Transmittal Form identify variations or revisions from the previously reviewed submittal, other than those called for by ENGINEER.

(2) ENGINEER's responsibility for variations or revisions is established in paragraphs 6.17.D.3 and 6.17.E.3 of the General Conditions.

G. Distribution

1. Manufacturer's Documents, Working Drawings, Product Data and Samples and Mock-ups:

   a. After a submittal is stamped "Approved" (See Subsection 3.2), place the date of approval on two additional copies of the submittal and transmit to the OWNER and FIELD ENGINEER, together with one copy of a Submittal Transmittal Form indicating the submittal is a "Distribution of Approved Submittal". For Mockups, distribute a Submittal Transmittal Form only.

      After a submittal is stamped "Approved as Noted" (See Subsection 3.2), make the changes noted by ENGINEER and place the date of approval on two additional copies of the submittal and transmit to the OWNER and FIELD ENGINEER together with one copy of a Submittal Transmittal Form indicating the submittal is a "Distribution of Approved as Noted Submittal".

   b. If changes other than those marked by the ENGINEER are made, follow the requirements of Paragraph 3.1, F to obtain ENGINEER approval.

   c. Unless required elsewhere, provide distribution of "Approved" and "Approved as Noted" submittals to subcontractors, suppliers, governing authorities, and others as necessary for proper performance of the Work.

   d. Maintain one set of "Approved" and revised "Approved as Noted" submittals at the Project site, available for use by the ENGINEER and others.

   e. Maintain returned final set of samples at the Project site, in suitable condition and available for quality control comparisons throughout the course of performing the Work. Incorporate only undamaged samples into the Work, when permitted by the Contract Documents.

H. CONTRACTOR's Licensed Professional Submittals

   a. After a submittal is acknowledged by the ENGINEER (See Subsection 3.2,2), place the date of acknowledgement on two additional copies of the submittal and transmit to the OWNER and FIELD ENGINEER together with one copy of a Submittal Transmittal Form indicating the submittal is a "Distribution of Acknowledged Submittal".

b. Maintain one set of submittals at the Project site, available for use by the ENGINEER and others.

3.2 ENGINEER'S ACTIONS ON SUBMITTALS

A. General:

1. Review and approval by the ENGINEER of Action Submittals will be subject to the provisions of General Conditions. ENGINEER's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the requirements of the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole. ENGINEER's review or approval of any submittal does not authorize a change to the Contract Time or Price.

2. ENGINEER's review and approval of Action Submittals will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) nor to safety precautions or programs incident thereto. The review and approval of a separate item will not indicate approval of the assembly in which the item is a part.

3. ENGINEER will stamp each Action Submittal except Requests for Interpretation or Clarification with an appropriate action stamp and transmit electronically to the CONTRACTOR.

B. ENGINEER's Action

1. Stamps:

a. Approved:

(1) Where submittals are stamped "Approved", Work covered by submittal may proceed PROVIDED THE WORK COMPLIES WITH THE CONTRACT DOCUMENTS. Acceptance of Work will depend upon that compliance.

b. Approved As Noted:

(1) When submittals are stamped "Approved as Noted", Work covered by submittal may proceed PROVIDED IT COMPLIES WITH ENGINEER'S NOTATIONS AND CORRECTIONS ON SUBMITTAL AND WITH THE CONTRACT DOCUMENTS. Acceptance of Work will depend on that compliance.

c. Revise and Resubmit:

(1) When submittals are stamped "Revise and Resubmit" do not proceed with Work covered by submittal. Do not permit Work covered by submittal to be used at Project site or elsewhere where Work is in progress.

(2) Revise submittal in accordance with ENGINEER's notations and corrections and resubmit in accordance with Subsection 3.1F of this Section.

2. Acknowledgements of Information Submittals

a. When Information Submittals conform to the format requirements in the Contract Documents ENGINEER will acknowledge such submittals electronically via a response transmittal.

b. If an Information Submittal does not conform to the format requirements of the Contract Documents, ENGINEER return the electronic submittal with comments or questions. Do not proceed with Work covered by the submittal and do not permit Work covered by the submittal to be used at Project site or elsewhere where Work is in progress. Resubmit the Information Submittal until the ENGINEER acknowledges that the submittal conforms to the format required.

3.3 REPETITIVE REVIEWS

A. Cost of Repetitive Reviews: Submittals will be reviewed no more than twice at the OWNER's expense. All subsequent reviews will be performed at times convenient to the ENGINEER and at the CONTRACTOR's expense based on the ENGINEER's then prevailing rates including all direct and indirect costs and fees. Reimburse the OWNER for all such costs and fees invoiced to the OWNER by the ENGINEER for third and subsequent submittals. ENGINEER will keep a submittal log and present it during monthly progress meetings. Log will note approvals, first rejection, second rejection and review time associated with reimbursable expenses.

B. Time Extension: Any need for more than one resubmission, or any other delay in ENGINEER's review of submittals, will not entitle CONTRACTOR to an extension of the Contract Time.

3.4 EXAMPLE FORMAT FOR CONTRACTOR'S APPROVAL AND CERTIFICATION STAMP

A. An example format for the CONTRACTOR's approval and certification stamp is as follows:

CONTRACTOR'S NAME

_____ Approved and Certified to comply with the Contract Documents.

_____ Approved and Certified to comply with the Contract Documents, except for variations specifically noted on the Submittal Transmittal Form and the associated documents.

PRINTED NAME: _____

TITLE: _____

SIGNATURE: _____

DATE: _____

3.5 CONTRACTOR'S SUBMITTAL TRANSMITTAL FORM

A. The format for the CONTRACTOR's Submittal Transmittal Form is as follows:

CONTRACTOR'S NAME

SUBMITTAL TRANSMITTAL FORM

Project Name

TO:_____ DATE:_____

SITE:_____

ATTN:_____ SPEC. REF. NO._____

DRAWING REF. NO._____

FROM:_____ SUBMITTAL NO. _____

1. The following documents are forwarded for your review:

No. of Repros/Copies	Document Originator	Description	Document No.	Date
/				
/				
/				
/				
/				
/				

2. Will item submitted for review fit in space provided in the Contract Documents? _____ Yes _____ No _____ Not Applicable

3. Has work indicated in this submittal been coordinated with all trades? _____ Yes _____ No _____ Not Applicable

4. Has the Contractor approved submittal and affixed completed approval and certification stamp? _____ Yes _____ No

5. Contractor's description and justification for variations from the Contract Documents. (Use additional pages, if necessary)

_____

_____

_____

_____

6. Remarks:_____

_____

_____

_____

Printed Name: _____

Signature:_____

END OF SECTION

City of Tulsa/TMUA/RMUA Equipment Warranty Information														
Project:														
Project No:														
Contractor:														
Contractor Ph:														
Engineer:	Greeley and Hansen													
Engineer Ph:	(312) 558-9000													
** Warranty start date is based on date of written acceptance from owner or if the following items have been completed (1) Start-up by Manufacture (2) Training (3) Approved O&M Manual														
Equipment/Matl/ Structure	Spec Section	Service	Type	Equipment Number	Supplier	Supplier Ph #	Approval Request	Approval Received	Anticipated Start Date	Start-up Date	Warranty Start **	Warranty Duration (Yrs)	Warranty End	O & M Approved
Location														

(NO TEXT FOR THIS PAGE)

SECTION 01 42 00

REFERENCES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Reference Abbreviations

B. Abbreviations

C. Reference Standards

D. Definitions

1.2 RELATED SECTIONS

A. Information provided in this section is used where applicable in individual Specification Sections, Divisions 1 through 49.

1.3 REFERENCE ABBREVIATIONS

A. Reference to a technical society, trade association or standards setting organization, may be made in the Specifications by abbreviations in accordance with the following list:

AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ACI	American Concrete Institute
ADC	Air Diffusion Council
AFBMA	Anti-friction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	Association of Home Appliance Manufacturers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
APA	American Plywood Association
ARI	American Refrigeration Institute
ASCE	American Society of Civil Engineers

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders' Hardware Manufacturers Association
BIA	Brick Institute of American
CABO	Council of American Building Officials
CAGI	Compressed Air and Gas Institute
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRD	U.S. Corps of Engineers Specifications
CRSI	Concrete Reinforcing Steel Institute
CTI	Cooling Tower Institute
DHI	Door and Hardware Institute
DOH	Department of Health
DOT	Department of Transportation
FCC	Federal Communications Commission
Fed. Spec.	Federal Specifications
FGMA	Flat Glass Marketing Association
FM	Factory Mutual
HMI	Hoist Manufacturing Institute
HPMA	See HPVA
HPVA	Hardwood Plywood Veneer Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IFI	Industrial Fasteners Institute
ISO	International Standards Organization
MIL	Military Specifications
MSS	Manufacturer's Standardization Society
NAAMM	National Association of Architectural Metal Manufacturers
NACM	National Association of Chain Manufacturers
NBS	National Bureau of Standards, See NIST
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NFPA	National Fluid Power Association
NIST	National Institute of Standards and Technology
NLMA	National Lumber Manufacturers Association
NSF	National Sanitation Foundation

OSHA	Occupational Safety and Health Act
PCI	Prestressed Concrete Institute
PDI	Plumbing and Drainage Institute
SAE	Society of Automotive Engineers
SCPRF	Structural Clay Products Research Foundation
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPI	Society of the Plastics Industry
SSPC	Steel Structures Painting Council
STI	Steel Tank Institute
TCA	Tile Council of American
TIMA	Thermal Insulation Manufacturers' Association
UL	Underwriters' Laboratories, Inc.
USBR	U. S. Bureau of Reclamation
USBS	U. S. Bureau of Standards, See NIST

1.4 ABBREVIATIONS

A. Abbreviations which may be used in individual Specification Sections Divisions 1 through 49 are as follows:

alternating current ..... ac
American wire gauge ..... AWG
ampere(s) ..... amp
ampere-hour(s) ..... AH
annual ..... ann
Ampere Interrupting Capacity ..... AIC
atmosphere(s) ..... atm
average ..... avg

biochemical oxygen demand ..... BOD
Board Foot ..... FBM
brake horsepower ..... bhp
Brinell Hardness ..... BH
British thermal unit(s) ..... Btu

calorie (s) ..... cal
carbonaceous biochemical oxygen demand ..... CBOD
Celsius (centigrade) C
Center to Center ..... C to C
centimeter(s) ..... cm
chemical oxygen demand ..... COD
coefficient, valve flow ..... C_v
condensate return ..... CR
cubic ..... cu
cubic centimeter(s) cc
cubic feet per day ..... cfd
cubic feet per hour ..... cfh
cubic feet per minute ..... cfm
cubic feet per minute, standard conditions ..... scfm
cubic feet per second ..... cfs
cubic foot (feet) ..... cu ft
cubic inch(es) ..... cu in
cubic yard(s) ..... cu yd

decibels ..... dB
decibels (A scale) ..... dBa
degree(s) ..... deg
dewpoint temperature ..... dpt
diameter ..... dia
direct current ..... dc
dissolved oxygen ..... DO
dissolved solids ..... DS
dry-bulb temperature ..... dbt

efficiency ..... eff
elevation ..... el
entering water temperature ..... ewt
entering air temperature ..... eat
equivalent direct radiation ..... edr

face area ..... fa
face to face ..... f to f
Fahrenheit ..... F
feet per day ..... fpd
feet per hour ..... fph
feet per minute ..... fpm
feet per second ..... fps
foot (feet) ..... ft
foot-candle ..... fc
foot-pound ..... ft-lb
foot-pounds per minute ..... ft-lb/min
foot-pounds per second ..... ft-lb/sec
formazin turbidity unit(s) ..... FTU
frequency ..... freq
fuel oil ..... FO
fuel oil supply ..... FOS
fuel oil return ..... FOR

gallon(s) ..... gal
gallons per day ..... gpd
gallons per day per cubic foot ..... gpd/cu ft
gallons per day per square foot ..... gpd/sq ft
gallons per hour ..... gph
gallons per minute ..... gpm
gallons per second ..... gps
gas chromatography and mass spectrometry ..... GC-MS
gauge ..... ga
grain(s) ..... gr
gram(s) ..... g
grams per cubic centimeter ..... gm/cc

Heat Transfer Coefficient ..... U
height ..... hgt
Hertz ..... Hz
horsepower ..... hp
horsepower-hour ..... hp-hr
hour(s) ..... hr

humidity, relative ..... rh
hydrogen ion concentration .....pH

inch(es) .....in
inches per second .....ips
inside diameter .....ID

Jackson turbidity unit(s) .....JTU

kelvin ..... K
kiloamperes .....kA
kilogram(s) .....kg
kilometer(s) .....km
kilovar (kilovolt-amperes reactive) .....kvar
kilovolt(s) .....kV
kilovolt-ampere(s) .....kVA
kilowatt(s) .....kW
kilowatt-hour(s) .....kWh

linear foot (feet) .....lin ft
liter(s) L

megavolt-ampere(s) .....MVA
meter(s) .....m
micrograms per liter ..... ug/L
miles per hour .....mph
milliampere(s) ..... mA
milligram(s) ..... mg
milligrams per liter ..... mg/L
milliliter(s) ..... mL
millimeter(s) ..... mm
million gallons ..... MG
million gallons per day ..... mgd
millisecond(s) ..... ms
millivolt(s) ..... mV
minute(s) ..... min
mixed liquor suspended solids .....MLSS

nephelometric turbidity unit .....NTU
net positive suction head .....NPSH
noise criteria .....nc
noise reduction coefficient .....NRC
number .....no

ounce(s) .....oz
outside air .....oa
outside diameter .....OD

parts per billion ..... ppb
parts per million ..... ppm
percent ..... pct
phase (electrical) .... ph
pound(s) ..... lb
pounds per cubic foot ..... pcf
pounds per cubic foot per hour .....pcf/hr
pounds per day .....lbs/day
pounds per day per cubic foot .....lbs/day/cu ft
pounds per day per square foot .....lbs/day/sq ft
pounds per square foot ..... psf
pounds per square foot per hour .....psf/hr
pounds per square inch ..... psi
pounds per square inch absolute .....psia
pounds per square inch gauge .....psig
power factor .....PF
pressure drop or difference .....dp
pressure, dynamic (velocity) .....vp
pressure, vapor .....vap pr

quart(s) .....qt

Rankine ..... R
relative humidity .....rh
resistance ..... res
return air .....ra
revolution(s) ..... rev
revolutions per minute .....rpm
revolutions per second ..... rps
root mean squared ..... rms

safety factor ..... sf
second(s) ..... sec
shading coefficient ..... SC
sludge density index ..... SDI

Sound Transmission Coefficient ..... STC
specific gravity ..... sp gr
specific volume ..... Sp Vol
sp ht at constant pressure ..... Cp
square ..... sq
square centimeter(s) ..... sq cm
square foot (feet) ..... sq ft
square inch (es) ..... sq in
square meter(s) ..... sq m
square yard(s) ..... sq yd
standard ..... std
static pressure ..... st pr
supply air .... sa
suspended solids ..... SS

temperature ..... temp
temperature difference ..... TD
temperature entering ..... TE
temperature leaving ..... TL
thousand Btu per hour ..... Mbh
thousand circular mils ..... kcmil
thousand cubic feet ..... Mcf
threshold limit value ..... TLV
tons of refrigeration ..... tons
torque ..... TRQ
total dissolved solids ..... TDS
total dynamic head ..... TDH
total kjeldahl nitrogen ..... TKN
total oxygen demand ..... TOD
total pressure ..... TP
total solids ..... TS
total suspended solids ..... TSS
total volatile solids ..... TVS

vacuum ..... vac
viscosity ..... visc
volatile organic chemical ..... VOC
volatile solids ..... VS
volatile suspended solids ..... VSS
volt(s) V
volts-ampere(s) ..... VA
volume ..... vol

watt(s) ..... W
watthour(s) ..... Wh
watt-hour demand ..... WHD
watt-hour demand meter ..... WHDM
week(s) ..... wk
weight ..... wt
wet-bulb ..... WB
wet bulb temperature ..... WBT

yard(s) ..... yd
year(s) ..... yr

B. Use ASME Y1.1-1989, "Abbreviations for use on Drawings and in Text" for abbreviations for units of measure not included herein in Paragraph 1.4.

1.5 REFERENCE STANDARDS

A. Latest Edition: Construe references to furnishing materials or testing, which conform to the standards of a particular technical society, organization, or body, to mean the latest standard, code, or specification of that body, adopted and published as of the date of bidding this Contract. Standards referred to herein are made a part of these Specifications to the extent which is indicated or intended.

B. Precedence: The duties and responsibilities of the OWNER, CONTRACTOR or ENGINEER, or any of their consultants, agents or employees are set forth in the Contract Documents, and are not changed or altered by any provision of any referenced standard specifications, manuals or code, whether such standard manual or code is or is not specifically incorporated by reference in the Contract Documents. Any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority, to undertake responsibility contrary to the powers of the ENGINEER as set forth in the Contract Documents cannot be assigned to the ENGINEER or any of the ENGINEER's consultants, agents or employees.

1.6 DEFINITIONS

A. In these Contract Documents the words furnish, install and provide are defined as follows:

1. Furnish (materials): to supply and deliver to the project ready for installation and in operable condition.

2. Install (services or labor): to place in final position, complete, anchored, connected in operable condition.

3. Provide: to furnish and install complete. Includes the supply of specified services. When neither furnish, install or provide is stated, provide is implied.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 45 00

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Inspection Services

B. Inspection of Materials

C. Quality Control

D. Costs of Inspection

E. Acceptance Tests

F. Failure to Comply with Contract

1.2 RELATED SECTIONS

Related Work Specified in Other Sections Includes, But is Not Limited to, the Following

A. Section 01 33 00 - Submittals: Specific Submittal Requirements

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Certificate Submittals: Furnish the ENGINEER authoritative evidence in the form of Certificates of Manufacture that the materials and equipment to be used in the Work have been manufactured and tested in conformity with the Contract Documents. Include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

1.4 INSPECTION SERVICES

A. OWNER's Access: At all times during the progress of the Work and until the date of final completion, afford the OWNER and ENGINEER every reasonable, safe, and proper facility for inspecting the Work at the site. The observation and inspection of any work will not relieve the CONTRACTOR of any obligations to

perform proper and satisfactory work as specified. Replace work rejected due to faulty design, inferior, or defective materials, poor workmanship, improper installation, excessive wear, or nonconformity with the requirements of the Contract Documents, with satisfactory work at no additional cost to the OWNER. Replace as directed, finished or unfinished work found not to be in strict accordance with the Contract, even though such work may have been previously approved and payment made therefor.

B. Rejection: The OWNER and the OWNER's Authorized Representatives have the right to reject materials and workmanship which are defective or require correction. Promptly remove rejected work and materials from the site.

C. Inferior Work Discoveries: Failure or neglect on the part of the OWNER or the OWNER's Authorized Representatives to condemn or reject bad or inferior work or materials does not imply an acceptance of such work or materials. Neither is it to be construed as barring the OWNER or the OWNER's Authorized Representatives at any subsequent time from recovering damages or a sum of money needed to build anew all portions of the Work in which inferior work or improper materials were used.

D. Removal for Examination: Should it be considered necessary or advisable by the OWNER or the OWNER's Authorized Representatives, at any time before final acceptance of the Work, to make examinations of portions of the Work already completed, by removing or tearing out such portions, promptly furnish all necessary facilities, labor, and material, to make such an examination. If such Work is found to be defective in any respect, defray all expenses of such examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the Contract, the cost of examination and restoration of the Work will be considered a change in the Work to be paid for in accordance with applicable provisions of the Contract.

E. Operation Responsibility: Assume full responsibility for the proper operation of equipment during tests and instruction periods. Make no claim for damage which may occur to equipment prior to the time when the OWNER accepts the Work.

F. Rejection Prior to Warranty Expiration: If at anytime prior to the expiration of any applicable warranties or guarantees, equipment is rejected by the OWNER, repay to the OWNER all sums of money received for the rejected equipment on progress certificates or otherwise on account of the Contract lump sum prices, and upon the receipt of the sum of money, OWNER will execute and deliver a bill of sale of all its rights, title, and interest in and to the rejected equipment. Do not remove the equipment from the premises of the OWNER until the OWNER obtains from other sources, equipment to take the place of that rejected. The OWNER hereby agrees to obtain other equipment within a reasonable time and the CONTRACTOR agrees that the OWNER may use the equipment furnished by the CONTRACTOR without rental or other charge until the other new equipment is obtained.

1.5 INSPECTION OF MATERIALS

A. Premanufacture Notification: Give notice in writing to the ENGINEER sufficiently in advance of the commencement of manufacture or preparation of materials especially manufactured or prepared for use in or as part of the permanent construction. When required, notice to include a request for inspection, the date of commencement, and the expected date of completion of the manufacture or preparation of materials. Upon receipt of such notice, ENGINEER will arrange to have a representative present at such times during the manufacture or testing as may be necessary to inspect the materials, or will notify CONTRACTOR that the inspection will be made at a point other than the point of manufacture or testing, or that the inspection will be waived. Comply with these provisions before shipping any materials. Such inspection will not constitute a release from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

B. Testing Standards: Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized, applicable test codes except as may otherwise be stated herein.

1.6 QUALITY CONTROL

A. Testing

1. Field and Laboratory

a. Provide personnel to assist the ENGINEER in performing the following periodic observation and associated services.

(1) Soils: Observe and test excavations, placement and compaction of soils. Determine suitability of excavated material. Observe subgrade soils and foundations.

(2) Concrete: Observe forms and reinforcement; observe concrete placement; witness air entrainment tests, facilitate concrete cylinder preparation and assist with other tests performed by ENGINEER.

(3) Masonry: Sample and test mortar and grout; inspect brick and block samples and sample panels; inspect placement of reinforcement and grouting.

(4) Structural Steel: Verify that all welders are certified; visually inspect all structural steel welds; mechanically test high-tensile bolted connections.

b. When specified in Divisions 2 through 46 of the Contract Documents, provide an independent laboratory testing facility to perform required testing. Qualify the laboratory as having performed previous satisfactory work. Prior to use, submit to the ENGINEER for approval.

c. Cooperate with the ENGINEER and laboratory testing representatives. Provide at least 24 hours notice prior to when specified testing is required. Provide labor and materials, and necessary facilities at the site as required by the ENGINEER and the testing laboratory.

d. Provide an independent testing agency, a member of the National Electrical Testing Association, to perform inspections and tests specified in Division 26 of these Specifications.

2. Equipment: Coordinate and demonstrate test procedures as specified in the Contract Documents or as otherwise required during the formal tests.

3. Pipeline and Other Testing: Conform to test procedures and requirements specified in the appropriate Specification Section.

4. Testing Costs: Include the costs of all testing other than soils, concrete, and masonry testing of material placed under this Contract in the Contract Item 1 (Structures and Equipment Work). Include the costs of strength chloride ion and shrinkage tests specified in Division 3.

B. Reports

1. Certified Test Reports: Where transcripts or certified test reports are required by the Contract Documents, meet the following requirements:

a. Before delivery of materials or equipment submit and obtain approval of the ENGINEER for all required transcripts, certified test reports, certified copies of the reports of all tests required in referenced specifications or specified in the Contract Documents. Perform all testing in an approved independent laboratory or the manufacturer's laboratory. Submit for approval reports of shop equipment tests within thirty days of testing. Transcripts or test reports are to be accompanied by a notarized certificate in the form of a letter from the manufacturer or supplier certifying that tested material or equipment meets the specified requirements and the same type, quality, manufacture and make as specified. The certificate shall be signed by an officer of the manufacturer or the manufacturer's plant manager.

2. Certificate of Compliance: At the option of the ENGINEER, or where not otherwise specified, submit for approval a notarized Certificate of

Compliance. The Certificates may be in the form of a letter stating the following:

a. Manufacturer has performed all required tests

b. Materials to be supplied meet all test requirements

c. Tests were performed not more than one year prior to submittal of the certificate

d. Materials and equipment subjected to the tests are of the same quality, manufacture and make as those specified

e. Identification of the materials

1.7 COSTS OF INSPECTION

A. OWNER's Obligation: Initial inspection and testing of concrete, mortar, grout, backfill and structural steel furnished under this Contract will be performed by the OWNER or his authorized Representatives or inspection bureaus without cost to the CONTRACTOR. If subsequent testing is necessary due to failure of the initial tests or because of rejection for noncompliance, reimburse the OWNER for expenditures incurred in making such tests.

B. CONTRACTOR's Obligation: Include in the Contract Price, the cost of all shop and field tests of equipment and other tests required by the Contract Documents except those tests described above under "OWNER's Obligation". The OWNER may perform tests on any material or equipment furnished under this Contract at any time during the Contract. If tests performed by the OWNER result in failure or rejection for noncompliance, reimburse the OWNER for expenditures incurred in making such tests. Tests performed by the OWNER shall prevail in determining compliance with Contract requirements.

C. Reimbursements to OWNER:

1. Materials and equipment submitted by the CONTRACTOR as the equivalent to those specifically named in the Contract may be tested by the OWNER for compliance. Reimburse the OWNER for expenditures incurred in making such tests on materials and equipment which are rejected for noncompliance.

2. When a witness or shop test is performed at the manufacturer's facilities or an operational test is performed at the site of work, the ENGINEER'S services associated with the first test of each material or equipment item will be furnished by the OWNER. Reimburse the OWNER for the costs for the ENGINEER'S services associated with retests or failed original tests or test extensions due to failure to complete the original tests as scheduled. Any

costs so incurred will be billed by the OWNER and deducted from the CONTRACTOR'S subsequent partial payment.

1.8 ACCEPTANCE TESTS

A. Preliminary Field Tests: As soon as conditions permit, furnish all labor and materials and services to perform preliminary field tests of all equipment provided under this Contract. If the preliminary field tests disclose that any equipment furnished and installed under this Contract does not meet the requirements of the Contract Documents, make all changes, adjustments and replacements required prior to the acceptance tests.

B. Final Field Tests: Upon completion of the Work and prior to final payment, subject all equipment, piping and appliances installed under this Contract to specified acceptance tests to demonstrate compliance with the Contract Documents.

1. Furnish all labor, fuel, energy, water and other materials, equipment, instruments and services necessary for all acceptance tests.

2. Conduct field tests in the presence of the ENGINEER. Perform the field tests to demonstrate that under all conditions of operation each equipment item:

   a. Has not been damaged by transportation or installation
   b. Has been properly installed
   c. Has been properly lubricated
   d. Has no electrical or mechanical defects
   e. Is in proper alignment
   f. Has been properly connected
   g. Is free of overheating of any parts
   h. Is free of all objectionable vibration
   i. Is free of overloading of any parts
   j. Operates as intended

3. Operate work or portions of work for a minimum of 100 hours or 14 days continuous service, whichever comes first. For those items of equipment which would normally operate on wastewater or sludge, plant effluent may be used if available when authorized by ENGINEER. If water can not properly exercise equipment, conduct 100-hour test after plant startup. Conduct test on those systems which require load produced by weather (heating or cooling) exercise only when weather will produce proper load.

C. Failure of Tests: If the acceptance tests reveal defects in material or equipment, or if the material or equipment in any way fails to comply with the requirements of the Contract Documents, then promptly correct such deficiencies. Failure or refusal to correct the deficiencies, or if the improved materials or equipment, when tested again, fail to meet the guarantees or specified requirements, the OWNER, notwithstanding its partial payment for work and materials or equipment, may reject said materials or equipment and may order the CONTRACTOR to remove the defective work from the site at no addition to the Contract Price, and replace it with material or equipment which meets the Contract Documents.

1.9 FAILURE TO COMPLY WITH CONTRACT

A. Unacceptable Materials: If it is ascertained by testing or inspection that the material or equipment does not comply with the Contract, do not deliver said material or equipment, or if delivered remove it promptly from the site or from the Work and replace it with acceptable material without additional cost to the OWNER. If the Contractor fails to remove unacceptable materials and equipment from the site, or make satisfactory progress in doing so, within forty-eight (48) hours after the service of a written notice from the ENGINEER ordering such removal, the unacceptable material or equipment may be removed by the OWNER and the cost of such removal to be taken out of money that may be due or become due the CONTRACTOR on account of or by virtue of this Contract. Fulfill all obligations under the terms and conditions of the Contract even though the OWNER or the OWNER's Authorized Representatives fail to ascertain noncompliance or notify the CONTRACTOR of noncompliance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 45 50

LEAKAGE TESTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Testing for any signs of leakage in all pipelines and structures required to be watertight.

1. Test all pipelines with water under the specified pressures.

2. Test all structures with water under the specified pressures.

B. Operation of Existing Facilities: Conduct all tests in a manner to minimize as much as possible any interference with the day-to-day operations of existing facilities or other contractors working on the site.

1.2 PERFORMANCE REQUIREMENTS

A. Written Notification of Testing: Provide written notice when the work is ready for testing, and make the tests as soon thereafter as possible.

1. Personnel for reading meters, gauges, or other measuring devices, will be furnished by the OWNER.

2. Furnish all other labor, equipment, air, water and materials, including meters, gauges, smoke producers, blower, pumps, compressors, fuel, water, bulkheads and accessory equipment.

1.3 REFERENCES

A. Codes and standards referred to in this Section are:

1. AWWA C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

1.4 SUBMITTALS

A. General: Provide all submittals, as specified in Division 1.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PRESSURE TESTS OF EXPOSED PLANT PIPING

A. Testing: Pressure test exposed pipelines for leakage by maintaining the fluid in the pipe at the specified pressure for a period of 60 minutes. Examine all accessible joints during the test. Stop all visible leakage.

B. Test Pressures: Test the various pipelines at the test pressures specified in Section 40 05 10.

3.2 PRESSURE TESTS OF BURIED OR CONCEALED PLANT PIPELINES AND WATER MAINS

A. Testing: Completely backfill all harnessed sections of buried piping before such sections are tested.

1. Pressure test buried or concealed pipelines for leakage by maintaining the fluid in the pipe at the specified pressure for a minimum period of 4 hours.

2. Pressure test the piping for leakage as a whole or in sections, valved or bulkheaded at the ends. Apply the specified pressure to the piping through a tap in the pipe by means of a hand pump or other approved method. Do not use air for testing.

B. Test Pressures: Test the piping at the test pressures specified in Sections 33 05 50 and 40 05 10.

C. Allowable Leakage: Stop all visible leakage. Do not allow leakage for any piping, as determined by the above test, to exceed the allowable leakage for cast-iron water mains as given by the following formula in Section 5.2 of AWWA C600:

$$L = \frac{S \times D \times (P)^{1/2}}{148{,}000}$$

in which L is the allowable leakage in gallons per hour, S is the length of water main tested in feet, D is the nominal diameter of the pipe in inches and P is the average test pressure in psi gauge.

3.3 VALVE TESTING

A. Testing: Operate valves in the section under test through several complete cycles of closing and opening. In addition, have the test pressure for each valve, when in the closed position, applied to one side of the valve only. Test each end of the valve in this manner.

B. Test Pressure: Test each valve at the same test pressure as that specified for the pipe in which the valve is installed.

C. Leakage: Stop all external and internal leakage through the valves.

D. Movement: Stop all valve movement or structural distress.

3.4 REPAIR OF PIPING LEAKS

A. Procedures: Repair leaks as follows:

1. Replace broken pipe or joint assemblies found to leak.

2. When leakage occurs in excess of the specified amount, locate and repair defective valves, pipe, cleanouts or joints.

3. If the excess leakage is determined to be caused by defective materials furnished, improper workmanship, or damage to the materials, make the necessary repairs or replacements at no addition to the Contract Price.

4. If defective portions cannot be located, remove and reconstruct as much of the original work as necessary to obtain piping that meets the leakage requirements specified herein and retest, all at no addition to the Contract Price.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 50 00

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Temporary Utilities

C. Temporary Construction

D. Barricades and Enclosures

E. Fences

F. Security

G. Contractor Access Cards

H. Safety

I. Protection of Property

J. Temporary Controls

K. Traffic Regulation

L. Field Offices and Sheds

M. Engineer's Field Office

1.2 GENERAL REQUIREMENTS

A. Plant and Facilities: Furnish, install, maintain and remove all false work, scaffolding, ladders, hoistways, braces, pumping plants, shields, trestles, roadways, sheeting, centering forms, barricades, drains, flumes, and the like, any of which may be needed in the construction of any part of the Work and which are not herein described or specified in detail. Accept responsibility for the safety and efficiency of such works and for any damage that may result from their failure or from their improper construction, maintenance or operation.

B. First Aid: Maintain a readily accessible, completely equipped first aid kit at each location where work is in progress.

C. Safety Responsibility: Accept sole responsibility for safety and security at the site. Indemnify and hold harmless the OWNER and the OWNER's Authorized Representatives, including Greeley and Hansen, LLC and its sub-contractors for any safety violation, or noncompliance with governing bodies and their regulations, and for accidents, deaths, injuries, or damage at the site during occupancy or partial occupancy of the site by CONTRACTOR's forces while performing any part of the Work.

D. Hazard Communication: Furnish two copies of the CONTRACTOR's Hazard Communication Program required under OSHA regulations before beginning on site activities. Furnish two copies of amendments to Hazard Communications Program as they are prepared.

1.3 TEMPORARY UTILITIES

A. Water: Provide all necessary and required water without additional cost, unless otherwise specified. If necessary, provide and lay water lines to the place of use; secure all necessary permits; pay for all taps to water mains and hydrants and for all water used at the established rates.

B. Light and Power: Provide without additional cost to the OWNER temporary lighting and power facilities required for the proper construction and inspection of the Work. If, in the ENGINEER's opinion, these facilities are inadequate, do NOT proceed with any portion of the Work affected thereby. Maintain temporary lighting and power until the Work is accepted.

C. Heat: Provide temporary heat, whenever required, for work being performed during cold weather to prevent freezing of concrete, water pipes, and other damage to the Work or existing facilities.

D. Sanitary Facilities: Provide sufficient sanitary facilities for construction personnel. Prohibit and prevent nuisances on the site of the Work or on adjoining property. Discharge any employee who violates this rule. Abide by all environmental regulations or laws applicable to the Work.

E. Connections to Existing Utilities:

1. Unless otherwise specified or indicated, make all necessary connections to existing facilities including structures, drain lines, and utilities such as water, sewer, gas, telephone, and electricity. In each case, obtain permission from the OWNER or the owning utility prior to undertaking connections. Protect facilities against deleterious substances and damage.

2. Thoroughly plan in advance all connections to existing facilities. Have on hand at the time of undertaking the connections, all material, labor and required equipment. Proceed continuously to complete connections in minimum time. Arrange for the operation of valves or other appurtenances on existing utilities, under the direct supervision of the owning utility.

1.4 TEMPORARY CONSTRUCTION

A. Bridges: Design and place suitable temporary bridges where necessary for the maintenance of vehicular and pedestrian traffic. Assume responsibility for the sufficiency and safety of all such temporary work or bridges and for any damage which may result from their failure or their improper construction, maintenance, or operation. Indemnify and save harmless the OWNER and the OWNER's representatives, including Greeley and Hansen, LLC and its sub-contractors, from all claims, suits or actions, and damages or costs of every description arising by reason of failure to comply with the above provisions.

1.5 BARRICADES AND ENCLOSURES

A. Protection of Workmen and Public: Effect and maintain at all times during the prosecution of the Work, barriers and lights necessary for the protection of Workmen and the Public. Provide suitable barricades, lights, "danger" or "caution" or "street closed" signs and watchmen at all places where the Work causes obstructions to normal traffic, excavation sites, or constitutes in any way a hazard to the public.

B. Barricades and Lights:

1. Protect all streets, roads, highways, excavations and other public thoroughfares which are closed to traffic; use effective barricades which display acceptable warning signs. Locate barricades at the nearest public highway or street on each side of the blocked section.

2. Statutory Requirements: Install and maintain all barricades, signs, lights, and other protective devices within highway rights-of-way in strict conformity with applicable statutory requirements by the authority having jurisdiction.

1.6 FENCES

A. Existing Fences: Obtain written permission from the OWNER prior to relocating or dismantling fences which interfere with construction operations. Reach agreements with the fence owner as to the period the fence may be left relocated or dismantled. Install adequate gates where fencing must be maintained. Keep gates closed and locked at all times when not in use.

B. Restoration: Restore all fences to their original or better condition and to their original location on completion of the Work.

1.7 SECURITY

A. The project site where equipment installation work is to be performed under this Contract is a secured site. The CONTRACTOR shall be responsible for security as described below at the site where he is performing work under this Contract.

B. The CONTRACTOR shall respect all existing security measures at the project site, and shall implement the following measures to apply to all work performed under this Contract.

1. For each employee the CONTRACTOR employs for work at the project site, CONTRACTOR shall provide the following information to the ENGINEER: Name, address, Social Security Number, telephone number, length of employment with CONTRACTOR. CONTRACTOR shall also complete background checks and ID quest forms for all his employees employed for this project, to gain access to the project site.

2. CONTRACTOR shall maintain a log book listing as a minimum the names of all persons admitted to the secured site by the CONTRACTOR, the purpose of the site visit, the dates and times of arrival at the site, entry to the secured site, and departure from the site.

3. CONTRACTOR and OWNER acknowledge that CONTRACTOR shall not solely be responsible for all secured access to the site, that City personnel will have access and will be performing their regular duties pertaining to the operation and maintenance of the site facilities, and that security at the site shall require the cooperation of all persons authorized to access the site for the performance of their work. To the extent that CONTRACTOR is responsible for and has control of secured access, CONTRACTOR shall restrict site access to only persons essential to the performance or inspection for the work being performed under the Contract.

4. CONTRACTOR shall provide ENGINEER twenty-four (24) hours advance notification of any delivery of equipment or materials to the site, and shall make arrangements with ENGINEER to provide for inspection of such delivery.

C. Any observation by the CONTRACTOR of activity at or associated with the project site that CONTRACTOR observes and considers to be unusual or suspicious in nature, or that CONTRACTOR believes poses a threat to the integrity or welfare of the project site or associated facilities, shall be duly noted at the time of the observation in the log book identified in item B.2 above. Any such observation shall be immediately reported to the ENGINEER.

D. No statement pertaining to security in these Specifications shall constitute a contract between CONTRACTOR and OWNER for the performance of security services.

1.8 CONTRACTOR ACCESS CARDS

A. A "Contractor Access Card" issued by the City of Tulsa Security Office is required for the following people:

1. The driver of each vehicle that will be entering the facility multiple times or on a regular basis.

2. Sub-contractors and foremen that will be supervising other workers.

B. CONTRACTOR will coordinate with the ENGINEER to request Contractor Access Cards. Application for a Contractor Access Card will require a background investigation. Each person that is applying for a Contractor Access Card will need to complete the following two (2) forms:

1. City of Tulsa Access Card / Identification Card Request Form

2. City of Tulsa Security, Background and Prescreen Investigation Form

A current soft copy of the forms can be obtained from the Engineer.

C. The CONTRACTOR will send the completed forms to the Engineer. The Engineer will submit the completed forms to the City of Tulsa Security Office. Approved individuals will coordinate with the City of Tulsa Security to complete the process and obtain their Contractor Access Card.

D. Six (6) months is the maximum time that a Contractor Access Card is active. The Contractor will coordinate with the Engineer to request re-activation of the Contractor Access Cards. Re-activation may require re-application and additional background investigation.

1.9 SAFETY

A. CONTRACTOR shall be responsible for performing all work under this contract in a safe manner and in compliance with the City of Tulsa General Specifications, Division 1, Part 112, and with all other applicable local, state, and federal safety and health regulations.

B. CONTRACTOR shall submit a site-specific safety plan and emergency response plan prior to start of work. CONTRACTOR's attention is directed to safety regulations applicable to the work under this contract.

C. Fire Prevention and Protection: The CONTRACTOR shall take all necessary measures to prevent fire, and shall provide satisfactory firefighting means at the location of work.

1.10 PROTECTION OF PROPERTY

A. Preservation of Property:

1. Preserve from damage, all property along the line of the Work, in the vicinity of or in any way affected by the Work, the removal or destruction of which is not called for by the Drawings. Preserve from damage, public utilities, trees, lawn areas, building monuments, fences, pipe and underground structures, and public streets. Note: Normal wear and tear of streets resulting from legitimate use by the CONTRACTOR are not considered as damage. Whenever damages occur to such property, immediately restore to its original condition. Costs for such repairs are incidental to the Contract.

2. In case of failure on the part of the CONTRACTOR to restore property or make good on damage or injury, the OWNER may, upon 24 hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from any moneys due or which may become due the CONTRACTOR under this Contract. If removal, repair or replacement of public or private property is made necessary by alteration of grade or alignment authorized by the OWNER and not contemplated by the Contract Documents, the CONTRACTOR will be compensated, in accordance with the General Conditions, provided that such property has not been damaged through fault of the CONTRACTOR or the CONTRACTOR's employees.

B. Public Utility Installations and Structures:

1. Public utility installations and structures include all poles, tracks, pipes, wires, conduits, vaults, manholes, and other appurtenances and facilities, whether owned or controlled by public bodies or privately owned individuals, firms or corporations, used to serve the public with transportation, gas, electricity, telephone, storm and sanitary sewers, water, or other public or private utility services. Facilities appurtenant to public or private property which may be affected by the Work are deemed included hereunder.

2. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. Existing public utility installations and structures are indicated on the Drawings only to the extent such information was made available to, or found by, the

ENGINEER in preparing the Drawings. These data are not guaranteed for completeness or accuracy, and the CONTRACTOR is responsible for making necessary investigations to become fully informed as to the character, condition, and extent of all public utility installations and structures that may be encountered and that may affect the construction operations.

3. Contact utility locating service sufficiently in advance of the start of construction to avoid damage to the utilities and delays to the completion date.

4. Remove, replace, relocate, repair, rebuild, and secure any public utility installations and structures damaged as a direct or indirect result of the Work under this Contract. Costs for such work are incidental to the Contract. Be responsible and liable for any consequential damages done to or suffered by any public utility installations or structures. Assume and accept responsibility for any injury, damage, or loss which may result from or be consequent to interference with, or interruption or discontinuance of, any public utility service.

5. Repair or replace any water, electric, sewer, gas, or other service connection damaged during the Work with no addition to the Contract price.

6. At all times in performance of the Work, employ proven methods and exercise reasonable care and skill to avoid unnecessary delay, injury, damage, or destruction to public utility installations and structures. Avoid unnecessary interference with, or interruption of, public utility services. Cooperate fully with the owners thereof to that end.

7. Give written notice to the owners of all public utility installations and structures affected by proposed construction operations, sufficiently in advance of breaking ground in any area or on any unit of the Work, to obtain their permission before disrupting the lines and to allow them to take measures necessary to protect their interests. Advise the Chiefs of Police, Fire and Rescue Services of any excavation in public streets or the temporary shut-off of any water main. Provide at least 24 hours notice to all affected property owners whenever service connections are taken out of service.

C. Miscellaneous Structures: Assume and accept responsibility for all injuries or damage to culverts, building foundations and walls, retaining walls, or other structures of any kind met with during the prosecution of the Work. Assume and accept liability for damages to public or private property resulting therefrom. Adequately protect against freezing all pipes carrying liquid.

D. Protection of Trees and Lawn Areas:

1. Protect with boxes, trees and shrubs, except those ordered to be removed. Do not place excavated material so as to cause injury to such trees or shrubs. Replace trees or shrubs destroyed by accident or negligence of the CONTRACTOR or CONTRACTOR's employees with new stock of similar size and age, at the proper season, at no additional cost to the OWNER.

2. Leave all existing lawn areas in as good condition as before the start of the Work. Restore all existing lawn areas damaged, removed or destroyed during the Work and that are to remain lawn areas by seeding or sodding.

1.11 TEMPORARY CONTROLS

A. During Construction:

1. Keep the site of the Work and adjacent premises free from construction materials, debris, and rubbish. Remove this material from any portion of the site if such material, debris, or rubbish constitutes a nuisance or is objectionable.

2. Remove from the site all surplus materials and temporary structures when they are no longer needed.

3. Neatly stack construction materials such as concrete forms and scaffolding when not in use. Promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.

4. Properly store volatile wastes in covered metal containers and remove from the site daily.

5. Do not bury or burn on the site or dispose of into storm drains, sanitary sewers, streams, or waterways, any waste material. Remove all wastes from the site and dispose of in a manner complying with applicable ordinances and laws.

B. Smoke Prevention:

1. Strictly observe all air pollution control regulations.

2. Open fires will be allowed only if permitted under current ordinances.

C. Noises:

1. Maintain acceptable noise levels in the vicinity of the Work. Limit noise production to acceptable levels by using special mufflers, barriers, enclosures, equipment positioning, and other approved methods.

2. Supply written notification to the OWNER sufficiently in advance of the start of any work which violates this provision. Proceed only when all applicable authorizations and variances have been obtained in writing.

D. Hours of Operation:

1. Operation of construction equipment between the hours of 7:00 p.m. and 6:00 a.m. the following day is prohibited. For operation of this equipment during this period obtain written consent from the OWNER.

2. Do not carry out nonemergency work, including equipment moves, on Sundays without prior written authorization by the OWNER.

E. Dust Control:

1. Take measures to prevent unnecessary dust. Keep earth surfaces exposed to dusting moist with water or a chemical dust suppressant. Cover materials in piles or while in transit to prevent blowing or spreading dust.

2. Adequately protect buildings or operating facilities which may be affected adversely by dust. Protect machinery, motors, instrument panels, or similar equipment by suitable dust screens. Include proper ventilation with dust screens.

F. Temporary Drainage Provisions:

1. Provide for the drainage of stormwater and any water applied or discharged on the site in performance of the Work. Provide adequate drainage facilities to prevent damage to the Work, the site, and adjacent property.

2. Supplement existing drainage channels and conduits as necessary to carry all increased runoff from construction operations. Construct dikes as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect the OWNER's facilities and the Work, and to direct water to drainage channels or conduits. Provide ponding as necessary to prevent downstream flooding.

3. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

G. Pollution: Prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris, and other substances resulting from construction activities. Do not permit sanitary wastes to enter any drain or watercourse other than sanitary sewers. Do not permit sediment, debris, or other substances to enter sanitary sewers. Take reasonable measures to prevent such materials from entering any drain or watercourse.

1.12 TRAFFIC REGULATION

A. Parking: Provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the Contract, to avoid any need for parking personal vehicles where they may interfere with public traffic or construction activities.

B. Access: Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian. Provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, give reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when the CONTRACTOR has obtained permission from the owner or tenant of private property, or from the authority having jurisdiction over the public property involved, to obstruct traffic at the designated point.

1.13 FIELD OFFICES AND SHEDS

A. CONTRACTOR's Office: Erect, furnish, and maintain a field office with a telephone. Have an authorized agent present at this office at all times while the Work is in progress. Keep readily accessible copies of the Contract Documents, required record documents, and the latest approved shop drawings at this field office.

B. Material Sheds and Temporary Structures: Provide material sheds and other temporary structures of sturdy construction and neat appearance.

C. Location: Coordinate location of field offices, material sheds and temporary structures with ENGINEER and OWNER.

1.14 ENGINEER'S FIELD OFFICE

Not Used

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 60 00

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description

B. Substitutions

C. Manufacturer's Written Instructions

D. Transportation and Handling

E. Storage, Protection and Maintenance

F. Manufacturer's Field Quality Control Services

G. Special Tools and Lubricating Equipment

H. Lubrication

1.2 DESCRIPTION

A. Proposed Manufacturers List: Within 15 calendar days of the date of the Notice to Proceed, submit to the ENGINEER a list of the names of proposed manufacturers, materialmen, suppliers and subcontractors, obtain approval of this list by OWNER prior to submission of any shop drawings. Upon request submit evidence to ENGINEER that each proposed manufacturer has manufactured a similar product to the one specified and that it has previously been used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

B. Furnish and install Material and Equipment which meets the following:

1. Conforms to applicable specifications and standards.

2. Complies with size, make, type, and quality specified or as specifically approved, in writing, by ENGINEER.

3. Will fit into the space provided with sufficient room for operation and maintenance access and for properly connecting piping, ducts and services, as applicable. Make the clear spaces that will be available for operation and maintenance access and connections equal to or greater than those shown

and meeting all the manufacturers' requirements. Make all provisions for installing equipment furnished at no increase in Contract Price.

4. Manufactured and fabricated in accordance with the following:

   a. Design, fabricate, and assemble in accordance with best engineering and shop practices.

   b. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.

   c. Provide two or more items of same kind identical, by same manufacturer.

   d. Provide materials and equipment suitable for service conditions.

   e. Adhere to equipment capabilities, sizes, and dimensions shown or specified unless variations are specifically approved, in writing, in accordance with the Contract Documents.

   f. Adapt equipment to best economy in power consumption and maintenance. Proportion parts and components for stresses that may occur during continuous or intermittent operation, and for any additional stresses that may occur during fabrication or installation.

   g. Working parts are readily accessible for inspection and repair, easily duplicated and replaced.

5. Use material or equipment only for the purpose for which it is designed or specified.

6. Whenever materials and equipment are specified in both descriptive terms and by the manufacturer's or supplier's product name, model number, catalog number, and the like and there appears to be a conflict between the descriptions and the manufacturer's or supplier's number or name for the product, the descriptions shall govern.

7. Provide equipment that is safeguarded in accordance with applicable federal, state and local codes.

8. Provide materials and equipment whose protruding members, joints, corners, gear covers, and the like are finished in appearance. Grind smooth all exposed welds and miter the corners of structural shapes.

1.3 SUBSTITUTIONS

A. Substitutions:

1. CONTRACTOR'S requests for changes in equipment and materials from those required by the Contract Documents are considered requests for substitutions and are subject to CONTRACTOR'S representations and review provisions of the Contract Documents when one of following conditions are satisfied:

a. Where request is directly related to an "or equal" clause or other language of same effect in Specifications.

b. Where required equipment or material cannot be provided within Contract Time, but not as result of CONTRACTOR'S failure to pursue Work promptly or to coordinate various activities properly.

c. Where required equipment or material cannot be provided in manner compatible with other materials of Work, or cannot be properly coordinated therewith.

2. CONTRACTOR'S Options:

a. Where more than one choice is available as options for CONTRACTOR'S selection of equipment or material, select option compatible with other equipment and materials already selected (which may have been from among options for other equipment and materials).

b. Where compliance with specified standard, code or regulation is required, select from among products which comply with requirements of those standards, codes, and regulations.

c. "Or Equal": For equipment or materials specified by naming one or more equipment manufacturer and "or equal", submit request for substitution for any equipment or manufacturer not specifically named.

B. Conditions Which are Not Substitution:

1. Requirements for substitutions do not apply to CONTRACTOR options on materials and equipment provided for in the Specifications.

2. Revisions to Contract Documents, where requested by OWNER or ENGINEER, are "changes" not "substitutions".

3. CONTRACTOR'S determination of and compliance with governing regulations and orders issued by governing authorities do not constitute substitutions and do not constitute basis for a Change Order, except as provided for in Contract Documents.

1.4 MANUFACTURER'S WRITTEN INSTRUCTIONS

A. Instruction Distribution: When the Contract Documents require that installation, storage, maintenance and handling of equipment and materials comply with manufacturer's written instructions, obtain and distribute printed copies of such instructions to parties involved in installation, including six copies to ENGINEER.

1. Maintain one set of complete instructions at jobsite during storage and installation, and until completion of work.

B. Manufacturer's Requirements: Store, maintain, handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's written instructions and in conformity with Specifications.

1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult ENGINEER for further instructions.

2. Do not proceed with work without written instructions.

C. Performance Procedures: Perform work in accordance with manufacturer's written instructions. Do not omit preparatory steps or installation procedures, unless specifically modified or exempted by Contract Documents.

1.5 TRANSPORTATION AND HANDLING

A. Coordination with Schedule: Arrange deliveries of materials and equipment in accordance with Construction Progress Schedules. Coordinate to avoid conflict with work and conditions at site.

1. Deliver materials and equipment in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Protect bright machined surfaces, such as shafts and valve faces, with a heavy coat of grease prior to shipment.

3. Immediately upon delivery, inspect shipments to determine compliance with requirements of Contract Documents and approved submittals and that material and equipment are protected and undamaged.

B. Handling: Provide equipment and personnel to handle material and equipment by methods recommended by manufacturer to prevent soiling or damage to materials and equipment or packaging.

1.6 STORAGE, PROTECTION, AND MAINTENANCE

A. On-site storage areas and buildings:

1. Conform storage buildings to requirements of Section 01 50 00.

2. Coordinate location of storage areas with ENGINEER and OWNER.

3. Arrange on site storage areas for proper protection and segregation of stored materials and equipment with proper drainage. Provide for safe travel around storage areas and safe access to stored materials and equipment.

4. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

5. Store materials such as pipe, reinforcing and structural steel, and equipment on pallets, blocks or racks, off ground.

6. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment which are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

B. Interior Storage:

1. Store materials and equipment in accordance with manufacturer's instructions, with seals and labels intact and legible.

2. Store materials and equipment, subject to damage by elements, in weathertight enclosures.

3. Maintain temperature and humidity within ranges required by manufacturer's instructions.

C. Accessible Storage: Arrange storage in a manner to provide easy access for inspection and inventory. Make periodic inspections of stored materials or equipment to assure that materials or equipment are maintained under specified conditions and free from damage or deterioration.

1. Perform maintenance on stored materials of equipment in accordance with manufacturer's instructions, in presence of OWNER or ENGINEER.

2. Submit a report of completed maintenance to ENGINEER with each Application for Payment.

3. Failure to perform maintenance, to notify ENGINEER of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

D. OWNER'S Responsibility: OWNER assumes no responsibility for materials or equipment stored in buildings or on-site. CONTRACTOR assumes full responsibility for damage due to storage of materials or equipment.

E. CONTRACTOR'S Responsibility: CONTRACTOR assumes full responsibility for protection of completed construction. Repair and restore damage to completed Work equal to its original condition.

F. Special Equipment: Use only rubber tired wheelbarrows, buggies, trucks, or dollies to wheel loads over finished floors, regardless if the floor has been protected or not. This applies to finished floors and to exposed concrete floors as well as those covered with composition tile or other applied surfacing.

G. Surface Damage: Where structural concrete is also the finished surface, take care to avoid marking or damaging surface.

1.7 MANUFACTURER'S FIELD QUALITY CONTROL SERVICES

A. General:

1. Provide manufacturer's field services in accordance with this subsection for those tasks specified in other sections.

2. Provide training as specified in Section 01 79 00.

3. Include and pay all costs for suppliers' and manufacturers' services, including, but not limited to, those specified.

B. Installation Instruction: Provide instruction by competent and experienced technical representatives of equipment manufacturers or system suppliers as necessary to resolve assembly or installation procedures which are attributable to, or associated with, the equipment furnished.

C. Installation Inspection, Adjustments and Startup Participation:

1. Provide competent and experienced technical representatives of equipment manufacturers or system suppliers to inspect the completed installation as follows.

a. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.

b. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

c. Verify that wiring and support components for equipment are complete.

d. Verify that equipment or system is installed in accordance with the manufacturer's recommendations, approved shop drawings and the Contract Documents.

e. Verify that nothing in the installation voids any warranty.

2. Provide manufacturer's representatives to perform initial equipment and system adjustment and calibration conforming to the manufacturer's recommendations and instructions, approved shop drawings and the Contract Documents.

3. Obtain ENGINEER'S approval before start-up of equipment. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.

4. Furnish ENGINEER with three copies of the following. When training is specified, furnish the copies at least 24 hours prior to training.

   a. "Certificate of Installation, Inspection and Start-up Services" by manufacturers' representatives for each piece of equipment and each system specified, certifying:

      (1) That equipment is installed in accordance with the manufacturers' recommendations, approved shop drawings and the Contract Documents.

      (2) That nothing in the installation voids any warranty.

      (3) That equipment has been operated in the presence of the manufacturer's representative.

      (4) That equipment, as installed, is ready to be operated by others.

   b. Detailed report by manufacturers' representatives, for review by ENGINEER of the installation, inspection and start-up services performed, including:

      (1) Description of calibration and adjustments if made; if not in Operation and Maintenance Manuals, attach copy.

(2) Description of any parts replaced and why replaced.

(3) Type, brand name, and quantity of lubrication used, if any.

(4) General condition of equipment.

(5) Description of problems encountered, and corrective action taken.

(6) Any special instructions left with CONTRACTOR or ENGINEER.

D. Field Test Participation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to participate in field testing of the equipment specified in Section 01 45 00.

E. Trouble-Free Operation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to place the equipment in trouble-free operation after completion of start-up and field tests.

1.8 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. General: Furnish, per manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)

B. Time of Delivery: Deliver special tools and lubricating equipment to OWNER when unit is placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.

C. Quality: Provide tools and lubricating equipment of a quality meeting equipment manufacturer's requirements.

1.9 LUBRICATION

A. General: Where lubrication is required for proper operation of equipment, incorporate in the equipment the necessary and proper provisions in accordance with manufacturer's requirements. Where possible, make lubrication automated and positive.

B. Oil Reservoirs: Where oil is used, supply reservoir of sufficient capacity to lubricate unit for a 24-hour period.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

CERTIFICATE OF INSTALLATION, INSPECTION AND START-UP SERVICES

Project _____

Equipment _____

Specification Section _____

Contract _____

I hereby certify that the named equipment has been inspected, adjusted and operated by the Manufacturers' Representative and further certify:

1. That the equipment is installed in accordance with the manufacturer's recommendations, approved shop drawings and the Contract Documents.
2. That nothing in the installation voids any warranty.
3. That equipment has been operated in the presence of the manufacturer's representative.
4. That equipment, as installed, is ready to be operated by others.

MANUFACTURERS' REPRESENTATIVE

Signature _____ Date _____

Name (print) _____

Title _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

Attach the detailed report called for by Specification Section 01 60 00.

Complete and submit three copies of this form with the detailed report to ENGINEER as specified.

SECTION 01 71 23

LINES AND GRADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General

B. Surveys

C. Datum Plane

D. Protection of Survey Data

1.2 GENERAL

A. Construct all work in accordance with the lines and grades shown on the Drawings. Assume full responsibility for keeping all alignment and grade.

1.3 SURVEYS

A. Control Points: Base horizontal and vertical control points will be established or designated by the ENGINEER and used as datum for the Work. Perform all additional survey, layout, and measurement work.

1. Keep ENGINEER informed, sufficiently in advance, of the times and places at which work is to be performed so that base horizontal and vertical control points may be established and any checking deemed necessary by ENGINEER may be done, with minimum inconvenience to the ENGINEER and at no delay to CONTRACTOR. It is the intention not to impede the Work for the establishment of control points and the checking of lines and grades set by the CONTRACTOR. However, when necessary, suspend working operations for such reasonable time as the ENGINEER may require for this purpose. Costs associated with such suspension are deemed to be included in the Contract Price, and no time extension or additional costs will be allowed.

2. Provide an experienced survey crew including an instrument operator, competent assistants, and any instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement of work performed by the CONTRACTOR.

1.4 DATUM PLANE

A. All elevations indicated or specified refer to the Mean Sea Level Datum Plane, 1988 General Adjustment, of the United States Coast and Geodetic Survey and are expressed in feet and decimal parts thereof, or in feet and inches.

1.5 PROTECTION OF SURVEY DATA

A. General: Safeguard all points, stakes, grade marks, known property corners, monuments, and bench marks made or established for the Work. Reestablish them if disturbed, and bear the entire expense of checking reestablished marks and rectifying work improperly installed.

B. Records: Keep neat and legible notes of measurements and calculations made in connection with the layout of the Work. Furnish copies of such data to the ENGINEER for use in checking the CONTRACTOR's layout. Data considered of value to the OWNER will be transmitted to the OWNER by the ENGINEER with other records on completion of the Work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Scheduling of Shutdown

1.2 RELATED SECTIONS

Related Work Specified in Other Sections Includes, but is Not Limited to, the Following

A. Section 01 11 00 - Summary of Work

1.3 GENERAL REQUIREMENTS

A. Coordination: Perform all cutting, fitting or patching of the Work that may be required to make the several parts thereof join in accordance with the Contract Documents. Perform restoration with competent workmen skilled in the trade.

B. Improperly Timed Work: Perform all cutting and patching required to install improperly timed work, to remove samples of installed materials for testing, and to provide for alteration of existing facilities or for the installation of new Work in the existing construction.

C. Limitations: Except when the cutting or removal of existing construction is specified or indicated, do not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without the ENGINEER's concurrence.

1.4 SCHEDULING OF SHUTDOWN

A. Connections to Existing Facilities: If any connections, replacement, or other work requiring the shutdown of an existing facility is necessary, schedule such work at times when the impact on the OWNER's normal operation is minimal. Overtime, night and weekend work without additional compensation from the OWNER, may be required to make these connections, especially if the connections are made at times other than those specified.

B. Request for Shutdowns: Submit a written request for each shutdown to the OWNER and the ENGINEER sufficiently in advance of any required shutdown.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Safeguards: Provide all shoring, bracing, supports, and protective devices necessary to safeguard all work and existing facilities during cutting and patching operations.

B. Location of Embedment's: Employ impulse radar (non x-ray type) nondestructive testing prior to core drilling or cutting of existing walls, floors and ceilings to identify location of embedded pipes or conduits.

C. Material Removal: Cut and remove all materials to the extent shown or as required to complete the Work. Remove materials in a careful manner with no damage to adjacent facilities. Remove materials which are not salvageable from the site.

3.2 RESTORATION

A. Final Appearance and Finish: Restore all work and existing facilities affected by cutting operations, with new materials, or with salvaged materials acceptable to the ENGINEER, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, patch and refinish entire surfaces.

END OF SECTION

SECTION 01 74 00

CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cleaning During Construction

B. Final Cleaning

C. Final Inspection

1.2 CLEANING DURING CONSTRUCTION

A. During construction of work, at all times, keep the site work and adjacent premises as free from material, debris, and rubbish as is practicable and remove it from any portion of the site, if in the opinion of the ENGINEER, such material, debris, or rubbish constitutes a nuisance or is objectionable.

B. Remove from the site all surplus materials and temporary structures when no further need therefore exists.

C. Immediately upon installation of any portion of the work, restore all fills, topsoil, and utilities to their location and condition prior to construction.

1.3 FINAL CLEANING

A. Requirements: At the completion of work and immediately prior to final inspection, clean the entire project as follows:

1. Thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. Leave the structures and site in a complete and finished condition to the satisfaction of the ENGINEER.

2. Direct all subcontractors to similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.

3. Remove all temporary structures and all debris, including dirt, sand, gravel, rubbish and waste material.

4. Should the CONTRACTOR not remove rubbish or debris or not clean the buildings and site as specified above, the OWNER reserves the right to have the cleaning done at the expense of the CONTRACTOR.

B. Employ experienced workers, or professional cleaners, for final cleaning.

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

D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.

F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.

G. Remove snow and ice from access to buildings.

H. Replace air-handling filters if units were operated during construction.

I. Clean ducts, blowers, and coils, if air-handling units were operated without filters during construction.

J. Vacuum clean all interior spaces, including inside cabinets.

K. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.

L. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

M. Clean interior of all panel cabinets, pull boxes, and other equipment enclosures.

N. Wash and wipe clean all lighting fixtures, lamps, and other electrical equipment which may have become soiled during installation.

O. Perform touch-up painting.

P. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

Q. Remove erection plant, tools, temporary structures and other materials.

R. Remove and dispose of all water, dirt, rubbish or any other foreign substances.

1.4 FINAL INSPECTION

A. After cleaning is complete the final inspection may be scheduled. The inspection will be done with the OWNER and ENGINEER.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 78 00

CONTRACT CLOSE OUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Warranties and Bonds

B. Record Drawings

C. Special Tools

1.2 WARRANTIES AND BONDS

Prior to final payment deliver to the OWNER the original and one copy of all bonds, warranties, guarantees and similar documents, including those customarily provided by manufacturers and suppliers which cover a period greater than the one year correction period. Show OWNER as beneficiary of these documents.

1.3 RECORD DRAWINGS

At the site keep and maintain one record copy of all Contract Documents, reference documents and all technical documents submitted in good order. On Mylar tracing media, and using drafting symbols and standards consistent with the original documents, annotate Contract Drawings to show all changes made during the construction period. Annotated drawings are to be made available to ENGINEER for reference at all times.

At completion of the CONTRACT and before final payment is made, deliver to the ENGINEER one set of clearly readable, reproducible Contract Drawings reflecting all changes made during construction. Mark each drawing "Record Drawing" in ink.

1.4 SPECIAL TOOLS

Special tools are considered to be those tools which, because of their limited use, are not normally available but which are necessary for maintenance of particular equipment.

For each type of equipment provided under this CONTRACT, furnish a complete set of all special tools including grease guns and other lubricating devices, which may be needed for the adjustment, operation, maintenance, and disassembly of

such equipment. Furnish only tools of high grade, smooth forged alloy tool steel. Manufacture grease guns of the lever type.

Furnish and erect one or more neat and substantial steel wall cases or cabinets with flat key locks and clips or hooks to hold each special tool in a convenient arrangement.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope: Furnish to the ENGINEER 3 hard copies and 6 electronic copies on compact disk (CD) of an Operation and Maintenance Manual for all equipment and associated control systems furnished and installed.

1.2 QUALITY ASSURANCE

A. Reference Codes and Specifications: No current government or commercial specifications or documents apply.

1.3 SUBMITTALS

A. Prior to the Work Reaching 50 Percent Completion, submit to the ENGINEER for approval two hard copies of the preliminary manual with all specified material for each piece of equipment provided as detailed in the subsequent specification sections. Submit the approval copies with the partial payment request for the specified completion. Furnish to the OWNER 3 copies of the CONTRACTOR's final project Operation and Maintenance manual after completion of equipment training. Provide space in the manual for additional material. Submit any missing material for the manual prior to requesting certification of substantial completion.

B. Prior to requesting a certificate of beneficial occupancy, the associated equipments' preliminary Operation and Maintenance manuals must be submitted and approved.

C. Provide 6 copies of the final CONTRACTOR's Operation and Maintenance manual electronically on CD complete after the submission of any missing material prior to requesting certification of substantial completion. CONTRACTOR shall ensure that all material required for a complete CONTRACTOR's Operation and Maintenance manual is included on the electronic copy. The electronic version of the final manual shall be submitted in the latest PDF file format and follow the same contents, organization and formatting as the final hardcopies of the manual. Provide final CONTRACTOR's Operation and Maintenance Manual after completion of equipment training.

1.4 FORMAT AND CONTENTS

A. Prepare and arrange each copy of the manual as follows:

1. One copy of an equipment data summary (see sample form) for each item of equipment which shall include the following as a minimum:

    a. Name and contact information of manufacturer.

    b. Name and contact information of local manufacturer representative.

    c. Equipment serial numbers.

    d. Equipment warranty information, including warranty start and end dates.

    e. Equipment layout drawings complete with as-built information and dimensions.

    f. Manufacturer's certificates of proper installation.

    g. Certified equipment test results (i.e. pump curves, load tests, etc…).

2. One copy of an equipment preventive maintenance data summary (see sample form) for each item of equipment.

3. One copy of equipment Antero nameplate and summary data (see sample form) for each item of equipment.

4. One copy of the manufacturer's operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts.

5. List of electrical relay settings and control and alarm contact settings.

6. Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems.

7. One valve schedule giving valve number, location, fluid, and fluid destination for each valve installed. Group all valves in same piping systems together in the schedule. Obtain a sample of the valve numbering system from the ENGINEER.

8. All information provided in the manual shall be modified so that it ONLY includes information pertaining to the approved equipment and shall accurately depict the equipment provided. All "optional" and non-pertinent

materials and information shall be excluded from the manual or noted as such.

9. Furnish all O&M Manual material on 8-1/2 by 11 commercially printed or typed forms or an acceptable alternative format.

B. Organize each manual into sections paralleling the equipment specifications. Identify each section using heavy section dividers with reinforced holes and numbered plastic index tabs. Use 3-ring, slant ring, hard-back binders Type No. AVE-VS11 as manufactured by Avery Company, or equal. Binder size shall be 3-inch maximum. Punch all loose data for binding. Arrange composition and printing so that punching does not obliterate any data. Print on the cover and binding edge of each manual the project title, and manual title, as furnished and approved by the ENGINEER.

C. Leave all operating and maintenance material that comes bound by the equipment manufacturer in its original bound state. Cross-reference the appropriate sections of the CONTRACTOR's O&M manual to the manufacturers' bound manuals.

D. Label binders Volume 1, 2, and so on, where more than one binder is required. Include the table of contents for the entire set, identified by volume number, in each binder.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

TMUA Southside Wastewater Treatment Plant
Digester Gas Improvements
TMUA Project Number: ES 2010-04 Contract 2

Equipment Name: Specification Reference:

Antero Number:

Vendor:

Manufacturer: Local Representative:

Name: Name:

Address: Address:

Telephone: Telephone:

Number Supplied: Location/Service:

Model No: Serial No:

Type:

Size/Speed/Capacity/Range (as applicable):

Power Requirement (Phase/Volts/Hertz):

Purchase Price:

Date placed in service:

Parts Associated/Details:

Maintenance Schedule:

If applicable Motor info:

Size/Speed/Capacity/Range (as applicable):

Power Requirement (Phase/Volts/Hertz):

TMUA Southside Wastewater Treatment Plant
Digester Gas Improvements
TMUA Project Number: ES 2010-04 Contract 2

Preventive Maintenance Summary

Equipment Name: Location:

Manufacturer:

Name:

Address:

Telephone:

Model No: Serial No:

Maintenance Task	Lubricant/Part	D W M Q SA A	O&M Manual Reference

NOTES:

*D-Daily W-Weekly M-Monthly Q-Quarterly SA-Semi-Annual A-Annual

ANTERO NAMEPLATE AND SUMMARY DATA

Antero Number: _____

Description: _____

Submittal Date: _____

Project #: _____

Spec. #: _____

Vendor: _____

Manufacturer: _____

Model #: _____

Serial #: _____

Purchase Price: $_____

Date Placed in Service: _____

Training Date: _____

Warranty Start Date: _____

Parts Associated/Details: _____

_____

_____

_____

Maintenance Schedule (Summarized from O&M Manual)

- ✓ Initial: _____
- ✓ Weekly: _____
- ✓ Monthly: _____
- ✓ Semi-Annual: _____
- ✓ Annual: _____

Applicable Motor Information: N.A. (Circle if not applicable)

Vendor: _____

Manufacturer: _____

Model #: _____

Serial #: _____

Frame: _____ Insul. Class: _____

Volts/Hz/Amps: _____

HP / RPM / SF: _____

(NO TEXT FOR THIS PAGE)

SECTION 01 79 00

TRAINING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Training

1.2 TRAINING

A. Training: Provide the services of knowledgeable, technically competent, factory trained specialists to instruct Plant personnel in the operation and maintenance of the equipment and system components listed in Paragraph B. The OWNER will furnish training classroom space.

1. Coordinate services with the OWNER, with a minimum of 30 days prior notice.

2. Provide a combination of classroom and "hands-on" instruction designed to completely familiarize operating and maintenance personnel with the systems theory, standard operating procedures, safety features and emergency procedures, and general maintenance of all components. The classroom setting will be followed up with a site visit to the equipment's location and continue training with additional "hands-on" instruction as appropriate and coordinated with the authority.

3. Conduct all training at the Plant on Wednesdays, as directed by Authority.

4. Provide final Operation and Maintenance Manual only after completion of training.

B. Provide two training sessions for the specified equipment below on different days as coordinated with the Authority:

Specification	Equipment Name	Minimum Hours
40 05 20	Valves	4
40 80 50	Onsite Process Control System Commissioning	4
40 91 00	Process Control System Instruments	4

C. Length of Training: The minimum lengths of training for one session are listed in Paragraph B. above.

D. Credentials: Submit for approval, credentials of equipment manufacturer representatives who are to be course instructors at least 30 days prior to a proposed training session.

E. Scheduling: Submit training outline and other information described in paragraphs G through K for approval at least 30 days prior to the proposed date for the training sessions. Verify scheduling with the OWNER at least 30 days prior to the training sessions.

F. Number of Copies: For each training class, provide instructional material including detailed drawings for at least ten attendees plus five extra copies, plus duplicate copies of all audio-visual aids utilized during each training course.

G. Training Outline Submission: Provide a proposed training outline including the topics presented in Paragraph K. Identify specific components and procedures in the proposed training outline.

H. Training Topic Detail: Detail specific training topics. Describe "hands-on" demonstrations planned for the training. Reference training aids to be utilized in the training (i.e. video tapes, slides, transparencies) and attach where applicable.

I. Training Handouts: Attach training handouts to the proposed training outline.

J. Training Segment Duration: Indicate the duration of each training segment.

K. Training Outline:

1. Equipment Operation

    a. Describe equipment's operating (process) function.

    b. Describe equipment's fundamental operating principles and dynamics.

    c. Identify equipment's mechanical, electrical and electronic components and features.

    d. Identify all support equipment associated with the operation of the subject equipment.

2. Detailed Component Description

    a. Identify and describe in detail each component's function.

    b. Where applicable, group related components into subsystems.

c. Identify, and describe in detail, equipment safety features and control interlocks.

3. Detailed Mode of Operations Description

a. Identify and describe in detail each Mode of Operation.

b. Identify, and describe in detail, equipment safety features and control interlocks.

4. Detailed SCADA Operation Description

a. Identify and describe in detail SCADA wet weather operations procedure.

b. Identify, and describe in detail, equipment safety features and control interlocks.

L. Certificate: Provide "Certificate of Instructional Services" signed by CONTRACTOR and manufacturer's representative, verifying that training has been accomplished to satisfaction of all parties. Use form provided in this section, and furnish ENGINEER with three copies.

M. Substantial Completion: Training provided by manufacturers' representative and OWNER does not constitute substantial completion.

N. Equipment Use: Use of equipment for training will not void manufacturers' or contract warranties.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

CERTIFICATE OF INSTRUCTIONAL SERVICES

Project _____

Equipment _____

Specification Section _____

Contract _____

I hereby certify the equipment Manufacturers' Representative has instructed OWNER's personnel in startup operation and maintenance of this equipment as required in the Contract Documents.

MANUFACTURER'S REPRESENTATIVE

Signature _____

Name: (print) _____

Title: _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

COMMENTS:

Complete and submit three copies of this form to ENGINEER upon completion of training as required by Specification Section 01 79 00.

SECTION 02 41 00

DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: All work necessary for the removal and disposal of buildings, structures, foundations, piping, equipment and roadways, or any part thereof including masonry, steel, reinforced concrete, plain concrete, electrical facilities, and any other material or equipment shown or specified to be removed.

B. Basic Procedures and Schedule: Carry out demolition so that adjacent structures, which are to remain, are not endangered. Schedule the work so as not to interfere with the day to day operation of the existing facilities. Do not block doorways or passageways in existing facilities.

C. Additional Requirements: Provide dust control and make provisions for safety.

1.2 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

B. Site Inspection: Visit the site and inspect all existing structures. Observe and record any defects which may exist in buildings or structures adjacent to but not directly affected by the demolition work. Provide the OWNER with a copy of this inspection record and obtain the (ENGINEER's) (OWNER's) approval prior to commencing the demolition.

1.3 QUALITY ASSURANCE

A. Limits: Exercise care to break concrete well for removal in reasonably small masses. Where only parts of a structure are to be removed, cut the concrete along limiting lines with a suitable saw so that damage to the remaining structure is held to a minimum.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION OF EXISTING DRAWINGS

A. Drawings of existing structures and equipment will be available for inspection at the office of the (ENGINEER) (OWNER).

3.2 PROTECTION

A. General Safety: Provide warning signs, protective barriers, and warning lights as necessary adjacent to the work as approved or required. Maintain these items during the demolition period.

B. Existing Services: Undertake no demolition work until all mechanical and electrical services affected by the work have been properly disconnected. Cap, reroute or reconnect interconnecting piping or electrical services that are to remain in service either permanently or temporarily in a manner that will not interfere with the operation of the remaining facilities.

C. Hazards: Perform testing and air purging where the presence of hazardous chemicals, gases, flammable materials or other dangerous substances is apparent or suspected, and eliminate the hazard before demolition is started.

3.3 DEMOLITION REQUIREMENTS

A. Explosives: The use of explosives will not be permitted.

B. Protection: Carefully protect all mechanical and electrical equipment against dust and debris.

C. Removal: Remove all debris from the structures during demolition and do not allow debris to accumulate in piles.

D. Access: Provide safe access to and egress from all working areas at all times with adequate protection from falling material.

E. Protection: Provide adequate scaffolding, shoring, bracing railings, toe boards and protective covering during demolition to protect personnel and equipment against injury or damage. Cover floor openings not used for material drops with material substantial enough to support any loads placed on it. Properly secure the covers to prevent accidental movement.

F. Lighting: Provide adequate lighting at all times during demolition.

G. Closed Areas: Close areas below demolition work to anyone while removal is in progress.

H. Material Drops: Do not drop any material to any point lying outside the exterior walls of the structure unless the area is effectively protected.

3.4 DISPOSAL OF MATERIALS

A. Final Removal: Remove all debris, rubbish, scrap pieces, equipment, and materials resulting from the demolition unless otherwise indicated. Take title to all demolished materials and remove such items from the site.

B. OWNER's Property: In addition to any items which may be shown, the following items remain the property of the OWNER. Remove carefully, without damage, all items listed or shown, and stockpile as directed.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03 01 31

CONCRETE REHABILITATION

PART 1 GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Crack Repair by Epoxy Injection: Section 03 0132.

B. Water Repellent Sealer: Section 07 1900.

C. Joint Sealant: Section 07 9200.

1.2 REFERENCES

A. Except as shown or specified, the Work of this Section shall conform to the requirements of International Concrete Repair Institute (ICRI), 3166 S. River Rd., Suite 132, Des Plaines, IL 60018, (847) 827-0830, www.icri.org.

1. ICRI Guideline No. 310.1R-2008 Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion (formerly Guideline No. 03730).

1.3 UNIT PRICES FOR ADDED OR DEDUCTED WORK

A. Do not exceed the quantities of repair work indicated by numeric units on the Drawings or the Bid Proposal, except by written approval of the Owner's Representative. In order to avoid delay, notify the Owner's Representative when the amount of completed repair work approaches the quantity indicated.

B. Refer to General Conditions regard payment for final quantities over or under the defined bid quantity of work units.

C. Unit prices shall include overhead, profit, and all other expenses incidental to the repair work. Include in the bid sum all additional costs in connection with quantity changes that are not compensated for at the given unit prices.

1.4 SUBMITTALS

A. Product Data: Manufacturer's specifications and installation instructions for factory packaged products.

1.5 QUALITY ASSURANCE

A. Field Examples: Where specifically required by the Contract Documents, prior to performing the repair work of this section, prepare a sample

panel, or a portion of existing concrete which is to be repaired, to represent each type of rehabilitation work required. Approved samples will be used as quality standards for the Work. Maintain approved samples at the site until the Work is completed.

B. Material Container Labels: Material containers shall bear the manufacturer's label indicating manufacturer's name, trade name of product, lot number, shelf life of product, and mix ratio (if applicable).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in original, sealed containers. Do not deliver materials that have exceeded shelf life limitation set forth by the manufacturer.

B. Comply with manufacturer's printed instructions for storing and handling materials.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Comply with the product manufacturer's printed limitations and instructions.

PART 2 PRODUCTS

2.1 COMPANIES

A. The Euclid Chemical Company, 19218 Redwood Rd., Cleveland, OH 44110-2799, (800) 321-7628, www.euclidchemical.com.

B. Sika Corporation, 201 Polito Ave., Lyndhurst, NJ 07071, (800) 933-7452, www.sikausa.com.

C. Kaufman Products, Inc., 3811 Curtis Ave., Baltimore, MD 21226, (800) 637-6372, www.kaufmanproducts.net.

D. BASF Building Systems, 889 Valley Park Dr., Shakopee, MN 55379, (800) 433-9517, www.buildingsystems.basf.com.

2.2 MATERIALS

A. The following brand names are provided to establish product generic type and standard of quality. Use appropriate product for depth of patch and temperature at time of application. A bonding agent/primer and/or sealer shall be used as recommended by the repair mortar manufacturer.

B. Vertical and Overhead Repairs - Cement/Acrylic/Latex Base Repair Mortar:
1. Verticoat Supreme by The Euclid Chemical Company;
2. SikaTop 123 Plus by Sika Corp;
3. Patchwell VO by Kaufman Products, Inc.
4. Emaco S88CI by BASF

C. Epoxy Base Repair Mortar: High modulus, high viscosity, moisture insensitive, epoxy resin and aggregate system:
1. Sikadur 31 Hi-Mod Gel by Sika Corporation;
2. Duralcrete Gel by The Euclid Chemical Company;
3. SurePoxy HM Gel,or SurePoxy 117 by Kaufman Products, Inc.
4. Aggregate: As recommended by the patching mortar manufacturer for the binder and application.

D. Rapid-hardening Cementitious Patching Mortar:
1. Durapatch by L&M Construction Chemicals, Inc.;
2. SikaQuick 1000, SikaQuick 2500, or SikaSet Roadway Patch by Sika Corp;
3. Duracrete II, Duracrete II HW, Duracrete II FR, Duracrete II HWFR by Kaufman Products, Inc.
4. Euco-Speed by Euclid Chemicals.

E. Rebar Coating:
1. SurePoxy HMEPL or SurePoxy HM 12 by Kaufman Products, Inc.
2. ECB by Conproco Corp.
3. Emaco P22 or Emaco P24 by BASF Building Systems;
4. Sika Armatec 110 EpoCem by Sika Corp;
5. DuralPrep A.C. by Euclid Chemical Corp.

F. Cleaning Agent, Bonding Agent/Primer, Sealer / Topcoat:
As recommended by the patching mortar manufacturer, including primer for the reinforcing steel and primer for the concrete substrate.

G. Concrete and Bonding Agent (for concrete): Normal weight cast-in-place concrete and adhesive bonding agent as specified in Section 03 3001.

H. Surface Applied Migrating Corrosion Inhibitor with silane or silane / siloxane carrier, (not a water-based or water carrier product):
   1. Basis of Design - Protectosil CIT by Evonik Industries

PART 3 EXECUTION

3.1 PREPARATION

A. Protection: Cover or otherwise protect adjacent surfaces not being repaired.

B. Surface Preparation:
   1. Prepare surfaces to be repaired in accordance with the product manufacturer's printed instructions and as specified.

   2. Cut out and remove cracked, spalled, and disintegrated concrete. Cut back to sound concrete. Cut edges of patch perpendicular to surface of patch, unless otherwise recommended by mortar manufacturer. If steel reinforcing bars are exposed, chip concrete out from behind exposed length of bars as required for a minimum clearance around circumference of bar of 3/4 inch. In addition, cut a minimum one-inch length of sound concrete away from each end of exposed length of reinforcing bars, to at least 1-inch beyond cleaned rebar corrosion.

   3. When the corrosion inhibitor has dried, Clean exposed steel reinforcement; remove bits of concrete and loose rust. If reinforcement is bowed out toward surface of the concrete, bend reinforcement back from surface.

   4. Remove paint, oils, grease, dirt, salt deposits, laitance and other contaminants from surfaces to be patched. Use cleaning agent where required.

   5. Clean areas to be patched with oil-free air or water under pressure, except as otherwise recommended by the mortar manufacturer.

3.2 COATING REBAR

A. Coat reinforcing as soon as possible after completion of surface preparation.

B. Place reinforcement coating complying with manufacturers printed instructions.

C. When using a fast set repair mortar, coating must be cured or dry before placing the mortar, or use a fast set epoxy resin bonding agent compatible with the repair mortar.

3.3 PATCHING CONCRETE

A. Patch concrete as soon as possible after completion of surface preparation.

B. Mixing Repair Mortar: Comply with mortar manufacturer's printed instructions. Proportion components and sizes of aggregate as recommended by mortar manufacturer for the particular job conditions.

C. Patch concrete in accordance with the product manufacturer's printed instructions.
   1. Coat contact surfaces of existing concrete and steel reinforcing with a bonding agent/primer as recommended in the product manufacturer's instructions.

D. Bring patches out to the original surfaces in true planes. Finish patches to match texture of adjoining concrete as close as possible.

E. Cure patches in accordance with the product manufacturer's printed instructions.

F. Clean surface and apply surface applied corrosion inhibitor to the area.
   (Not required for Slab-on-Grade patches.)

3.4 CLEANING

A. Clean up spatters and droppings.

3.5 PROTECTION

A. Protect mortar after placement in accordance with the product manufacturer's printed instructions.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03 01 32

CRACK REPAIR BY EPOXY INJECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Structural repair of cracks in concrete by permanently rebonding the concrete with epoxy resin adhesive injected under pressure with special equipment.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Rehabilitation: Section 03 0131.

1.3 PERFORMANCE REQUIREMENTS

A. Seepage of water through cracks repaired under the repair work of this section will be regarded as defective work subject to the one year guarantee required by the General Conditions.

B. Work on this Contract shall conform to all requirements of ACI Specification 503.7-07, "Specification for Crack Repair by Epoxy Injection," published by the American Concrete Institute, Famington Hills, Michigan, except as modified by these Contract Documents."

1.4 SUBMITTALS

A. Product Data: Manufacturer's printed specifications and installation instructions for epoxy adhesive and surface seal material.

B. Quality Control Submittals:
   1. Test Reports:
      a. Submit reports for tests specified under Source Quality Control.
      b. If requested, submit test reports for all specified characteristics and properties of the epoxy adhesive materials from an Independent Testing Laboratory.
   2. Certificates: Epoxy adhesive manufacturer's written certification that each batch of epoxy adhesive material shipped for this Project complies with the requirements of these specifications.

1.5 QUALITY ASSURANCE

A. Installer's Qualifications: Epoxy injection shall be performed by a firm that is licensed or approved by the epoxy adhesive manufacturer to perform such work. In addition, the person supervising the epoxy injection shall be experienced in epoxy injection, and shall have been regularly employed for a minimum of five years by a company specializing in repairing cracks by epoxy injection.

1. If requested, furnish to the Owner the names and addresses of five similar projects for which the supervisor has supervised epoxy injection work.

B. Workers' Qualifications: Workers engaged in the repair work of this section shall have satisfactorily completed a program of instruction in the epoxy injection process. The instruction shall include this specific method of repairing cracks in concrete, the technical aspects of correct material use, and the operation, maintenance and checking of equipment.

C. Testing Agency: Tests for all specified characteristics and properties of the epoxy adhesive materials shall have been performed by a qualified Independent Testing Laboratory and copies of the test results shall be available. Tests indicated under Source Quality Control shall be performed by the adhesive manufacturer.

D. Source Quality Control: The following quality control tests shall be performed on each lot of epoxy adhesive materials supplied for this Project.
1. Resin viscosity at 77 degrees F and epoxide equivalent weight.
2. Hardener viscosity at 77 degrees F and amine value.
3. Combined components pot life at 77 degrees F.
4. Cured (for 7 days) adhesive ultimate tensile strength and tensile elongation at break; and slant shear strength for wet/wet concrete cured 3 days.

E. Material Container Labels: Material containers shall bear a manufacturer's label indicating manufacturer's name, trade name of product, lot number, shelf life of product, and mix ratio by volume.

F. Equipment for Injection: The injection equipment shall meter and mix the adhesive components, and inject the mixed adhesive into the cracks. Equipment shall be a portable, positive displacement type pump unit with interlock to insure exact ratio control of the two components at the nozzle. Unit shall have metering pumps, electrically or air powered, which will provide in-line metering and mixing of the adhesive components.

1. Discharge Pressure: The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi (within a tolerance of plus or minus 5 psi), and shall be equipped with a manual pressure control override.

2. Ratio Tolerance: The injection equipment shall have the capability of maintaining the volume ratio for the adhesive, as prescribed by the manufacturer of the adhesive, within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.

3. Automatic Shut-Off Control: The injection equipment shall have sensors on both component reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

1.6 DELIVERY AND STORAGE

A. Deliver materials to the site in original, sealed containers bearing manufacturer's label. Do not deliver materials which have exceeded shelf life limitation set forth by the manufacturer.

B. Comply with manufacturer's printed instructions for storing materials in original, sealed containers at a temperature between 32 degrees F and 90 degrees F.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Comply with manufacturer's recommendations for conditions under which materials can be applied.

PART 2 PRODUCTS

2.1 MATERIALS

A. Epoxy Adhesive: Two component, low viscosity, epoxy resin adhesive system containing 100 percent solids, with no solvents or non-reactive diluents and shall comply with ASTM C-881 and AASTHO M-235. Acceptable systems and product manufacturers are provided to establish product generic type and standard of quality:
   1. Sikadur 35, Hi-Mod LV injection resin with Sikadur 31 or Sikadur 33 sealing paste adhesive by Sika Corporation, 800-933-7452.
   2. Eucopoxy Injection resin with Euco #452 sealing gel by Euclid Chemical Company, 800-321-7628.
   3. Pro-Poxy 100 injection resin with Pro-Poxy 300 sealing paste by Dayton Superior / Unitex, 800-977-9600.

B. Surface Seal: Material with adequate strength and adhesion to hold injection fittings firmly in place and to prevent leakage of epoxy adhesive during injection, and removable without damaging or defacing structure being repaired.

C. Finishing Patching Materials: As required to match color, texture, and performance of adjoining surfaces as closely as practicable.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean cracks and adjacent surfaces free of loose material, dust, dirt, grease, oil, efflorescence, and other foreign matter in accordance with epoxy adhesive manufacturer's printed instructions and as required for proper bonding of surface seal. Do not use acids or corrosives.

B. Inspect each crack noted for repair to determine its width, condition, and potential daily movement. Measure cracks when they will be at their widest during the day. Do not repair any crack that is less than 0.13 mm (0.005 in.) at its widest point.

C. Remove fines, dirt, and moisture from cracks with compressed air or water injected under pressure. If necessary, drill holes to intersect a crack below observed contamination to determine if it is injectable and if it will obtain satisfactory bonding of the two sides of crack.

D. Establish entry ports along each crack spaced at intervals not greater than the thickness of the concrete member being repaired.

E. Apply surface seal material to the face of each crack between the entry ports as required to prevent escape of injected epoxy adhesive. For cracks all the way through the concrete member, apply surface seal to both faces of cracks where accessible. Provide ports on the opposite face to demonstrate full penetration of the crack with resin for thin or narrow members. Allow sufficient time for the surface seal material to gain adequate strength before proceeding with epoxy injection.

F. If cracks extend into moving joints, plug or seal off the cracks at the joints.

3.2 EPOXY INJECTION

A. Set up and check injection equipment and material in accordance with the manufacturer's instructions and as specified in ACI 503.7. Do not thin epoxy adhesive.

B. Beginning at the lowest entry port in the crack, unless otherwise recommended by the installer because of the configuration of the crack, inject epoxy adhesive in the entry port until there is an appearance of adhesive at the next adjacent entry port.

When epoxy adhesive travel is indicated at the next adjacent port, discontinue injection in the port, seal off the port, and resume injection in the next adjacent port. Continue this procedure until the crack has been injected full of epoxy adhesive for its entire length in one continuous operation. For horizontal cracks, proceed from one end of the crack to the other end in the same manner. Seal the last port, and allow the adhesive to cure. Hold pressure constant at last port for at least 5 minutes with no pressure drop or cycling of pump to insure complete filling with epoxy.

C. If port to port travel of epoxy adhesive does not result after a reasonable amount of pumping, stop injecting adhesive. Report abnormal conditions (if any) immediately to the Owner's Representative and Engineer for evaluation.

3.3 FINISHING

A. Remove surface seal and entry port fittings when epoxy adhesive has sufficiently cured to allow removal without disturbing the adhesive.

B. Fill the face of the crack out flush with the concrete surface plane with patching materials. Eliminate indentations and evidence of port fittings. Finish patches to match texture of adjoining concrete surface as closely as practicable.

3.4 FIELD QUALITY CONTROL

A. Furnish equipment necessary to perform field testing.

B. Pressure and RatioTests: Perform the pressure and discharge tests specified in ACI 503.7 for each injection equipment unit.

C. Frequency of Pressure and Ratio Tests: Perform a pressure test and ratio tests for each injection equipment unit at the beginning of each shift and any time the unit is used after a 4-hour or long shutdown period. If the ratio of the two components is not within specified tolerance, stop injection work unit the equipment is brought into compliance.

D. Perform and pass the Qualification tests for mixing effectiveness of equipment according to paragraph 1.5.3 of ACI 503.7 before the start of test injection work of paragraph 1.5.4 of ACI 503.7, by repairing a test crack selected by the Owner's Representative or the Engineer.

3.5 CLEANING

A. Remove adhesive runs and spills from existing surfaces by a method which will not deface the surfaces being cleaned.

B. Recoat painted surfaces to match the original coating if damaged by runs and spills of epoxy during this repair.

END OF SECTION

SECTION 03 10 00

CONCRETE FORMWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Provide concrete formwork for structural concrete as specified to form concrete to profiles shown.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 20 00 - Concrete Reinforcement
2. Section 03 15 00 - Concrete Accessories
3. Section 03 31 00 - Cast-In-Place Concrete

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ACI 318 - Building Code Requirements for Reinforced Concrete
2. ACI SP-4 - Formwork for Concrete
3. ACI 303R - Guide to Cast-in-Place Architectural Concrete
4. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials
5. ACI 301- Specifications for Structural Concrete for Buildings
6. ACI 347- Recommended Practice for Concrete Formwork

1.3 SUBMITTALS

A. Construction Joints: Submit diagrams of construction joints.

B. Product Data:
1. Form oil
2. Form release agent
3. Form sealer

1.4 QUALITY ASSURANCE

A. Formwork Compliance: Use formwork complying with ACI SP-4 and ACI 303R.
B. Design and construct forms to withstand stresses due to weight of fresh concrete, vibration during consolidation and loads of equipment and workmen. Comply with ACI 318.

C. Limit deflections of forms to provide smooth, straight surfaces without unsightly bulges and deformations.

1.5 DELIVERY, STORAGE AND PROTECTION

A. Store materials off of the ground and protected from weather.

1. Prevent warpage, twisting and excessive moisture gain of wood materials.
2. Discard damaged or deformed materials.

B. Protect smooth faces of form liner materials from abrasion, denting or scarring during handling.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Release Agent
   Magic Kote VOC by Symons Corporation
2. Form coating
   A.C. Horn Corporation, Brooklyn, NY
3. Form liners
   Dura-Tex by Symons Corporation, Des Plaines, IL
4. Form ties
   a. Water Retaining Structures and Below Grade Structures: Symons, S-Panel Ties, or equal, with water seal and one (1) inch break back cones on both tie ends, shall be used on all wall forms.
   b. Other Structures: Symons, S-Panel Ties, or equal, with one (1) inch break back cones on both tie ends, unless otherwise called out or shown in the DRAWINGS or approved by ENGINEER, shall be used on all wall forms.
5. Rustications
   Symons Corporation, Des Plaines, IL

2.2 MATERIALS

A. Forms for unexposed concrete surfaces: plywood, lumber, metal or another acceptable material. Provide lumber dressed on at least two edges and one for tight fit.

B. Forms for concrete surfaces exposed to view: plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth exposed surfaces. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown on drawings. For plywood, use one of the following:

1. Overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
2. Concrete form plywood, complying with U.S. Product Standard PS-1 "B-B Plywood, Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

C. Forms for sidewalks and paving: nominal 2-inch thick wood or steel secured in place by stakes or pins.

D. Structural Concrete: Provide structural concrete form materials as follows:

1. Obtain approval for form material before construction of the forms.

2. Use a barrier type form release agent.

3. Use form ties, hangers, and clamps of such type that, after removal of the forms, no metal will be closer than 1.5 inch from concrete surface. Wire ties will not be permitted.

4. Provide ties with swaged washers or other suitable devices to prevent seepage of moisture along the ties. Leave the ties in place.

5. Twisted Wire Ties: Twisted wire ties with loops to hold forms in position are not permitted.

6. Use lugs, cones, washers, or other devices which do not leave holes or depressions greater than 7/8-inch in diameter.

PART 3 EXECUTION

3.1 DESIGN

A. Design Responsibility: Be responsible for the design, engineering and construction of the architectural concrete formwork and the structural concrete formwork. Conform the work to the recommendations of ACI SP-4 and ACI 303R.

B. Setting Time and Slag Use: The presence of fly ash or ground granulated blast furnace slag in the concrete mix for architectural concrete and structural concrete

will delay the setting time. Take this into consideration in the design and removal of the forms.

C. Responsibility during Placement: Assume and take sole responsibility for adequate design of all form elements for support of the wet concrete mixtures specified and delivered.

D. Consistency: Design forms to produce concrete members identical in shape, lines and dimensions to members shown.

3.2 CONSTRUCTION DETAILS FOR FORMWORK

A. Structural Concrete Details: Follow the following details for all structural concrete:

1. Provide forms which are substantial, properly braced, and tied together to maintain position and shape and to resist all pressures to which they may be subjected. Make forms sufficiently tight to prevent leakage of concrete.

2. Determine the size and spacing of studs and wales by the nature of the work and the height to which concrete is placed. Make forms adequate to produce true, smooth surfaces with not more than 1/8-inch variation in either direction from a geometrical plane. Provide horizontal joints which are level, and vertical joints which are plumb.

3. Supply forms for repeated use in sufficient number to ensure the required rate of progress.

4. Thoroughly clean all forms before reuse and inspect forms immediately before concrete is placed. Remove deformed, broken, or defective forms from the work.

5. Provide temporary openings in forms at convenient locations to facilitate cleaning and inspection.

6. Coat the entire inside surfaces of forms with a suitable form release agent just prior to placing concrete. Form release agent is not permitted on the reinforcing steel.

7. Assume and take responsibility for the adequacy of all forms and remedying any defects resulting from their use.

B. Construction Joints:

1. Locate construction joints only where required as shown on submittals.

a. Construction joints shall be plumb and level. In order to avoid irregular lines at horizontal construction joints in exposed concrete faces, tack a continuous strip of dressed lumber, one inch thick, to inside of wall or grade beam form, with its lower edge at line of construction joint. About one hour after placing concrete in lower part of wall or grade beam, remove strip, level off irregularities which appear in joint line with wood float and remove any laitance present.

b. Provide shear keys and waterstops as required in construction joints.

3.3 FORM REMOVAL

A. Structural Concrete Form Removal: Do not remove forms for structural concrete until the concrete has hardened sufficiently to support its own load safely, plus any superimposed load that might be placed thereon. Leave the forms in place for the minimum length of time indicated below or until the concrete has reached the minimum strength indicated as determined by testing, whichever time is reached first.

1. The times indicated represent cumulative days or hours, not necessarily consecutive, during which the air surrounding the concrete is above 50 degrees F. These times may be decreased if reshores are installed.

		Minimum Time	Minimum Strength (psi)
a.	Columns	24 hrs.	1800
b.			
c.	Side forms for girders and beams	24 hrs.	1800
d.	Walls	24 hrs.	1800
e.	Bottom forms of slabs		
	Under 10 feet clear span	4 days	2300
	10 to 20 feet clear span	7 days	2700
	Over 20 feet clear span	10 days	2900
f.	Bottom forms of beams and girders		
	Under 10 feet clear span	7 days	2700
	10 to 20 feet clear span	14 days	3000
	Over 20 feet clear span	21 days	3500

2. Increase form removal times as required if concrete temperature following placement is permitted to drop below 50 degrees F or if fly ash or ground granulated blast furnace slag is used in the concrete mix.

3. Withdraw the removable portion of form ties from the concrete immediately after the forms are removed. Clean and fill holes left by such ties with grout as specified in Cast-In-Place Concrete, Subsection Structural Concrete Surfaces.

4. Plug tie holes flush with the surface using portland cement mortar. Prewet tie holes with clean water and apply a neat cement slurry bond coat. Densely tamp mortar of a dry-tamp consistency into the tie holes exercising care so as not to smear mortar onto the finished concrete surface. Include sufficient white cement in the mortar mix to cause the plugged holes to blend in with the adjacent surfaces. Make sample patches with different mixes to assure that this requirement is met.

3.4 RESHORING

A. Reshoring Method: Develop a system for reshoring and early removal of forms, in the event early stripping of forms becomes necessary. Include details and schedules in this system for each element which is to be reshored.

B. Construction Load Support: Do not support construction loads upon any unshored portion of the structure exceeding the structural design loads.

3.5 TOLERANCES

A. Tolerance Limits: Design, construct and maintain concrete form and place the concrete to provide completed concrete work within the tolerance limits set forth in ACI SP-4.

3.6 SURVEY OF FORMWORK

A. Field Survey: Employ an engineer or surveyor to check by instrument survey the lines and levels of the completed formwork before concrete is placed and make whatever corrections or adjustment to the formwork are necessary to correct deviations from the specified tolerances.

B. Placement Surveying Requirements: Check formwork during the placement of the concrete to verify that the forms, braces, tie rods, clamps anchor bolts, conduits, piping, and the like, have not been knocked out of the established line, level or cross section by concrete placement or equipment.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03 15 00

CONCRETE ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing concrete accessories shown and specified herein such as waterstops, dovetail anchor slots, cast-in-place reglets, inserts, joint filler, preformed joint seal, joint sealant and neoprene pads.

B. Products Installed: Waterstops, dovetail anchor slots, cast-in-place reglets, inserts, joint filler, preformed joint seal, joint sealant and neoprene pads.

C. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 20 00 - Concrete Reinforcement
3. Section 03 31 00 - Cast-in-Place Concrete

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AASHTO - Standard Specifications for Highway Bridges
2. ASTM A 240 - Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
3. ASTM A 536 - Standard Specifications for Ductile-Iron Castings
4. ASTM D 412 - Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
5. ASTM D 3545 - Test Methods for Alcohol Content and Purity of Acetate esters by Gas Chromatography
6. ASTM D 3575 - Test Methods for Flexible Cellular Materials Made From Olefin Polymers
7. CRD-C513 - Specifications for Rubber Waterstops

8. CRD-C572 - Specifications for Polyvinyl Chloride Waterstop

9. Fed. Spec. TT-S-00227 - Sealing Compound, Elastomeric Type, Multicomponent (for Calking, Sealing, and Glazing in Buildings and Other Structures)

10. Fed. Spec. TT-S-00230 - Sealing Compound, Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures)

1.3 SUBMITTALS

A. General: Provide all Work related submittals, including the following, as specified in Division 1.

B. Product Data and Information:

1. Manufacturer's Data and Specifications: Submit printed manufacturer's data and specifications for each item used on this project.

2. Samples: Provide one sample of each item used.

3. Joint Sealant and Preformed Joint Seal: Indicate special procedures, surface preparation and perimeter conditions requiring special attention. All products in contact with potable water, shall be "NSF Standard 61" certified. Submit certified material records indicating approval for use with potable water.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 and as follows:

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Joint Filler

a. Sonoflex F Foam by Sonneborn Building Products

b. PVC Joint Filler No. 327 by A.C. Horn

2. Sealant Backup Material

a. Sealtight Backer Rod
b. Sonofoam Backer Rod

3. Preformed Joint Seal

a. Evazote 380, ESF by Epoxy Industries

4. Wedge Inserts

a. Type F-7 by Dayton Superior, Miamisburg, OH

5. Dovetail Anchor

a. A.A. Wire Products Co.
b. Dur-O-Wal Inc.

6. Flashing Reglets

a. Standard reglets by Beehive Anchoring System

2.2 MATERIALS

A. Extruded Waterstops: Provide waterstops made of extruded polyvinyl chloride unless otherwise shown or specified.

1. Do not use any reclaimed plastic material in their manufacture.

2. Provide plastic waterstops meeting the requirements of CRD-C572, except as modified herein. Provide a Shore A/10 durometer hardness between 73 and 79, the tensile strength not less than 1850 psi, and specific gravity not more than 1.38.

3. Unless otherwise shown, use waterstops for construction joints which are flat, at least 6 inches wide, and not less than 3/8-inch thick at the thinnest section. Provide these waterstops with ribbed longitudinal strips.

4. Unless otherwise shown, provide waterstops for expansion joints at least 9 inches wide and not less than 1/4-inch thick at the narrowest point and not less than 3/8-inch thick immediately adjacent to the center of the waterstop. Provide the waterstop with ribbed longitudinal strips with a 3/4-inch inside diameter hollow bulb center. Limit joint movement to 1/4-inch under a tensile force of not more than 500 pounds per lineal inch.

B. Stainless Steel Waterstops: Provide stainless steel waterstops where shown or specified.

1. Fabricate stainless steel waterstops from ASTM A 240 Type 316, 20 gauge stainless steel, conforming to the dimensions and profiles shown.

2. Prefabricate and miter corners and intersections for all stainless steel waterstops. Make only butt joints in the field.

C. Rubber Waterstops: Provide rubber water stops where shown or specified.

1. Provide rubber water stops of either the molded or extruded type, fabricated from a high grade tread type compound, either SBR or natural rubber, conforming to CRD-C513.

2. Provide water stops for construction joints at least 6 inches wide and 3/8-inch thick and with solid end bulbs 3/4-inch in diameter.

3. Provide water stops for expansion joints 9 inches wide and 3/8-inch thick and with solid end bulbs 1-inch in diameter and a hollow center bulb 1-1/2 inches in diameter with a 3/4-inch diameter center cavity.

D. Expansion Joint Filler: Use joint filler for all expansion joints.

1. Provide a closed cell polyethylene or PVC joint filler of the thickness shown.

E. Joint Sealant Requirements: Finish expansion joints with a joint sealant where shown or specified.

1. Joint sealant materials may be either a single component urethane compound meeting the requirements of Fed. Spec. TT-S-00230C, or a 2-component urethane compound meeting the requirements of Fed. Spec. TT-S-00227E, except as modified in this specification.

2. Provide the urethane sealant of 100 percent polymer, non-extended, containing no solvent, lime, or coal tar. Color as selected by the ENGINEER, but not black. Conform sealant properties to the following:

	Property	Value	Test Method
a.	Maximum final cure	3 days	--
b.	Minimum tensile strength	140 to 200 psi	ASTM D 412
c.	Minimum elongation	400%	ASTM D 412

d.	Modulus at 100% elongation	40-60 psi	ASTM D 412
e.	Shore A hardness	25-40	ASTM D 2240
f.	Solid content	98-100%	--
g.	Peel strength	20-40 lb/in.	Fed. Spec. TT-S-00230C Fed. Spec. TT-S-00227E
h.	Minimum recovery	80-90%	Fed. Spec. TT-S-00230C Fed. Spec. TT-S-00227E
i.	Initial tack-free cure	24-48 hrs.	Fed. Spec. TT-S-00230C Fed. Spec. TT-S-00227E

3. Provide primer as recommended by the manufacturer of the sealant, subject to approval.

4. Provide fillers and backup materials in contact with sealant which are nonimpregnated and free from asphalt, creosote, oil or extractable plasticizers. Use a backup material of a closed cell polyethylene foam rod with a diameter 1/4-inch larger than the joint width.

F. Preformed Joint Seal: Provide a preformed joint seal where shown or specified.

1. Provide joint material which is resilient, non-extrudable, impermeable, closed-cell, cross-linked, ethylene vinyl acetate, low density, polyethylene copolymer, nitrogen blown material which is ultraviolet light, weather and wear resistant, and which is concrete beige in color.

2. Conform material properties with the following:

	Property	Value	Test Method
a.	Density, pcf	2.8 to 3.4	ASTM D 3575 Suffix: W, Method A
b.	Water Absorption total immersion 3 months	0.02% by volume	ASTM D 3575 Suffix: L
c.	Tensile Strength	125 psi	ASTM D 3575 Suffix: T
d.	Elongation before breaking	255%	ASTM D 3575 Suffix: T
e.	Working Temperature	-94 to 160 F	--

G. Neoprene Pads: Use neoprene pads as shown or required where slabs or beams must be prevented from bonding to footings, walls, columns or other rigid parts of the structure.

1. Use neoprene pads of a structural grade meeting the requirements of Section 25, Division 2 of the AASHTO Standard Specifications for Highway Bridges.

2. Do not use neoprene pads thinner than 1/4-inch.

H. Wedge Inserts: Make wedge inserts for 5/8-inch and 3/4-inch bolts of ductile iron conforming to ASTM A 536.

I. Dovetail Anchors: Provide dovetail anchors of one of the following types:

1. Dovetail anchors having a 3/16-inch by 1-inch by 1/2-inch stainless steel dovetail section with 3/16-inch diameter stainless steel wire.

2. Dovetail anchor slots of 24 gauge galvanized steel 1-inch by 1-inch by 5/8-inch throat. Fill anchor slots.

J. Flashing Reglets: Provide flashing reglets of 24 gauge galvanized steel foam filled reglets.

PART 3 EXECUTION

3.1 INSTALLING OF WATERSTOPS

A. Assembly of Extruded Waterstops: Prefabricate corners and intersections for all waterstops. Make only butt joints in the field. Miter and assemble corners and intersections with approved equipment, as described for field joints.

1. Make field joints by cutting the ends of the sections to be spliced so they will form a smooth even butt joint. Heat the cut ends with the splicing tool until the plastic melts. Press the two ends together until the plastic cools. Do splicing in a way that limits damage to the continuity of the ribbed strips.

2. Carry waterstops in the walls into lower slabs and join them to the waterstops in the slabs. Make all waterstops continuous. Set waterstops accurately to the position and line shown. Hold edges securely fixed in position at intervals of not more than 24 inches so that they will not move during the placing of the concrete. Do not drive nails through the waterstops.

B. Prefabricated Stainless Steel Waterstops: Prefabricate corners and intersections for all stainless steel waterstops. Make only butt joints in the field. Miter and weld corners and intersections.

1. Provide field joints having a nominal 1-inch lap joint, with the exposed edge welded or brazed on each side.

2. Make field joints with PVC waterstops as shown.

3. At expansion joints, seal the base of the expansion section of the waterstop with at least one layer of 2-inch wide duct tape.

4. Carry waterstops in the walls into lower slabs and join them to the waterstops in the slabs. Make all waterstops continuous. Set waterstops accurately to the position and line shown. Hold edges securely fixed in position at intervals of not more than 24 inches so that they will not move during the placing of the concrete. Do not drive nails through the waterstops.

C. Splices: Use splices made in the manufacturer's plant where possible for rubber waterstops.

1. Use a preformed rubber union or fitting and splicing cement as recommended by the manufacturer when splices are made.

2. Carry waterstops in the walls into lower slabs and join them to the waterstops in the slabs. Make all waterstops continuous. Set waterstops accurately to the position and line shown. Hold edges securely fixed in position at intervals of not more than 24 inches so that they will not move during the placing of the concrete. Do not drive nails through the waterstops.

D. Joint Filler Placement: Place joint filler for expansion joints against the completed portion of the work before the concrete for the next section is placed.

1. Fasten the filler to the hardened concrete with a compatible adhesive in accordance with manufacturer's instructions. Extend the filler through the thickness of the wall or slab and make it flush with the finished surface, except where a preformed joint seal or joint sealant is shown.

2. In joints having a waterstop, fit the filler accurately on each side of the waterstop to prevent the intrusion of concrete.

E. Preparation of 2-Component Sealants: Mix 2-component joint sealant using a slotted paddle and slow speed mixer for 5 to 8 minutes, continually working paddle from top to bottom until the sealant color is uniform. Scrape down the side of the container and paddle blade several times during the mixing operation to ensure uniform mixing.

1. Properly prepare joint surfaces by removing all foreign matter and concrete laitance so that concrete surfaces are structurally sound, clean, dry, and free of all oil, grease, wax, waterproofing compounds or form release materials prior to the application of primer and sealant.

2. Prime all concrete joint surfaces and all surfaces exposed to water prior to sealing, with no exceptions. Prime all other surfaces as recommended by the manufacturer of the sealant. Provide the prime as recommended by the manufacturer of the sealant, subject to approval. Apply the primer by either brushing or spraying on the joint surfaces. Apply and install the sealant within 2 to 24 hours after the application of primer.

3. For horizontal joints, install the sealant by pouring directly from a suitable shaped can or by flowing from a bulk-loading gun.

4. Fill vertical joints from a gun, starting from the bottom, to avoid bridging and the formation of air voids.

5. Fill overhead joints from a gun, by laying a bead along each side of the joint and then filling the middle. Immediately after installation, tool in the sealant in order to establish firm contact with joint surfaces and to provide a smooth sealant surface. Tool in accordance with the manufacturer's instructions.

6. Control joint depth with the use of joint fillers and backup materials. Make joint widths and sealant depths as shown. Do not exceed 1/2-inch for sealant depth.

F. Preformed Joint Seal Surface Preparation: Properly prepare joint surfaces by removing all foreign matter and concrete laitance so that concrete surfaces are structurally sound, clean, dry, and free of all oil, grease, wax, water-proofing compounds or form release materials.

1. Blast clean or saw cut all existing concrete surfaces to expose a clean bare concrete surface. Allow new concrete to be well cured, and attain a minimum of 80 percent of the specified strength before installing sealant.

2. Apply bonding adhesive, as recommended by the manufacturer to the concrete surfaces in strict compliance with the manufacturer's recommendations. Install the joint material under a compression of 25 percent and in one continuous operation, in accordance with manufacturer's recommendations. Do all splices and directional changes using heat welding method as recommended by the manufacturer.

G. Unbonded Joints: Use unbonded horizontal joints as shown or required where slabs of beams must be prevented from bonding to footings, walls, columns or other rigid parts of the structure.

1. Prevent bonding by use of structural grade neoprene pads placed over the bearing surface of the footing, wall or other supporting part of the structure so as to isolate it from the new concrete being placed.

H. Encasing Inserts: Encase wedge inserts, flashing reglets and dovetail anchor slots in the concrete as shown. Take special care to place and maintain them to the proper lines and grades and to compact concrete thoroughly around them to prevent the passage of water. Set these items before placing concrete and thoroughly brace them to prevent movement during the progress of the work. Provide dovetail anchor slots spaced not more than 16 inches apart for all concrete walls faced with masonry.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing concrete reinforcement as shown and specified herein. Reinforcement includes all steel bars, wire and welded wire fabric as shown and specified.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 31 00 - Cast-In-Place Concrete

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ACI SP66	-	ACI Detailing Manual
2.	ACI 318	-	Latest edition "Building Code Requirements for Reinforced Concrete"
3.	ASTM A 185	-	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
4.	ASTM A 615/A615M	-	Deformed and Plains Billet-Steel Bars for Concrete
5.	ASTM A 706/A706M	-	Low Alloy Steel Deformed Bars for Concrete Reinforcement
6.	ASTM A 775/A775M	-	Epoxy Coated Reinforcing Steel Bars
7.	AWS D1.4	-	Structural Welding Code - Reinforcing Steel

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

1. Product Data and Information: Submit manufacturers literature with product data, and material description of fusion bonded epoxy coating for reinforcement and reinforcement accessories, including manufacturer's recommendations for field touch-up of mars and cut ends.

2. CONTRACTORS' Shop Drawings: Submit checked Working Drawings, including bar lists, schedules, bending details, placing details and placing plans and elevations for fabrication and placing reinforcing steel conforming to "ACI Detailing Manual - 2004".

    a. Do not bill wall and slab reinforcing in sections. Show complete elevations of all walls and complete plans of all slabs, except that, when more than one wall or slab are identical, only one such elevation or plan is required. These plans and elevations need not be true views of the walls or slabs shown. Bill every reinforcing bar in a slab on a plan. Bill every reinforcing bar in a wall on an elevation. Take sections to clarify the arrangement of the steel reinforcement. Identify all bars, but do not bill on such sections.

    b. For all reinforcing bars, unless the location of a bar is clear, give the location of such bar or bars by a dimension to some structural feature which will be readily distinguishable at the time bars are placed.

    c. Make the reinforcing steel placing drawings complete for placing reinforcement including the location of support bars and chairs, without reference to the design drawings.

    d. Submit Detailer certification that every reinforcing steel placing drawing and bar list is completely checked and corrected before submittal for approval.

    e. If, after reinforcing steel placing drawings and bar lists have been submitted for approval, a review reveals that the drawings and lists obviously have not been checked and corrected they will be returned for checking and correcting by the Detailer.

3. Samples: Submit the following samples when epoxy coated reinforcement is specified to be used.

    a. 12-inch long epoxy-coated steel reinforcing bar, of any size typical to this Project

    b. One of each type of epoxy-coated reinforcement accessory used on this Project

    c. 12-inch long, nylon coated tie wire

4. Certificates: Test certificates of the chemical and physical properties covering each shipment of reinforcing steel bars.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 (and as follows:)

1. Delivery Requirements: Have reinforcing steel delivered to the work in strongly tied bundles. Identify each group of both bent and straight bars with a metal tag giving the identifying number corresponding to the reinforcing steel placing drawings and bar lists.

2. Storage: Properly store all bars in an orderly manner, with all bars completely off the ground. Keep bars clean after delivery to the site of the work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Mechanical connections

a. Dowel Bar Splicer/Dowel-In System and Coupler Splice System of the Richmond Screw Anchor System

b. Cadweld Rebar Splice by Erico Products Inc.

c. Bar Grip Splice by Barsplice Products Inc.

2.2 MATERIALS

A. Steel Bars: Use new billet steel bars, deformed bars, meeting the requirements of ASTM A 615/A625M Grade 60 for reinforcing steel bars.

1. Roll all reinforcing steel bars with special deformations or identifying marks indicating the ASTM Specification and Grade.

2. Use bars free from defects, kinks and from bends that cannot be readily and fully straightened in the field.

3. Supply reinforcing bars in lengths which will allow convenient placement in the work and provide the required lap of joints as shown. Provide dowels of

proper length, size and shape for tying walls, beams, floors, and the like together.

B. Epoxy Coating: Conform fusion bonded epoxy coated reinforcing steel bars to ASTM A 775/A775M when used. Leave portions of the reinforcing steel bars uncoated where mechanical connections are shown.

C. Welded Wire Fabric: Use welded wire fabric of the electrically welded type, with wires arranged in rectangular patterns, of the sizes shown or specified and meeting the requirements of ASTM A 185.

D. Supports and Accessories: Provide bar supports and other accessories and, if necessary, additional supports to hold bars in proper position while concrete is being placed.

1. Use side form spacers against vertical or sloping forms to maintain prescribed side cover and cross position of bars.

2. Use individual hi-chairs with welded cross ties or circular hoops to support top bars in slabs thicker than 8 inches.

3. Bolsters, chairs and other accessories:

a. Use hot-dipped galvanized or provide plastic coated legs when in contact with forms for surfaces of concrete other than architectural surfaces.

b. Use stainless steel when in contact with forms for architecturally exposed surfaces.

c. Use epoxy coated bolsters, chairs and accessories including wire ties for epoxy coated reinforcing bars.

d. Use chairs of an approved type and space them properly to support and hold reinforcing bars in position in all beams and slabs including slabs placed directly on the subgrade or work mat. Do not use continuous hi-chairs for supporting of top bars in slabs over 8 inches in thickness.

E. Mechanical Connections: Provide mechanical connections that develop at least 125 percent of the specified yield strength of the bar in tension.

2.3 FABRICATION

A. Drawing Review Prior to Fabrication: Do not fabricate any material before final review and approval of shop drawings.

B. Bending and Cutting: Cut bars to required length and bend accurately before placing. Bend bars in the shop unless written approval for field bending is obtained. If field bending is permitted, do it only when the air temperature, where the bending operation is performed, is above 30 degrees F. Do not field bend bars which have been partially embedded in concrete.

C. Splices: Use lapped splices for tension and compression splices unless otherwise noted.

D. Cleaning: Clean and bend reinforcement in accordance with ACI 315 and ACI 318.

PART 3 EXECUTION

3.1 INSTALLATION

A. Placement: Place all bars in accordance with CRSI "Recommended Practice for Placing Reinforcing Bars".

B. Tolerances: Place bars used for top reinforcement in slabs to a vertical tolerance of plus or minus 1/4-inch. Place all other reinforcement to the tolerances given to ACI 318.

C. Cleaning: Have reinforcing steel delivered without rust other than that accumulated during transportation to the work. At all times, fully protect reinforcing steel from moisture, grease, dirt, mortar and concrete. Before being placed in position, thoroughly clean reinforcing steel of all loose mill scale and rust and of any dirt, oil, grease coatings, or other material that might reduce the bond. If there is a delay in depositing concrete, inspect and satisfactorily clean the steel immediately before the concrete is placed.

D. Bar Positioning: Place bars in the exact positions shown with the required spacing and cross wire bars securely in position at intersections to prevent displacement during the placing of the concrete. Fasten the bars with annealed wire of not less than 17 gauge or other approved devices.

E. Bar Extension Beyond Formwork: On any section of the work where horizontal bars extend beyond the length of the forms, perforate the form or head against which the work ends or at the proper places to allow the bars to project through a distance at least equal to the lap specified.

F. Unacceptable Materials: Do not place reinforcing steel with damaged, unsuitably bonded epoxy-coating or rusting. If approved, mars, exposed threads of mechanical connections and cut ends may be field coated with approved epoxy coating material.

G. Review of Placement: Have reinforcing placement reviewed by the ENGINEER before concrete is placed.

H. Welding - Not Approved: Do not use reinforcing bar assemblies made by welding of any kind, or accessories of any kind which require field welding to reinforcing bars.

I. Welding - Approved: Where welding of reinforcing steel is shown, AWS D1.4 "Structural Welding Code - Reinforcing Steel" applies.

J. Tension and Compression Lap Splices: Conform tension and compression lap splices to ACI 318 with all supplements. Avoid splices at points of maximum tensile stress wherever possible. Provide temperature bars with the clear spacing shown. Stagger all bar splices in hoop tension bars in circular tanks with not more than 50 percent of the bars spliced in any one direction. Have welded splices made by certified welders in accordance with AWS D1.4.

K. Welded Wire Fabric: Place welded wire fabric in the positions shown, specified or required to fit the work. Furnish and place suitable spacing chairs or supports, as specified for bars, to maintain the fabric in the correct location. Where a flat surface of fabric is required, provide flat sheets, when available. Otherwise reverse roll the fabric or otherwise straighten to make a perfectly flat surface before placing. Obtain approval for the length of laps not indicated.

L. Concrete Cover: Place reinforcing steel and welded wire fabric and hold in position so that the concrete cover, as measured from the surface of the bar or wire to the surface of the concrete, is as shown or specified.

END OF SECTION

SECTION 03 31 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Providing cast-in-place concrete as specified herein to form concrete to profiles as shown on the plans including the following work:

1. Setting of anchor bolts, base plates, floor grating and plate, frames, stop log grooves, and other steel and aluminum members embedded in concrete as indicated

2. Furnishing and setting of sleeves, inserts and other embedded accessories for mechanical and electrical equipment.

3. Furnishing concrete fill for steel pan stair treads, landings and associated items.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 20 00 - Concrete Reinforcement
3. Section 03 15 00 - Concrete Accessories
4. Section 03 60 00 - Grout

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ACI 212 - Chemical Admixtures for Concrete

2. ACI 301 - Specifications for Structural Concrete for Buildings

3. ACI 303R - Guide to Cast-In-Place Architectural Concrete

4. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete

5. ACI 305R - Hot Weather Concreting

6. ACI 306R - Cold Weather Concreting

7. ACI 308 - Practice for Curing Concrete

8. ACI 503R - Use of Epoxy Compounds with Concrete

9. ASTM C 31 - Practice for Making and Curing Concrete Test Specimens in the Field

10. ASTM C 33 - Specifications for Concrete Aggregates

11. ASTM C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens

12. ASTM C 42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

13. ASTM C 94 - Specifications for Ready Mixed Concrete

14. ASTM C 143- Test Method for Slump of Hydraulic Cement Concrete

15. ASTM C 150- Specifications for Portland Cement

16. ASTM C 157- Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

17. ASTM C 171- Specification for Sheet Materials for Curing Concrete

18. ASTM C 172- Practice for Sampling Freshly Mixed Concrete

19. ASTM C 173- Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method

20. ASTM C 309- Specification for Liquid Membrane-Forming Compounds for Curing Concrete

21. ASTM C 618- Specification for Coal Fly Ash and Raw Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

22. ASTM C 881- Specification for Epoxy-Resin-Base Bonding Systems for Concrete

23. ASTM C 989- Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

24. ASTM C 1116 - Specification for Fiber-Reinforced Concrete and Shotcrete

25. ASTM E 1155 - Standard Test Method for Determination of F_F

26. ASTM C 1218 - Test Method for Water-Soluble Chloride in Mortar and Concrete

27. ASTM C 1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

1. Notarized certificates of manufacture as evidence that the cement, fly ash and ground granulated blast furnace slag conform to the specified requirements. Include in these certificates the mill-test reports on the cement.

2. Samples of aggregates, sieve analyses and manufacturers data showing conformance to the specified requirements.

3. Concrete mix designs for each type of concrete.

4. Test reports for laboratory and field cured cylinders.

5. Air content tests in accordance with ASTM C 138 or C 173 with mix design data.

6. Drying shrinkage tests for each class of concrete with mix design data. Test shrinkage in accordance with Section 3.3.H.

7. Detailed field report records of ready-mixed-concrete.

8. Manufacturers' Literature: Material description and application or installation instructions for curing compound, vapor barrier, floor hardener, floor sealer, epoxy adhesives, synthetic fibers, admixtures, polymer modified nonsag mortar, and corrosion-resistant coatings.

9. Certified reports of tests made for maximum water soluble chloride ion concentration of design mix hardened concrete.

10. Test reports of floor flatness (F_F) and floor levelness (F_L) conforming to ASTM E 1155.

1.4 QUALITY ASSURANCE

A. Codes: The following specific codes and standards apply:

1. ACI 318 - Latest Edition, "Building Code Requirements for Reinforced Concrete".

2. ASTM - as referred to in the various subsections herein.

B. Testing Requirements: Testing laboratory provided by OWNER is responsible for conducting tests as required in Division 1.

C. Testing Assistance: Cooperate with the laboratory personnel, provide access to Work, and manufacturer's operations. Provide and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used which require testing.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 (and as follows:)

1. Cement: Store cement delivered in bulk to the batching plant in weathertight bins and batch using an appropriate weighing device, in accordance with ASTM C 94.

a. Store cement in weathertight buildings, bins or silos which will exclude moisture and contaminants. Do not use cement that has deteriorated from storage. Retest, before use, cement stored for a period longer than 6 months after the previous testing and reject it if it fails to meet all of the specified requirements. Do not use accepted cement that has been in storage for more than one year from the time of original acceptance.

b. Store cement delivered to the job site in strong, well-made bags plainly marked with the brand, name of manufacturer and net weight. Reject packages received in a damaged condition.

2. Aggregates: Keep aggregates clean and free from all other materials during transportation and handling. Keep them separated from each other until measured in batches and placed in the mixer.

a. Stockpile aggregates in a manner to prevent segregation unless finish screening is provided at the batch plant.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cement Requirements: Provide a cement which is a domestic product from an approved source. Use standard portland cement meeting the requirements of ASTM C 150 Type I or Type II.

1. Provide portland cement used in the manufacture of concrete pressure pipe which does not have an air-entraining agent. Also, use a nonplastic (0 slump) mix if portland cement without air-entraining agent is used in the manufacture of concrete sewer pipe.

B. Cementitious Material Requirements:

1. Fly Ash Requirements: Provide fly ash with a uniform light color from a source approved by the ENGINEER and with cementitious properties conforming to the requirements of ASTM C 618 Class C or F, with the following exceptions:

Loss on ignition - 5 percent maximum
Sulfur trioxide - 4 percent maximum

Store fly ash at the concrete mixing plant separate from the cement and do not intermix cement and fly ash prior to being added to the concrete mix.

2. Slag Requirements: Provide ground granulated blast furnace slag with cementitious properties conforming to the requirements of ASTM C 989, Grade 120, from an approved local product for normal weight concrete. Provide material having a uniform light color. Do not intermix cement and ground granulated blast furnace slag prior to being added to the concrete mix.

C. Synthetic Fiber Requirements: Provide synthetic fibers for inclusion in portland cement normal weight concrete of Caprolan -RC nylon fibers as manufactured by Allied Signal Inc., Petersburg, VA or approved equal.

1. Provide synthetic fibers exhibiting the following material, dimensional and strength characteristics:

a. Material: Nylon (100 percent)
b. Weight: 6 to 8 Denier per filament
c. Filament diameter: 23 microns
d. Specific gravity: 1.16
e. Fiber length: 3/4-inch minimum
f. Melting point: 435 degrees F
g. Tensile strength: 130,000 psi

h. Young's modulus: 750,000 psi
i. Toughness: 125,000 psi

2. Provide synthetic fibers manufactured by extrusion to the dimensions specified and not produced by slitting or chopping of sheet material or any other process.

D. Fine Aggregate Requirements: Provide fine aggregate of natural sharp sand meeting the requirements of ASTM C 33 for normal weight concrete, except as modified herein. Provide fine aggregate subjected to the test for organic impurities that will not produce a color darker than standard.

1. Provide fine aggregate meeting the requirements of the soundness test set forth in Paragraph 7.1 of ASTM C 33. The exceptions stated in Paragraphs 7.2 and 7.3 do not apply.

E. Coarse Aggregate Requirements: Provide coarse aggregate consisting of crushed stone, processed from natural rock or stones, meeting the requirements of ASTM C 33 for normal weight concrete.

1. The limits for deleterious substances and physical property requirements given in Table 3 of ASTM C 33 apply for each concrete class designation without exception.

2. Grade coarse aggregate according to Size No. 467 or No. 57 in Table 2 of ASTM C 33 for Class C concrete and Size No. 57 for Class B concrete.

F. Lightweight Aggregate Requirements: Provide lightweight aggregate meeting the requirements of ASTM C 330 for Class E Concrete as defined in Section 2. Design Mix.

G. Admixture Use: Limit the use of admixtures to the following:

1. Air-entraining admixture conforming to ASTM C 260

2. Water-reducing admixture conforming to ASTM C 494 Type A

3. Water reducing set retarders conforming to ASTM C 494 Type D

4. Use water-reducing and set-retarding admixtures only after obtaining written permission. Provide test data indicating that the concrete containing the admixtures has improved workability and does not show any abnormal behavior such as premature stiffening or slump loss for at least 30 minutes after mixing has been completed, or any other abnormal differences when compared with concrete made without the admixture. Base such test data on fresh concrete from the proposed supplier, using batching equipment proposed for use on the project.

5. Do not use admixtures containing calcium chloride, thiocyanates or more than 0.05 percent chloride ion. Obtain written conformance to the above requirements and the chloride ion content of each admixture from the admixture manufacturer prior to mix design review.

6. When more than one admixture is used, dispense each admixture separately into the mix, and at different times during mixing, in accordance with the recommendation of ACI Committee 212. After system approval, make no changes in batching equipment or concrete constituents without approval.

H. Water: Use clean water in mixing concrete which does not contain deleterious amounts of acids, alkalies or organic materials, furnished only from water from approved sources.

I. Curing Covers: Provide water curing blankets consisting of an outer covering of burlap or cotton or other approved material, and needled, punched or sandwiched inner layer of cotton batting or other approved material, in all weighing not less than 20 ounces per square yard. Use curing blankets by Midwest Canvas Corporation, Chicago, Illinois, by Max Katz, Indianapolis, IN or approved equal.

1. Use curing water having a temperature that is within 20 degrees F of the concrete's surface temperature.

J. Waterproof Paper and Film: Provide waterproof paper or polyethylene film both meeting the requirements of ASTM C 171 for use as sheet material curing covers.

1. Provide waterproof paper consisting of one ply of an approved type of fiber, reinforced waterproof building paper, consisting of cross fibers embedded in asphalt, between two layers of waterproof building paper, the whole being combined under heat and pressure to form a monolithic sheet.

2. Provide polyethylene film consisting of white opaque sheeting manufactured from virgin resin and containing no scrap or additives. Do not use a film of less than 4 mils in thickness.

K. Residual Acrylic Curing and Sealing Compound Membrane: Provide a clear curing and sealing compound: "Super Aqua-Cure VOX" by The Euclid Chemical Company; "Masterkure® N-Seal-HS" by ChemRex/ MBT®; or "Cure & Seal 1315" by Symons Corporation. Provide a compound of a clear styrene acrylate type, 25 percent solids content minimum, which shall have test data from an independent testing laboratory indicating a maximum moisture loss of 0.040 grams per square centimeter. when applied at a coverage rate of 300 square feet per gallon, in accordance with ASTM C 1315 Class A or Class B.

L. Dissipating Resin Type, Membrane Forming, Curing Compound: Provide a dissipating resin type curing compound, conforming to ASTM C 309 Type 1D Class B, "Kurez DR" with The Euclid Chemical Co., Resi-Chem Clear Cure by Symons or equal. Use film having a chemical break down of a four-to-six-week period.

M. Chemical Floor Hardener: Provide chemical floor hardener consisting of magnesium and zinc fluosilicate such as "Lapidolith as manufactured by L. Sonneborn Sons, Inc., "Saniseal" as manufactured by Master Builders Co., or Fluosilicate by Symons or equal.

1. Alternatively, where chemical hardening is required, substitute a natural, nonmetallic aggregate surface hardener at the time the floor is placed, in which case omit the latter application of chemical floor hardener. Obtain the hardening by incorporating into the surface of the freshly floated concrete a dry shake of Master Builders Mastercron Pre-Mixed, Procron as made by Protex Industries, Inc., Hard Top as made by Symons Corporation or equal, at the rate as recommended by the manufacturer. Perform all preparation, application procedures, curing and precautions in strict compliance with the manufacturer's recommendations and instructions submitted for approval prior to use. Use this material for interior applications only and limit air content for the design mix to 3 percent.

N. Nonslip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for nonslip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rust-proof, and nonglazing, and is unaffected by freezing, moisture, and cleaning materials.

O. Epoxy Adhesives: Provide epoxy adhesives as follows:

1. Sikadur 32 Hi-Mod by Sika Corporation, Richmond, VA or Euco 452 MV by Euclid Chemical Co., Cleveland, OH, Rescon 649 by Rescon Technology Corporation or equal. Use a two component, solvent-free, moisture insensitive, structural epoxy adhesive, conforming to ASTM C 881, Type I and II, Grade 2, Class B and C, epoxy resin adhesive.

2. Sikadur 31, Hi-Mod Gel by Sika Corporation, Richmond, VA or Euco No. 452 Gel by Euclid Chemical Co., Cleveland, OH, Rescon R306 by Rescon Technology Corporation or equal. Use a 2-component solvent-free, moisture insensitive, high modulus, high strength, structural epoxy paste adhesive, conforming to ASTM C 881, Type I and II, Grade 3, Class B and C, epoxy resin adhesive.

P. Nonsag Mortar: Provide Polymer Modified Nonsag Mortar as follows:

1. Sikatop 123 by Sika Corporation, Richmond, VA, Rescon R626 by Rescon Technology Corporation or equal. Use a 2-component, fast setting, nonsag, patching mortar, specifically formulated for application by trowel on vertical and overhead surfaces.

Q. Corrosion-Resistant Coating: Use Sika Armatec 110 by Sika Corporation, Richmond, VA, Rescon R-504 by Rescon Technology Corporation or equal as a corrosion-resistant coating.

2.2 DESIGN MIX

A. Concrete Mix Classifications: Furnish and place concrete of the type divided into various classes according to use and compressive strength.

1. Use Class A concrete for all precast concrete units.

2. Use Class B concrete for all reinforced concrete structures designed for high strength and watertightness; and for columns, walls, beams, slabs, stairs, and, in general, wherever formwork other than simple forms are required.

3. Use Class C concrete for all reinforced concrete structures designed for high strength and watertightness; and for bottoms of structures, electrical duct encasement, and, in general, where concrete is deposited directly on the bottoms of slopes of excavations and where only simple forms are required.

4. Use Class D concrete for low-strength concrete, plain or reinforced, used for work mats beneath structures, soil stabilization, pipe cradles and encasement, filling, and other similar purposes. Clean boulders or fragments of rock excavated during construction may be embedded in large volumes of Class D concrete to provide added bulk. Use care in placing the boulders or rock fragments so that there will be no voids in the concrete.

5. Use Class E concrete for sand/lightweight concrete slabs placed over metal decks.

B. Compressive Strength: Provide, as a minimum, the specified compressive strength of concrete in pounds per square inch for the classes previously described as follows. Designate the 28-day strength as f'_c.

Class	7-Day Test	28-Day Test
A	3,400	5,000
B	3,000	4,500
C	3,000	4,500
D	1,300	2,000
E	2,700	4,000

1. Proportion and produce concrete to provide an average 28-day compressive strength in excess of the specified compressive strength, f'_c. Base the required proportions on tests of cylinders made, cured and tested as specified.

2. Prepare mix designs for each type of concrete required and submit for approval. Concrete which will be placed by pumping methods will require a separate mix design and mix design approval, as described herein, in addition to the mix design approval required for other placement methods.

C. Concrete Proportions: Select concrete proportions to provide the required strength and durability and to provide workability and consistency so that the concrete can be worked into forms and around reinforcement without segregation or excessive bleeding.

1. Provide concrete for all structures which is watertight. Do not allow the maximum water-cementitious material ratio to exceed 0.45 by weight of the total cementitious constituent. Measure the quantity of water to be the total quantity, including free surface moisture contained in the aggregates.

2. Do not allow the amount of fly ash to exceed 20 percent by weight of the cement plus fly ash, while maintaining a minimum cement content of 450 pounds per cubic yard.

3. Do not allow the amount of ground granulated blast furnace slag contained in Class B and C concrete to exceed 30 percent by weight of the cement plus slag, while maintaining a minimum cement content of 450 pounds per cubic yard.

4. Provide Class B and C concrete which also contains a minimum of 1-pound of synthetic fibers per cubic yard. Conform fiber reinforced concrete to the requirements of ASTM C 1116 unless otherwise specified.

5. Establish concrete proportions including the water-cementitious material ratio on the bases of field experience or trial mixtures with the materials to be used in accordance with Section 5.3 of ACI 318.

6. Provide sand/lightweight concrete with a dry weight not more than 115 pounds per cubic foot.

D. Air Entrainment:

1. Provide Class A, B and C concrete with an average total air content of 5 percent. Allow a tolerance of plus or minus 1.5 percent on air content as delivered.

E. Slumps: When tested in accordance with ASTM C 143, provide a concrete mix design with slumps within the following limits:

Concrete Placement	Minimum and Maximum Slump in Inches	
	Class B, C and E	Class D
Normal	3 to 4	3 to 5
Pumped	4 to 6	4 to 6

1. Base the mix design slump on the concrete mix with water reducing admixture. For production concrete, allow no more than 1-inch increase in slump by use of specified water reducing admixtures. Measure slump at the end of the hose for pumped concrete.

2. Grade the combined aggregates for the design mix such that when a sample of the mix is separated on No. 4 standard sieve, the weight passing the sieve is not less than 30 percent nor greater than 40 percent of the total, unless otherwise specified.

F. Chloride Ion Concentration: Provide a maximum water soluble chloride ion concentration, percent by weight of cementitious materials, with two 28 day tests of design mix hardened concrete as follows:

1. Cast-in place concrete, exposed to moisture, water or sewage in service 0.10.

2. Cast-in-place concrete that will be dry or protected from moisture in service 1.00.

G. Shrinkage Control: Select materials and proportion mix to achieve an average 21 day drying shrinkage less than:

1. 0.036% for liquid-containing structures.

2. 0.048% for all other structures.

Provide one test (3 specimens) for each design mix in accordance with Section 3.3.H.

H. Measurement and Mixing: Measure and mix concrete in accordance with the recommendations of ACI 304R, as modified.

1. Measure cement, and fine and coarse aggregates separately by weight by equipment providing an accuracy within one percent of the net load weighed. Measure cement and water within 1 percent accuracy by weight. Measure aggregates within 2 percent accuracy. Measure admixtures within 3 percent accuracy by weight.

2. Use weighing equipment meeting the requirements of the United States Bureau of Standards. Make available standard testing weights and other necessary equipment at all times for testing the equipment.

3. Mix concrete in a rotary, batch-type mixer of adequate design to produce a thorough mix, homogeneous in composition and uniform in color. Mix each batch of one cubic yard or less not less than 1-1/2 minutes after the last of the ingredients have been added to the mixer. Increase the mixing time 15 seconds for each cubic yard or fraction thereof.

2.3 CONCRETE WORKMATS

A. As a working base for all new, reinforced-concrete structural foundation elements supported on soil, rock, select fill, backfill stone, drainage stone and the like, provide a Class D concrete workmat having a minimum thickness of 2 inches.

2.4 READY MIX CONCRETE

A. Ready Mix Requirements: For ready-mixed concrete meet the requirements of ASTM C 94, except as modified in the following paragraphs, and subject the mix to all provisions herein relative to materials, strength, proportioning, consistency, and testing. Article 18 of ASTM C 94, however, does not apply. In the event of low strengths, procedures outlined in Section 3.01 "Low Concrete Strength Test Results" apply.

B. Delivery: Provide the rate of delivery of the mixed concrete such that the interval between placing of fresh concrete in contact with concrete already placed from previous batches does not exceed 45 minutes. Do not allow the elapsed time between the introduction of mixing water to the cement and aggregates and depositing concrete in the work to exceed 60 minutes, including mixing and agitating time.

C. Agitation: Do not deliver concrete in nonagitating equipment.

D. Field Records: Prepare a detailed concrete field record in which the following information is identified:

1. Number of concrete batches produced.

2. Proportions of materials used.

3. Approximate location of final deposit of each batch in the structure.

4. Time and date of mixing and placing.

PART 3 EXECUTION

3.1 PLACING CONCRETE

A. General: Place concrete only in the presence of the ENGINEER. Where the procedure is not specified, place concrete in accordance with the recommendations of ACI 304R.

B. Continuous Operation: Place no concrete after its initial set has occurred, and do not use retempered concrete under any conditions. Make concreting operations continuous until the section, panel, or scheduled placement is completed. Should the concreting operations be unavoidably interrupted, provide construction joints formed at proper locations as specified.

C. Minimum Handling: Convey and place concrete with minimum handling and deposit the concrete in the forms as close as possible to its final position and in no case more than 5 feet in a horizontal direction therefrom. Do not rehandle concrete.

D. Horizontal Layers: Place concrete in horizontal layers shallow enough so that the previous layer is still soft when the next layer is added and the two layers can be vibrated together. Do not exceed 18 inches in depth for each layer.

E. Use of Chutes: Deposit wall and column concrete through heavy duck canvas or galvanized steel chutes equipped with suitable hopper heads. Provide chutes of variable lengths so that the free fall of concrete does not exceed 3 feet. Provide illumination where required, inside the forms so that the concrete is visible from the deck and runways at the point of deposit.

F. Protection Against Elements: Protect freshly placed exposed concrete against damage from the elements or other sources.

G. Hot Weather Placement: For placement of concrete during hot weather, follow the recommendations of ACI 305R.

1. Place no concrete if the temperature of the concrete at the time of placement exceeds 90 degrees F.

2. When the temperature of the concrete at the time of placement is consistently above 75 degrees F and a noticeable decrease in slump or an increase in mixing water demand occurs, use a retarding admixture, after obtaining written permission to do so.

3. Protect unformed surfaces of concrete placed during hot weather from drying by continuous moist curing for at least 24 hours. Start curing as soon as the concrete has hardened sufficiently to withstand surface damage. If moist curing is not carried beyond 24 hours, cover the surface while damp with a suitable heat-reflecting plastic membrane or spray exterior surfaces with a white pigmented dissipating curing compound in accordance with Section 3.5 Curing. Use curing water having a temperature that is within 20 degrees F of the concrete's surface temperature.

4. Protect formed surfaces of concrete placed during hot weather from drying as recommended in ACI 305 R.

H. Cold Weather Placement: For placement of concrete during cold weather, follow the recommendations of ACI 306R, except that set-accelerators will not be permitted.

1. Before placement of concrete, completely remove all ice, snow and frost from all surfaces to be in contact with the concrete. Do not place concrete on a frozen subgrade. Heat surfaces to be in contact with the concrete to a temperature as near as practical to that of the concrete being placed.

2. When mean daily temperatures at the site are below 40 degrees F provide concrete at a temperature, as placed, of not less than 50 degrees F, except for mass concrete provide a temperature of the concrete as placed of not less than 45 degrees F. Heat aggregates or mixing water or both to obtain these placement temperatures. Do not permit the concrete temperatures as mixed to exceed the placement temperature by more than 10 degrees F for air temperatures of 0 degrees to 30 degrees F, nor by more than 15 degrees F for air temperatures below 0 degrees F.

3. Maintain concrete in place at a temperature of 50 degrees F by keeping forms in place, covering with insulated blankets, heated enclosures or combinations of these for the following minimum time intervals, except that forms shall not be removed in less than the time specified in Section 03100.

a.	Footings and walls below grade and slabs on grade	2 days
b.	Exposed walls and columns carrying no load	3 days

c. Exposed floor slab, beams and girders above grade and partially loaded — 6 days

4. Protect exposed surfaces of new concrete from drying out. When dry heating is used for protection against low temperatures, cover exposed concrete surfaces with an approved sheet material or membrane as specified in Section 03310 subsection "Curing". Use water curing only if icing problems can be avoided. During periods of very cold weather, continue the protection against low temperature for an extended curing period as required to prevent freezing of the concrete.

5. Permit concrete which is to be exposed to freezing temperatures to undergo some drying just prior to and during the period of adjustment to ambient cold-weather conditions. When protection against low temperatures is removed, do not allow the resulting temperature drop in any part of the concrete to exceed 5 degrees per hour nor 40 degrees F for the first 24 hour period.

I. Concrete Embedments:

1. Encase pipes, anchor bolts, sleeves, steps, castings, floor drains, manhole frames, cast-in reglets, dovetail anchor slots, and other inserts in concrete as shown. Take special care to place and maintain them to the proper lines and grades and to compact concrete thoroughly around them to prevent the passage of water. Insofar as possible, set them before placing concrete and thoroughly brace to prevent movement during the progress of the work.

2. Space dovetail anchor slots vertically not more than 16 inches apart on all concrete walls faced with masonry.

3.2 VIBRATING CONCRETE

A. Use of Vibrators: Consolidate all concrete by means of mechanical internal vibrators applied directly into the concrete in a vertical position in accordance with the recommendations of ACI 309.

B. Vibrator Size: Provide a sufficient intensity and duration of vibration to cause concrete to combine with previously placed concrete, to fill corners, to compact thoroughly and to embed reinforcement, pipes, conduits, and similar work completely. Insert vibrators into and withdraw from the concrete vertically at close intervals. Do not use vibrators to move concrete laterally.

C. Spare Units: Have on hand a sufficient number of vibrators to assure that the incoming concrete can be properly compacted within 15 minutes after placing. Provide reserve vibrators for use when others are being serviced. Do not start the placement of any concrete unless more than one vibrator is available.

3.3 CONCRETE TESTS

A. Compression Testing: Test concrete test cylinders in compression at the laboratory designated.

B. Samples: Take samples for strength tests of laboratory cured cylinders for tests of each class of concrete placed each day consisting of four cylinders from the same batch of concrete. Test two cylinders at 7 days and two at 28 days. Determine concrete strength by the average of the two cylinder strengths determined at either age. Take samples not less than once a day nor less than once for each 150 cubic yards of concrete, or 5,000 square feet of area.

C. Field Curing: Take samples for field cured cylinders to determine concrete compressive strength for form removal time as required.

D. Laboratory Curing: Sample fresh concrete in accordance with ASTM C 172. Mold and laboratory cure cylinders for strength tests in accordance with ASTM C 31.

E. Slump Tests: Perform slump tests in accordance with ASTM C 143, at the same time cylinders are made. Make tests to determine air content of fresh concrete twice daily, at least 4 hours apart, in accordance with either ASTM 173 or with an approved testing device. Concrete with excessive slump or improper air content will be rejected. Deliver no additional concrete until the cause of the deficiency is determined and corrected.

F. Test Requirements: Test cylinders in accordance with ASTM C 39 for both the 7-day and the 28-day compressive strength.

G. Successful Testing Requirements: Consider the strength level of the concrete mix for each individual class of concrete satisfactory when:

1. The average of all sets of three consecutive 28-day strength tests (average of two cylinders) equal or exceed the specified compressive strength (f'_c).

2. No individual 28-day strength test (average of two cylinders) falls below f'_c by more than 500 psi.

3. If either of these requirements are not met, make changes in the mix proportions immediately to achieve the required strength.

H. Shrinkage Tests: Perform drying shrinkage test on each 1000 cubic yards placed. Test in accordance with ASTM C157, modified as follows:

1. Make three (3) 4-inch x 4-inch x 11-inch specimens for each test.

2. Remove specimens from molds at an age of 23 hours ∀ 1 hour. Immediately submerge in water at 73 degrees F ∀ 3 degrees F for at least 30 minutes and measure within 30 minutes thereafter to determine original length. Then immediately submerge in lime-saturated water in accordance with ASTM C 157. After 7 days, remove specimens from lime-saturated water and measure. Use this measurement as the base length to determine shrinkage deformation. After measuring, immediately store in a humidity-controlled room maintained at 73 degrees F ∀ 3 degrees F and 50% ∀ 4% relative humidity for the remainder of the test measurements. To determine shrinkage take measurements, expressed as percentage of base length, and report separately for 7, 14 and 21 days ∀ 4 hours.

3. Results of the drying shrinkage on test shall be reported to the nearest 0.001 percent. If drying shrinkage of any specimen deviates from the average for that test age by more than 0.004 percent, the results of that specimen shall be disregarded.

3.4 LOW CONCRETE STRENGTH TEST RESULTS

A. Test Cores: If it is determined that the serviceability of the concrete is significantly reduced by low concrete strength test results, take test cores from the area in question. Drill and test cores in accordance with ASTM C 42 except as noted. Take three cores for each strength test more than 500 psi below the specified f'_c.

B. Acceptable Levels of Strength: Concrete in the area represented by core tests will be accepted if the average of three cores is equal to or greater than 0.85 f'_c and no single core is less than 0.75 f'_c.

C. Unacceptable Concrete: Remove and replace concrete which does not meet the core test requirements or strengthen the concrete to the satisfaction of the ENGINEER.

3.5 CURING

A. General: Generally follow the recommendations of ACI 308 for curing concrete.

B. Protection: Protect concrete surfaces normally exposed to the atmosphere against too rapid drying by curing for a minimum period of 7 days. For hot weather concreting and cold weather concreting follow the recommendations of ACI 305R and ACI 306R for curing concrete. Commence the curing period immediately following the placing of the concrete. Accomplish curing by one of the following methods. Should there be any delay in the application of the method of curing used, cover the concrete with moistened burlap held in complete contact with the surface or kept wet by continuous sprinkling. Use curing water having a temperature that is within 20 degrees F of the concrete's surface temperature.

1. Accomplish water curing by the use of curing blankets wetted and applied to the concrete surface as soon as the forms have been removed, or in the case of slabs, as soon as the concrete has set up sufficiently to prevent marring of the surface. Maintain the covering material in a thoroughly saturated condition and maintain the presence of free water between the mat and the surface of the concrete at all times throughout the curing period.

2. Accomplish sheet material curing by use of waterproof paper or polyethylene film applied to the concrete surface as soon as it has set sufficiently hard to prevent marring. First, thoroughly wet the concrete surface, and then place the sheet materials in direct contact and anchor thereto in a manner to assure continuous contact throughout the curing period. Lap the sheet materials a minimum of 3 inches with the seams taped, cemented, or glued. Discoloration is objectionable on floors which have been steel troweled to a hard finish. Do not use polyethelene film on these floors.

3. Accomplish curing by using clear residual acrylic curing and sealing compound membranes on all interior concrete floor surfaces that do not receive a finish, overlays or hardener, and on stairs, landings and walking surfaces. Accomplish membrane curing immediately after removal of forms or in the case of unformed surfaces, immediately after final finishing. Uniformly coat the entire exposed surface with a clear curing compound membrane by means of an approved pressure spray distributor at the rate of 300 square feet per gallon of material. Apply the material so that the concrete surface is completely coated and sealed with one application. Do not apply the membrane to faces of construction joints or other surfaces against which additional concrete will be placed. Keep such surfaces continuously wet by other means.

4. Accomplish curing by using dissipating resin type curing compounds. Apply to all concrete surfaces except those listed in paragraph 3.5.B.3. Start curing immediately after removal of forms as in the case of unformed surfaces, immediately after final finishing while the concrete surface is still moist. Coat the entire exposed surface by means of approved pressure spray distributor at the rate of 200 square feet per gallon of material. Apply the material so that the concrete surface is uniformly coated with one application. Do not apply to the faces of construction joints or other surfaces against which additional concrete will be placed. Keep such surfaces wet by other means.

3.6 JOINTS AND BONDING

A. Joints: Make construction joints where shown or permitted. Locate such joints to ensure stability, strength, and watertightness, and provide a waterstop where

shown. Build all corners monolithically, and continuously concrete on either side to points shown.

B. Timing Between Placement: Provide at least 2 hours of elapsed time after placing concrete in the columns or walls before depositing concrete in beams, girders, or slabs supported thereon. Consider beams, girders, brackets, column capitals, and haunches as part of the floor system and place them integrally with the floor.

C. Horizontal Keyways: Build horizontal keyways to permit flushing water to escape from the keyways.

D. Keyway Description: Provide continuous, straight, and regular keys or grooves in joints. Bring exposed concrete surfaces to a true level line at the top of every horizontal construction joint. Provide the exposed construction joints with a row of form ties located in the concrete at from 4 to 6 inches from the joint to tighten the forms for subsequent sections. Set reinforcement to extend into subsequent sections of construction, as shown. If required, provide water stops having watertight splices and corner intersections and meet the requirements as specified. Remove all bulkheads or other joint forming material before placing adjacent concrete.

E. Continuous Placement Procedure: Carry on continuous placing of concrete between the construction joints shown. If for any reason it becomes necessary to stop the placing of concrete at locations other than those indicated, such locations and the manner of making the joint are subject to approval.

F. Grout Use Between Surfaces: Thoroughly clean and wet concrete surfaces against which the new concrete is to be placed. Just prior to placing new concrete, slush horizontal surfaces and joints with at least 2 inches of cement grout of the same mixture as the concrete but with coarse aggregate omitted. Use special care in placing and puddling concrete at vertical joints to ensure a bond with existing concrete. Do not make vertical construction joints in watertight construction, unless shown or approved in writing.

G. Contraction (Control) Joints in Slabs-on-Ground (for walkways and pavements outside the structure or building): Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 1/8" x 1/4 slab depth or inserts 1/4" wide x 1/4 of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

    a. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.

2. If no joint pattern is shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third-bays).

3.7 CONCRETE FLOOR SURFACES

A. Floor Surfaces: Construct the concrete floor surfaces monolithicly with the structural slab being finished as indicated in the following schedule, unless otherwise shown or as specified:

1. Bottoms of structures and other surfaces not to be used as walkway areas - screeded, wood floated, steel troweled.

2. Bottoms of structures to receive grout topping swept in by mechanisms - screeded, wood floated.

3. Exterior walkways and platforms over tanks to be used as walking areas - screeded, wood floated, steel troweled, broomed.

4. Exterior sidewalks - screeded, wood floated, divided into panels, steel troweled, broomed.

5. Reservoir bottoms - screeded, wood floated.

B. Panel Construction: Construct panels, where required, approximately 10 feet square using an edger to form dummy joints 1/4-inch deep.

C. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, as otherwise indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if the area is small or inaccessible to power units. For nonsloping level surfaces check and level the surface plane to tolerances of F_F 18 and as determined by ASTM E 1155. For sloping surfaces check the surface planes to a tolerance of F_F 18 as determined by ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Check the floors flatness (F_F) and levelness (F_L) on an area of 400

square feet for level floors and 400 square feet of sloping floors or tanks to be selected by the ENGINEER.

D. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.

1. After floating, begin first trowel finish operation using a power-driven trowel. For nonsloping level surfaces check and level the surface plane to tolerances as determined by ASTM E 1155. Cut down high spots and fill low spots. For sloping surfaces check the surface planes to a tolerance of $F_F = 20$ as determined by ASTM E 1155. Check the floor flatness (F_F) and levelness (F_L) on an area of 400 square feet for level floors 400 square feet for sloping floor or tanks to be selected by the ENGINEER. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances specified. Grind smooth surface defects which would telegraph through applied floor covering system.

E. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.

F. Nonslip Broom Finish: Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere, where indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with the ENGINEER before application.

G. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floor slabs that do not receive a floor covering. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water (parts of hardener/water as follows), and apply in 3 coats; first coat, 1/3-strength; second coat, 1/2-strength; third coat, 2/3-strength. Evenly apply each coat, and allow 24 hours for drying between coats.

1. Apply proprietary chemical hardeners, in accordance with the manufacturer's printed instructions.

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

H. Nonslip Aggregate Finish: Apply the nonslip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and elsewhere where indicated.

1. After completion of float finishing, and before starting trowel finish, uniformly spread 25 pounds of dampened nonslip aggregate per 100 square feet of surface. Tamp aggregate flush with surface using a steel trowel, but do not force it below the surface. After broadcasting and tamping, apply trowel finishing as specified.

2. After curing, lightly work the surface with a steel wire brush, or an abrasive stone and water to expose nonslip aggregate.

I. Protection: Cover all finished floors, walkways, and slabs with boards, canvas, heavy paper or similar covering to protect them from damage.

3.8 CONCRETE SURFACES

A. Beveling Edges: Finish top edges of walls and equipment pads with a 1/2-inch beveled edge, unless other details are shown, and rub off any burrs remaining upon removal of the forms.

B. Form Removal Inspection: Immediately after stripping the forms, inspect all concrete surfaces. Remove all fins, offsets, burrs, ridges, or other unsightly marks from the exposed concrete.

C. Patching: Patch placement joints, voids, stone pockets, or other defective areas before the concrete is thoroughly dry. Chip away defective areas to a depth of not less than 1 inch with all edges perpendicular to the surface. Wet the area to be patched, including at least 5 inches of the adjoining surface, prior to placing the patching mortar. Then scrub onto the surface a grout of equal parts of cement and sand mixed to a brushing consistency followed immediately by the patching mortar. Make the patch of the same material and of approximately the same proportions as used for the concrete, except omit the coarse aggregate. For exposed concrete, substitute white cement for part of the gray cement so that the patch will match the color of the surrounding concrete. Determine the proportion of white and gray cement by making a trial patch. Use as little water as consistent with requirements of handling and placing. Mortar: Do not retemper mortar. Thoroughly compact and screed off the mortar so as to leave the patch slightly higher than the surrounding surface. Then leave it undisturbed for a period of 1 to 2 hours to permit initial shrinkage before being finally finished. Finish the patch to match the adjoining surface and cure as specified for the original concrete.

D. Tie Hole Patching: Patch tie holes before the concrete is thoroughly dry. Plug tie holes flush with the surface using portland cement mortar. Prewet tie holes with clean water and apply a neat cement slurry bond coat. Densely tamp mortar of a dry-tamp consistency into the tie holes exercising care so as not to smear mortar onto the finished concrete surface. Included sufficient white cement in the mortar mix to cause the plugged holes to blend in with the adjacent surfaces. Make sample patches with different mixes to assure that this requirement is met.

3.9 CONCRETE STAIR TREADS AND LANDINGS

A. Tread and Landing Application: Construct treads and landings of all exterior and interior concrete stairs by applying a nonslip surface which is applied as an integral cement finish before the initial set of the slab has taken place, unless abrasive nosings or other finish is indicated. Compound and apply the finish consisting of 1/2-inch layer of stiff, thoroughly mixed mortar comprising 1 part cement and 2 parts sand to which is added carborundum grit in the amount of 1/4 to 1/2 pound per square foot of finished surface. Screed and trowel the mortar to a smooth and even surface.

3.10 EPOXY ADHESIVE

A. Epoxy Adhesives for Bonding: Use epoxy adhesive for bonding fresh concrete to existing concrete where shown and grouting dowels into vertical holes.

B. Recommendations: Mix and apply epoxy adhesive in accordance with the manufacturer's recommendations and in accordance with the requirements of the "Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive - ACI 503R.

C. Surface Preparation: Roughen existing concrete, by sandblasting. Provide all surfaces free of standing water and clean as required.

3.11 EPOXY GEL

A. Epoxy Gels for Dowels: Use epoxy gel for grouting dowels into horizontal holes.

B. Application: Apply epoxy gels in accordance with the manufacturer's recommendations.

3.12 POLYMER MODIFIED NONSAG MORTAR

A. General: Mix and apply material in accordance with the manufacturer's recommendations.

B. Surface Preparation: Clean existing concrete that is to receive the material of all loose concrete, dirt, oil, grease and bond-inhibiting materials and mechanically roughen to obtain an aggregate-fractured surface with a minimum profile of 1/16-inch.

C. Mortar Placement: At the time of application, saturate existing concrete such that it is surface dry with no standing water. Scrub mortar into the substrate filling all pores and voids. Force the material against the edges of repairs, working it toward the center. After applying material, consolidate and then screed. Do not place the material in lifts greater than 1-inch. Where multiple lifts are required to achieve the

required thickness, score the top surface of each lift to produce a roughened surface for the next lift. Allow the preceding lift to reach final set, 30 minutes minimum before applying fresh material. Scrub fresh mortar into the preceding lift. Allow mortar to set to desired stiffness and then finish with wood or sponge float for a smooth surface.

D. Curing Requirements: Moist cure with a fine mist spray of water, wet burlap, or nonsolvent-based curing compound. If necessary, protect newly applied material from rain. To prevent freezing, cover with insulating material.

3.13 CORROSION-RESISTANT COATING

A. Blast Cleaning: Blast clean existing exposed reinforcing steel to white metal color and immediately coat reinforcement with two 10 mil thick coats of corrosion-resistant coating applied in accordance with the manufacturer's recommendations.

3.14 MISCELLANEOUS CONCRETE ITEMS

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

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

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

END OF SECTION

SECTION 03 60 00

GROUT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnishing non-shrink grout under column and beam bearings and under equipment bases.

2. Furnishing non-shrink grout around handrail posts and base plates of handrail posts.

3. Furnishing grout topping and fillet grout in bottoms of concrete tanks.

4. Furnishing grout around tunnel liners and around pipes in tunnels.

B. Related Work Specified in Other Sections Include, But is Not Limited to, the Following:

1. Section 03 10 00 - Concrete Formwork
2. Section 03 31 00 - Cast-In-Place Concrete

1.2 REFERENCES

A. Codes and Standards Referred to in this Section:

1. ASTM C 33 - Specifications for Concrete Aggregates

2. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in. [or 50 mm] Cube Specimens).

3. CRD C-619 - Specification for Grout Fluidifier.

4. CRD C-621 - Specification for Non-Shrink Grout.

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1:

1. Submit notarized certificate of manufacturer as evidence that pre-packaged non-shrink grout conforms to specified requirements. Include manufacturer's literature.

2. Submit mix design, for each class of grout, as specified in Section 03 31 00 "Cast-In-Place Concrete".

3. Submit the following test reports:

   a. Compression tests on cylinders for grout topping and fillet grout, as specified in Section 03 31 00, Subsection 3.3 "Concrete Tests".

   b. Compression tests, on mortar cubes for non-shrink grout and for tunnel liner and pipe grout, as specified in Section 03 31 00, Subsection 3.3 "Concrete Tests".

   c. Air content tests, for grout topping and fillet grout, as specified in Section 03 31 00 "Cast-In-Place Concrete".

   d. Slump tests, for grout topping and fillet grout and for tunnel liner and pipe grout, as specified in Section 03 31 00, Subsection 3.3 "Concrete Tests".

4. Test results showing that in projects of similar scope and size, the effective bearing area (EBA) under column bearings, beam bearings and equipment bases is between 95 and 100 percent.

5. Detailed field records for ready-mixed grout as specified in Section 03 31 00.

1.4 QUALITY ASSURANCE

A. Testing Requirements: Testing laboratory provided by OWNER is responsible for conducting tests required in Division 1.

B. Testing Assistance: Cooperate with the laboratory personnel, provide access to Work, and manufacturer's operations. Provide and deliver to the laboratory adequate quantities of representative samples of materials proposed to be used which require testing.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1, and as follows:

1. Pre-packaged, Non-shrink Grout:

Deliver in unopened packages. Store in a dry place protected from moisture.

2. Portland Cement, Aggregates:

Deliver, store and handle as specified in Section 03 31 00.

PART 2 PRODUCTS

2.1 MATERIALS

A. Non-Shrink Grout:

1. Furnish a flowable, pre-packaged non-shrink grout without dependence on gas expansion forces or enlargement of metal particles for its non-shrinkage characteristics and conforming to CRD C-621.

2. Furnish one of the following:

a. Masterflow 928, as manufactured by MasterBuilders, Incorporated.
b. Multipurpose, as manufactured by Symons Corporation.
c. Sika grout 212, as manufactured by Sika Corporation.
d. Or equal.

B. Grout Fluidifier:

Furnish grout fluidifier conforming to CRD C-619.

C. Portland Cement, Aggregates, Admixtures.

1. Furnish as specified in Section 03 31 00.

2. Use air-entraining admixture in all grout.

2.2 GROUT MIXES

A. Non-Shrink Grout:

1. Add water to pre-packaged grout material and mix, as recommended by the manufacturer, to produce a flowable, non-shrink grout having a minimum compressive strength of 3000 psi in 24 hours.

2. Provide grout which when exposed to weather will be free of discoloration, without the necessity of special surface treatments.

B. Bonded Grout Topping and Fillet Grout for Tank Bottoms:

1. Grout to be proportioned from cement, fly ash, fine aggregate and ASTM C33, size no. 7 coarse aggregate with a water-reducing admixture.

2. Proportion to provide a grout having the following properties:

   a. A minimum compressive strength of 4000 psi in 28 days.

   b. An average air content of 5 percent ∀ 1.5 percent.

   c. Minimum and maximum slumps:

      (1) Fillet grout: 2-4 inches.
      (2) Grout topping: 3-5 inches.

   d. A maximum water-cementitious material ratio of 0.45 by weight of the total cementitious material.

3. Prepare design mixes, for each class of grout, as specified in Section 03 31 00 "Cast-In-Place Concrete".

C. Tunnel Liner and Pipe Grout:

1. Tunnel liner grout:

   Mix grout for backfilling the space between the tunnel liner and tunnel or other locations as specified or directed in the proportion of 1 part Portland cement to 1 part sand by volume.

2. Pipe grout:

   Mix lean grout for backfilling the space surrounding the pipe sections in tunnel or other areas as specified or directed in the proportion of 1 part Portland cement to 12 parts sand by volume.

3. Mix grout to a consistency that can be pumped into the space between the tunnel liner or pipe and tunnel. Use a grout fluidifier to reduce water quantity and improve workability.

4. Prepare design mixes, for each class of grout, as specified in Section 03 31 00 "Cast-In-Place Concrete".

D. Measurement and Mixing

Measure and mix material as specified in Section 03 31 00 "Cast-In-Place Concrete."

PART 3 EXECUTION

3.1 INSPECTION

A. Substrate Condition:

Examine the substrate and conditions under which grout is to be placed and notify the ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the OWNER.

3.2 INSTALLATION

A. General:

1. Place grout as shown and in accordance with the manufacturer's instructions. Notify the OWNER if manufacturer's instructions conflict with the Specifications. Do not proceed with installation until directed by the OWNER.

2. Drypacking will not be permitted.

3. Have manufacturers of proprietary products make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions. The cost of this service, if any, shall be borne by the Contractor.

4. Conform grout placement to temperature and weather limitations in Section 03 31 00 "Cast-In-Place Concrete".

B. Columns, Beams and Equipment Bases:

1. After shimming columns, beams and equipment to proper grade, securely tighten anchor bolts. Properly form around the base plates allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with the non-shrink grout.

C. Handrails and Railings

1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink grout. Bevel grout at juncture with post so that moisture flows away from post.

D. Grout Topping and Fillet Grout for Concrete Tanks:

1. Prior to proceeding with Work, ensure that tank equipment has been checked for accurate adjustment.

2. Use a metal screed on the tank mechanism to check the surface elevation of the base slab and to ensure that at least the thickness of grout shown can be placed. If there is insufficient room for this grout, remove the high spots in the concrete or adjust the mechanism, or both, as necessary to provide proper grout thickness and equipment clearance.

3. Prior to placement of grout, remove all laitance, debris and loose and foreign material from the base slab. Use waterblasting, sandblasting or other methods acceptable to the City.

4. Thoroughly wet the base slab at least 24 hours before placing the grout.

5. Roughen the concrete surface to receive the grout with a rolling tamp. Prior to placing the grout, the surface must be wetted and cleaned as described above. Apply a cement water paste to the surface with a stiff broom.

6. Where recommended by manufacturer, use the tank mechanism to screed the grout on the tank floor and sweep grout into fillets as it is placed. Have a representative of the equipment manufacturer be present during the screeding operation, unless otherwise approved. Screed in accordance with manufacturer's instructions.

7. Cure and protect the grout as specified in Section 03 31 00 "Cast-In-Place Concrete".

8. Level the grout topping to comply with requirements of Section 03 31 00.

9. Float finish topping as specified in Section 03 31 00.

3.3 TESTS

A. Sample and test grout for compressive strength, air content and slump as specified in Section 03 31 00 "Cast-In-Place Concrete", except as follows:

1. Non-shrink grout and tunnel liner and pipe grout: Prepare and test standard 2-inch mortar cubes in accordance with the requirements of ASTM C109. Make a minimum of one set of 6 cubes for each day of work or each 150 cubic yards of grout for each type of grout. Test two cubes for compressive strength at 7 days, one at 14 days and two at 28 days.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Ornamental light iron, steel, aluminum and stainless steel items, including nosings, ladders, safety posts, thresholds, anchors, bolts and accessories required for the attachment of items specified herein, and other items shown, to complete the Work in accordance with the Contract Documents.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 31 00 - Cast-In-Place Concrete
2. Section 05 05 13 - Galvanizing
3. Section 05 12 00 - Structural Steel
4. Section 05 52 00 - Handrails and Railings
5. Section 07 72 33 - Roof Hatches
6. Section 08 11 13 - Steel Doors and Frames
7. Section 08 11 16 - Aluminum Doors and Frames
8. Section 09 96 00 - High Performance Coatings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM A 36/A36 - Structural Steel
2. ASTM A 193/A193M Grade MT316 - Stainless Steel Bolts
3. ASTM A 283/A283M - Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
4. ASTM A 554 - Welded Stainless Steel Mechanical Tubing
5. ASTM B 137 - Method for Measurement of Mass of Coating on Anodically Coated Aluminum
6. ASTM B 244 - Method for Measurement of Thickness of Anodic Coatings on Aluminum and Other

Nonconductive Coatings on Nonmagnetic Basic Metals with Eddy-Current Instruments

7. FS FF-S-325 - Expansion Shields for Masonry Anchorage

8. FS FF-B-588 - Toggle Bolts

9. ANSI A14.3 - Safety Requirements for Fixed Ladders

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Certification: Submit certificates in triplicate for anodic treatment of aluminum. Certificates shall be properly attested by the aluminum fabricator stating that the aluminum has been treated as herein specified.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Nonslip nosings for interior concrete stairs

a. Wooster Products, Inc., Wooster, OH
b. Safe-T-Metal Company, Inc. Style Ax., Garden City Park, NY

2. Ladder Safety Post

a. The Bilco Company, New Haven, CT, Model 2 Ladder Up

3. Ladder Rungs

a. Safe-T-Metal Co., Inc. Style LR

4. Thresholds

a. Wooster Products, Inc., Wooster, OH, Type 115S - Exterior
Type 115 - Interior

2.2 MATERIALS

A. Standards: Provide metal items meeting the requirements of the following standards:

1.	Structural steel, shapes and plates, except plates to be bent or cold-formed	ASTM A 36/A36M
2.	Steel plates, bent or cold-formed	ASTM A 283/A283M, Grade C
3.	Steel bars and bar size shapes	ASTM A 36/A36M
4.	Sheet aluminum and extrusions	As required for color (3003 Alloy with mill finish)
5.	Aluminum castings thresholds and the like ornamental	Alloy 356-T6 Alloy 214-F
6.	Aluminum screw machine parts	Alloy 2024-T4
7.	Structural aluminum	Alloy 6061-T6
8.	Aluminum bar	Alloy 6061-T6511
9.	Stainless steel sheet	U.S. Steel 16-10, Grade MT316
10.	Pipe, stainless steel	ASTM A 554 Grade MT304
11.	Bolts: stainless steel	ASTM A 193/A193M, Grade MT316 85 percent copper, 5 percent lead, tin and zinc, unless otherwise specified

12. Provide steel which is to be hot-dip galvanized after fabrication, that has a silicone content in the range of 0 to 0.04 percent or 0.15 percent to 0.25 percent unless otherwise approved.

13. Provide lead expansion anchors for concrete meeting the requirements of FS FF-S-325, wedge type, Group II, Type 4, Class 1 or 2; self-drilling type, Group III, Type I or nondrilling type, Group VIII, Type 1 or 2.

14. Provide bolt anchor expansion shields for masonry meeting the requirements of FS FF-S-325, lag shield type, Group II, Type I, or split shield type, Group II, Type 3, Class 3.

15. Provide expansion bolts of Grade 316MT stainless steel.

16. Provide gauges specified to refer to U.S. Standard gauge for sheet steel, plate iron and steel, and to Brown & Sharp Gauge for wire and sheet aluminum.

17. Provide stainless steel screws, bolts, nuts and similar items used in connection with galvanized exterior Work.

18. Anodically treat aluminum to meet the test requirements of ASTM B 137 for weight and ASTM B 244 for thickness.

B. Nosings: Provide nonslip nosings on all interior stairs, that are 4 inches wide and 6 inches less in length than the length of the tread and of cast abrasive aluminum No. 101. Finish the top surface flush with the cement finish. Install nonslip nosings at the edge of each interior stair landing and platform. Provide a minimum of three anchors to each nosing.

C. Ladders: Provide ladders made of aluminum bar rails 2-1/2 inches by 1/2-inch as shown. Space rungs uniformly and at not more than on 12-inch centers. Provide flat top rungs with serrated abrasive surface. Provide ladders that comply with the latest edition of OSHA and ANSI A14.3 requirements.

1. Secure ladders to concrete or masonry walls and stiffen with aluminum brackets. Fasten to concrete or masonry with stainless steel expansion bolts, unless otherwise indicated. Weld connections between brackets and rails of ladders.

2. Construct protective cages of aluminum as shown.

D. Ladder Safety Post: Install a ladder safety post at the top of all fixed ladders and cast-in ladder rungs below floor and sidewalk doors and roof hatches. Provide the device manufactured of high-strength galvanized steel and include a telescoping section that locks automatically when fully extended. Control upward and downward movement by a spring balancing mechanism with the spring of a special corrosion-resistant alloy. Assemble the unit completely and install it in strict accordance with the manufacturer's instruction. Coat contact surfaces between dissimilar metals as specified in Section 09 96 00.

E. Thresholds: Provide thresholds for door openings of cast abrasive aluminum, and extruded aluminum, unless otherwise shown or specified. Provide 5-inch wide thresholds of the types indicated. Make thresholds the full width of door openings, ends notched to fit the door jambs, and secured to the concrete base with lead expansion shields and stainless steel bolts.

F. Aluminum Finishes: Provide aluminum finishes specified below in strict compliance with the National Association of Architectural Metal Manufacturers (NAAMM) aluminum finish designations, unless otherwise indicated or specified.

1. Provide miscellaneous aluminum angles and cover moldings which are indicated to be painted with a mill finish.

2. Provide aluminum finishes as follows:

a. Exterior aluminum items, unless otherwise specified: NAAMM Architectural Class 1, AA-A41 clear coating

b. Interior aluminum items, unless otherwise specified: NAAMM Architectural Class 2, AA-A31 clear coating

G. Stainless Steel Finish: Provide stainless steel with a No. 4 satin finish unless otherwise shown.

H. Galvanizing: Galvanize in accordance with Section 05 05 13.

I. Painting: Metal fabrications shall be shop painted in accordance with Section 09 96 00.

2.3 FABRICATION

A. General: Form all Work true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, and free from defects impairing strength or durability. Precision fitting and jointings are required for all Work. Perform all welding in a way to prevent pitting or discoloration.

B. Welding: Weld joints of such character and assemble so that they will be as strong and rigid as the adjoining section. Select wire for welding to prevent discoloration and to insure sound structural welds. Continuously weld exposed joints their entire length unless otherwise shown or specified. Provide all exposed welded face joints dressed flush and smooth.

C. Surface Flaws: Remove surface flaws on aluminum before the anodic coating is applied.

D. Structural Steel: Provide structural steel plates, shapes, bars, sheets and other metal items meeting the requirements of Section 05 12 00.

E. Miscellaneous: Perform all drilling, tapping, cutouts, and reinforcement required to attach, insert or fit thereto, fixtures and fittings in accordance with the drawings templates or instruction for the fixtures and fittings. Do not begin fabrication of metalwork until all drawings, templates or instructions are available.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install metal fabrications in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Alignment: Install all items and set plumb, square, level and true at their proper elevation and plane, and located in true alignment with all Work.

C. Fastening: Securely anchor, ready for operation in every respect. Unless indicated otherwise, fasten metalwork to solid masonry and concrete with expansion bolts and to void areas of unit masonry with toggle bolts.

D. Examine metal Work after installation, painting and glazing have been completed as required. Adjust, repair and replace metalwork as required. Clean and retouch exposed surfaces of metal Work where necessary to bring the color of the finished surfaces reasonably uniform and free from scratches and other surface blemishes.

END OF SECTION

SECTION 06 82 10

FIBERGLASS GRATING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Fiberglass grating, supporting angles and appurtenances.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 05 50 00 - Metal Fabrication
2. Section 09 96 00 - High Performance Coatings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

2. ASTM D 256 - Impact Resistance of Plastics and Electrical Insulating Materials

3. ASTM D 638 - Test Method for Tensile Properties of Plastics

4. ASTM D 695 - Test Method for Compressive Properties of Rigid Plastics

5. ASTM D 790 - Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

6. ASTM D 792 - Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement

7. ASTM D 2583 - Test Method for Indentation Hardness of Rigid Plastic by Means of a Barcol Impressor

8. ASTM D 2584 - Test Method for Ignition Loss of Curved Reinforced Resins

9. ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Design grating for a live load of not less than 150 pounds per square foot with the deflection not exceeding 1/360 of the span.

B. Performance Requirements: Meet or exceed the following requirements:

Property	Test Method	Strength	
		Protruded	Molded
Tensile Strength	ASTM D 638	100,000 psi	25,000 psi
Flexural Strength	ASTM D 790	100,000 psi	35,000 psi
Flexural Modulus	ASTM D 790	5,500,000 psi	1,500,000 psi
Compressive Strength	ASTM D 695	58,000 psi	20,000 psi
Izod Impact-Notched	ASTM D 256	25 FT-lb/in.	8 FT-1b/in.
Barcol Hardness	ASTM D 2583	50	35
Coefficient of Thermal Expansion	ASTM C 177	$4x10^{-6}$in/in/F	$7x10^{-6}$in/in/F
Specific Gravity	ASTM D 792	1.85	1.50
Glass Content		70%	35%

Meet ASTM E 84 Class 1 flame spread 0-25.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. CONTRACTOR's Drawings: Submit completely detailed working drawings of all grating and plate for approval before any fabrication is started.

C. Literature: Submit manufacturer's literature including load, span and deflection tables for floor grating and plate, and field installation instructions.

D. Samples: Submit samples of each type of floor grating and plate to be used.

E. Laboratory Certification: Submit reports of compliance with performance requirements. Pull one random sample from each product batch for testing.

1.5 QUALITY ASSURANCE

A. Design Professional: Engage a professional structural engineer experienced in design of floor grating and licensed in the State of Oklahoma, to perform design and seal grating design.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery, store and handle all products and materials as specified in Division 1 (and as follows:)

1. Dumping or dropping from trucks is not permitted. Return all damaged sections and supply a new piece.

2. Store materials in areas set aside for such use. Store on skids or platforms above ground. Do not permit warping, bending or loads exceeding design capacity.

1.7 WARRANTY

A. Provide warranty as specified in Division 1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. IKG Borden

2. Chemgrate

2.2 MATERIALS

A. General:

1. Provide molded type grating which are readily removal and replaceable.

2. Use premium grade, chemical resistant, isophthalic polyester resin, meeting the requirements of ASTM E 84 Class I.

3. Form pultruded grating of bars of I-shaped cross section, at least 5/16-inch wide by 1-1/2 inches deep on 1-3/16-inch centers. Provide cross bars on 6-inch centers. Mechanically lock and bond cross bars to bearing bars to form a flush walking surface. Make bearing bars and cross bars uniform with no

evidence of fiber orientation, irregularities, voids, porosity, resin rich or resin starved areas. Reject work showing evidence or signs of patching.

4. Form molded grating from bars in a square mesh pattern at least 1-1/2 inches deep on 1-1/2-inch centers.

5. Provide holes where required for the passage of pipes, gate stems, or for other purposes. Reinforce holes to preserve strength. Band openings and ends of all grating to the full depth of the grating with fiberglass strips bonded to all intersecting members.

6. Provide ultraviolet resistance designed for outdoor application.

7. Provide skid-resistant surface.

8. Provide grating of uniform and constant profile.

9. Provide grating free of warps, twists or other defects which affect appearance or serviceability.

10. Provide grating in safety yellow color.

B. Supporting Angles: Provide and install supporting angles of type 316 stainless steel supplied and installed in accordance with Section 05 50 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Erect grating in place on supporting angles, as shown, with full and uniform bearing on the supports, precluding rocking movement. Do not use wedges or similar shimming devices. Lock individual grating panels securely in place with approved clamps or devices. Paint surfaces of aluminum supporting angles and anchors which will be in contact with concrete as specified in Section 09 96 00.

B. Positioning: Install grating sections for ease of removal and replacement. Permit a maximum clearance of 1/4-inch at ends and between sections. Neatly fit adjacent sections so that transverse members form an uninterrupted straight line.

C. Fasteners: Fasten each grating section to the support angles with approved fasteners. Do not permit fasteners to extend above the top plane of the grating.

D. Penetrations: Provide penetrations where required for the passage of pipes, gate stems, or for other purposes. Reinforce grating where necessary to preserve its

strength. Band openings in, and ends of all grating to the full depth of the grating with fiberglass strips bonded to all intersecting members.

E. Cut Ends: Seal all field-cut surfaces in accordance with the grating manufacturer's recommendations or instructions.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 08 31 00

SIDEWALK DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Stainless steel floor sidewalk doors

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 31 00 - Cast-in-Place Concrete

1.2 DESIGN REQUIREMENTS

A. Provide floor sidewalk doors designed to withstand a minimum live load of 300 pounds per square foot.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Floor Sidewalk Doors:

a. Xylem – Safe Hatch
b. The Bilco Co. - Type JD-SS
c. Acudor Products Inc.

2.2 MATERIALS

A. Sidewalk Doors: Provide floor sidewalk doors fabricated of diamond tread plate and stainless steel hardware. Provide Type 316 stainless steel hinges. Provide doors with compression spring operators enclosed in tubes, that open 90 degrees, lock automatically and have slam lock and safety chains. Provide latch with interior handle and removable exterior key handle.

2.3 FALL PROTECTION GRATING SYSTEM

A. Grating: Provide fiberglass panels, molded in one piece, with load bearing bars in both directions to allow for use without continuous side support. Designed grating to support a 300 PSF live load.

B. Lift assistance: Provide type 316 stainless steel torsion rod incorporated into the grating panel design to provide lift assistance when opening the grating panel.

C. Hold open feature: Provide type 316 stainless steel hold open arm provided to lock the cover in the fully open 90 degree position. Provide a release handle to allow the grating panel to be closed.

D. Hardware: Type 316 stainless steel for all hardware, including mounting brackets, hinges, torsion rod, hold open arm, padlock loop, and fasteners.

E. Grating system panels shall meet the following performance characteristics:

1. High visibility safety yellow in color.

2. Lock in the fully open position.

3. Lift assistance for ease of operation.

4. UV and corrosion resistant construction with a twenty-five year manufacturer's warranty.

5. Locking to prevent unauthorized opening.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install floor sidewalk doors in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

FLOOR SIDEWALK DOOR SCHEDULE

Location	Size W x H (Inches)	Quantity	Remarks
Modified Valve Vault No. 6	36 x 36	1	Single leaf w/ Fall Protection Grating System

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 09 96 00

HIGH PERFORMANCE COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Preparation of surfaces, shop painting of items furnished, field painting of new, existing structures, piping, and equipment.

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. SSPC - The Society for Protective Coatings

a. SSPC SP 1 - Solvent Cleaning

b. SSPC SP 2 - Hand Tool Cleaning

c. SSPC SP 3 - Power Tool Cleaning

d. SSPC SP 5 - White Metal Blast Cleaning

e. SSPC SP 6 - Commercial Blast Cleaning

f. SSPC SP 10 - Near-White Blast Cleaning

g. SSPC SP 11 - Power Tool Cleaning to Bare Metal

h. SSPC SP 13 - Surface Preparation of Concrete

i. SSPC SP 16 - Brush-off Blast Cleaning of Non-Ferrous Metals

2. FS-TT-V-51F - Asphalt Varnish

3. NSF/ANSI Standard 61 - Drinking Water System Components

4. ASME A13.1 - Scheme for the Identification of Piping Systems

5. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

6. ASTM E-1795 - Standard Specification for Non-Reinforced Liquid Coating Encapsulation Products for Leaded Paint in Buildings

7. NAFP 500-03 – Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

1.3 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

1. Submit manufacturer's standard color chart for color selection.

2. Where equipment is customarily shipped with a standard finish, submit samples of the proposed color and finish for approval prior to shipping.

3. Furnish affidavits from the manufacturer certifying that materials furnished conform to the requirements specified and that paint products have been checked for compatibility.

4. Submit a supplementary schedule of paint products with mil thickness and solids by volume, including all paint applied in the shop and in the field. Provide a schedule that is in accordance with the recommendations of the paint manufacturer.

5. Furnish affidavits from the manufacturer certifying that coatings in immersion service contain no water soluble solvents or corrosion inhibitive (active) pigments with slight water solubility.

1.4 PAINTING REQUIREMENTS

A. Shop Primed and Finished Items: Furnish the following items with the manufacturer's standard prime and finish coats applied in the shop: motors, wall fans, temperature control and instrument panels, engines, filters, strainers, air dryers, meters, switchboards, motor control centers, panelboards, condensing units, water chillers, condensers, heat exchangers, humidifiers, air handling units, sound attenuators, air conditioning and dehumidification units, convector cabinets, unit heaters, enclosures for finned tube radiators, cabinet heaters, , aluminum fascia, aluminum light standards, hoisting equipment. Coat steel reinforcing bars for concrete in accordance with Section 03 30 00.

B. Shop Primed and Field Painted Items: Furnish the following items shop primed and field painted: structural steel and wrought metals, steel joists and joist girders, pipelines, hangers and supports, valves, guard housings, air filter equipment, heat exchangers, air receivers, air silencing equipment, steel lintels, steel doors and frames.

C. Field Primed and Finished Items: Field prime and finish, where exposed to view, all items not shop primed or shop finished. This Work generally includes, but is not limited to, the following: interior concrete block, columns, beams and ceilings, covering over insulation on piping, cast iron electrical boxes, small piping and copper tubing, ducts, covering over ducts, exterior PVC piping valves, and fittings, drain piping

D. Unpainted Items: Do not paint the following items, unless otherwise specified: interior structural steel not exposed to view, registers, grilles, dampers and linkage, name and identification plates and tags, brass pipe and fittings, brass valves, stainless steel, fiberglass and fiber reinforced polymer enclosures, wood, cast-iron piping installed underground, spray-on fireproofing steel to receive spray-on fireproofing, surfaces to receive field welding, faying surfaces of high strength bolted connections.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 1.

B. Delivery and Storage: Deliver and store paint at the site from the approved manufacturer only.

C. Packaging and Labeling: Prepare, pack and label paints, stains, varnish or ingredients of paints to be used on the job. Deliver all material to the site in original, unbroken containers.

D. Storage: Store the painting materials at the site in accordance with applicable codes and regulations and in accordance with manufacturer's instructions. Keep the storage space clean at all times. Take every precaution to eliminate fire hazards.

1.6 JOB CONDITIONS

A. Provide all necessary labor equipment supplies, power and materials to protect the surrounding property and facilities and personnel during sandblasting and painting operations and preclude the migration of sandblast residue or coating materials.

1.7 QUALITY ASSURANCE

A. Observe all applicable local, state and federal rules and regulations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Paint - General:

a. AkzoNobel (Ceilcote, Devoe, Enviroline, International)
b. Tnemec Coatings.
c. Sherwin Williams

2.2 MATERIALS

A. General: Furnish paint and other materials of the type and quality of the manufacturer on which the painting schedule specified herein is based.

1. Provide compatible shop and field coats.

2. Provide all coats of paint for any particular surface from the same manufacturer.

3. Provide coatings, including paints, primers and materials in contact with potable water listed by NSF International under Standard 61 for materials and products in contact with potable water.

4. Provide paint of approved color as selected from the manufacturer's standard range of colors.

5. Provide pipe color designation per owner's standard. Provide pipe coloring and band as indicated in color match chart at end of this specification.

B. Paint Schedule: Provide all painting in accordance with the following schedule with the number of coats not less than the number shown on the schedule.

Class of Work	Surface Preparation	Field Coats 1st	2nd	3rd	Total DFT
Steel-Structural, Pipe, and Equipment:					
Interior	SSPC-SP 6	F	F		8.0-16.0
Exterior	SSPC-SP 6	E	F	C	8.5-15.0
Nonferrous Metal:					

Class of Work	Surface Preparation	Field Coats 1st	2nd	3rd	Total DFT
Interior	SSPC-SP 16	G	F		6.0-11.0
Exterior	SSPC-SP 16	G	C		4.0-6.0
Ductile or Cast Iron,-Pipes, Pumps, and Valves:					
Interior & Exterior Exposed	NAFP 500-03	G	F	C*	8.0-14.0
Below Ground	NAFP 500-03	H	H		32.0-40.0
PVC:					
Exterior Exposed	Scarify	G	C		4.0-6.0
Interior Exposed	Scarify	G	F		6.0-11.0
Insulated Piping:					
Interior/Exterior Exposed	SSPC-SP 10	I	I		8.0-12.0
Concrete Walls (Cast and Precast):					
Below Grade	SSPC SP-13	H			16.0-20.0
Interior Exposed	SSPC SP-13	M	F	F	8.0-16.0
Exterior Exposed	SSPC SP-13	M	L	L	7.0-10.0
CMU Walls:					
Interior Exposed (General Service)	SSPC-SP 13	J	K	K	4.0-8.0
Interior Exposed (High Humidity & Moisture)	SSPC-SP 13	J	F	F	8.0-16.0
Exterior Exposed	SSPC-SP 13	J	L	L	4.0-6.0

Concrete Floors: See Specification Section 03 30 00, Cast-in-Place Concrete

Concrete Lining Systems: see section 09 93 00 Protective Lining System For Concrete

*Optional

C. Schedule of Paints: Alphabetical designations in the following list are given solely for the purpose of indicating the type and quality of materials desired. Equivalent material from other approved manufacturers may be submitted for approval.

Symbol	Product Name and Number	Volume Solids %	Dry Film Thickness Mils Per Coat	VOCs (g/L)
A	International Paint-Devoe Coatings Bar-Rust 231LV	71	4.0-8.0	36
B	International Paint-Devoe Coatings Bar-Rust 233LV	80	4.0-6.0	87
C	International Paint-Devoe Coatings Devthane 379 H	63	2.0-3.0	44
D	International Paint-Devoe Coatings Pre-Prime 167	100	1.0-1.5	95
E	International Paint-Devoe Coatings Cathacoat 302H	78	2.5-4.0	282
F	International Paint-Devoe Coatings Devran 224V	77	4.0-8.0	28
G	International Paint-Devoe Coatings Devran 201 V	58	2.0-3.0	250
H	International Paint-Devoe Coatings Devtar 5A-HS	79	16.0-20.0	98
I	International Paint-Devoe Coatings Intertherm 228HS	70	4.0-6.0	265
J	International Paint-Devoe Coatings Tru-Glaze 4015	53	9.0-11.0	99
K	International Paint-Devoe Coatings Tru-Glaze-WB 4428	36	2.0-4.0	43
L	International Paint-Devoe Coatings Devcryl 1448 – Semi-gloss	38	1.5-4.0	98
M	International Paint-Devoe Coatings Devran 203	45	3.0-4.0	91
N	International Paint-Devoe Coatings Devcryl 1440	44	2.0-3.0	77
O	International Paint-Devoe Coatings Devran 124	100	20.0-25.0	35
P	International Paint-Devoe Coatings Pre-Prime 167	100	1.0-1.5	95

PART 3 EXECUTION

3.1 REPAIR

A. Fill all pits in concrete having a depth in excess of 1/8 of an inch with a 100 percent solids epoxy repair compound. Provide fill material in compliance with NSF Standard 61 for materials and products in contact with potable water and from the same manufacturer.

B. Notify the ENGINEER of all pits with a depth greater than 1/4 inch to determine whether structural repairs are necessary. Repair such pits in a manner approved by ENGINEER.

3.2 PREPARATION

A. Inspection: Prior to surface preparation perform the following:

1. Verify that surface substrate conditions are ready to receive Work as instructed by the product manufacturer.

2. Examine specifications for all Work and become thoroughly familiar with all provisions regarding painting.

3. Document conditions of substrate prior to beginning work. Indicate any damaged or deficient substrates requiring repair and report findings to the ENGINEER.

B. Surface Preparation: After inspection and prior to painting, perform the following:

1. Inspect all Work prior to application of any paint or finishing material.

2. Brush and wash concrete and masonry surfaces. Remove all loose dirt, free lime, form oil, curing compounds and other foreign matter by approved methods such as SSPC SP13. Patch concrete surfaces requiring repair and spackle and repair surfaces to receive paint. Acid etch concrete surfaces to be painted as recommended by the manufacturer of the coating to be applied, to produce a slightly granular surface required for adherence of the paint to the concrete unless otherwise indicated. Determine that concrete and concrete masonry is thoroughly dry prior to painting per ASTM D4263.

3. Thoroughly clean surfaces to be given protective coatings.

4. Refinish shop-coated equipment that has scratches and abrasions.

5. Do not begin field painting prior to approval of the surface preparation.

6. Thoroughly clean wood surfaces to remove all foreign matter. Properly fill and smooth cracks and nail holes. Finish exposed wood with sandpaper to a fine finish and wipe clean of dust.

7. Prepare and clean all surfaces prior to painting, as specified and required. Verify that surfaces are dry before any paint is applied. Perform special surface preparation work as directed by the manufacturer of the paint specified to be applied to the surface.

8. Clean the surface of structural steel, exterior and interior dry surfaces of water storage tanks and steel encased in concrete, masonry or spray-on fireproofing by removing all rust, mill scale, oil, grease or dirt in accordance with SSPC-SP6.

9. Prior to painting steel and interior wet surfaces of water storage tanks, grind smooth all welds, beads, blisters or protuberances per NACE SP0178, other than identification markings and remove other imperfections. Remove all rust, mill scale, oil, grease and dirt by abrasive blasting in accordance with SSPC-SP-10 unless otherwise indicated.

10. Prior to painting metals other than steel, grind smooth all welds, beads, blisters of protuberances, other than identification markings, and remove other imperfections. Solvent clean all nonferrous metals, and stainless steel whether shop primed or field primed, in accordance with SSPC-SP-1 prior to the application of the primer.

11. Prime cleaned metal the same day immediately after sandblasting to prevent rusting.

12. Remove all adhering debris on pipe and duct covering and smooth out indentations or unsightly spots and brush clean.

13. Remove all bituminous or asphaltic coating from cast iron drain and soil pipe prior to painting.

14. Remove all adhering debris on PVC, roughen surface with sandpaper and brush clean.

3.3 INSTALLATION

A. General: Install all painting and coatings in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

1. Refer to manufacturer's guidelines as it relates to minimum/maximum allowable temperatures for application.

2. The surface temperature of the steel shall be at least 5 degrees F above the dew point.

3. Paint surfaces in accordance with the material painting schedule included in this Section.

4. Completely cover all surfaces to be painted. Cover by additional coats when color on undercoats shows through the final coat of paint, until paint is of uniform color and appearance and coverage is complete.

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

6. Provide sufficient temporary ventilation during painting operations in enclosed areas to remove moisture and solvents, and to keep the atmosphere safe from harmful or dangerous fumes and dust levels for personnel.

B. Touch-Up Shop-Primed and Finished Items: Touch-up all damaged portions and imperfections in shop-primed and finished items. Use the same paint as used for the shop prime and finish. Prepare the surface prior to touch-up by wire brushing and sanding to remove rust, scale and loose paint per SSPC SP 2, 3, or 11, as determined by each situation.

C. Aluminum and Incompatible Surfaces: Where aluminum surfaces come in contact with incompatible metals, lime, mortar, concrete or other masonry materials, apply one field coat of International Paint-Devoe Coatings Bar-Rust 231 Epoxy or two coats of asphalt varnish conforming to FS-TT-V-51F. The aluminum surface should be abraded to a 1.5-2.0 mil profile before coatings application is done to ensure maximum adhesion to the surface.

D. Steel Pipe: Applicable to insulated and uninsulated steel pipe. Immediately after installation, prime pipe not furnished with a shop coat.

E. Field Painting: Perform field painting at the job site as follows:

1. Mix all paints and similar materials in approved containers of adequate capacity.

2. Mix all paint thoroughly before being taken from the containers. Keep mixed while painting. Apply all ready-mixed paint exactly as received from the manufacturer without addition of any kind of drier or thinner, except as specified, to mix colors to conform to approved color schedule. Tint successive coats of paint to make various coats easily distinguishable. Tint undercoats of paint to the approximate shade of the final coat of paint.

3. Use only skilled painters on the Work, and employ specialists where required. Apply paint by brush, roller or sprayer in accordance with the manufacturer's recommendation.

4. Paint top and bottom edges of doors. Thoroughly and uniformly sand undercoats on hollow metal Work with No. 00 sandpaper or equal abrasive to remove all surface defects and provide a smooth, even surface. Do not allow brush marks or other irregularities on finished surfaces.

5. Perform painting as a continuous and orderly operation to facilitate adequate inspection. Prime coat and paint materials subject to weathering or corrosion before erection. Perform all paint application methods in accordance with the instructions of the paint manufacturer and as approved. Do not field paint equipment, such as electrical control cabinets, motors, unit heaters and similar items which are shipped with a final baked enamel finish and having received prior approval unless the finish is damaged in transit or installation. Paint access panels, pipe, pipe covering, ducts and other building appurtenances built into adjoining walls the same color as adjacent walls, unless color coding applies. Remove or protect hardware and accessories, fixtures and similar items placed prior to painting during painting and replace them upon completion of painting.

6. Paint piping up to and including the flanges attached to mechanical equipment. Paint electrical conduit up to and including the flexible conduit connected to equipment.

7. Paint all wall surfaces which will be concealed by equipment before equipment installation.

8. Fully protect areas under and adjacent to painted work at all times and promptly remove dripped or spattered paint.

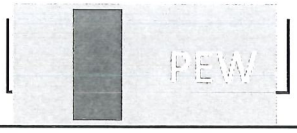
9. Repair, refinish and repaint any adjacent surfaces that have been damaged or discolored by overspray.

10. Do not paint when the air or surface temperature is below that recommended by the manufacturer, or in dust-laden air, or until moisture on the surface has completely disappeared. If necessary, provide sufficient heating and ventilation to keep the atmosphere and all surfaces to be painted dry and warm until each coat of paint has hardened.

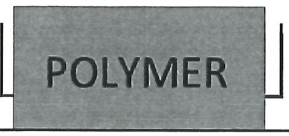
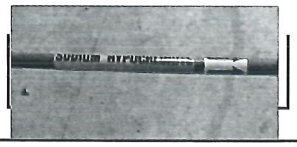
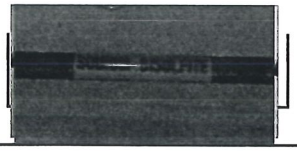
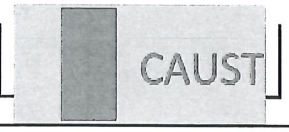
11. Remove any painting found defective. Touch-up and provide remedial painting as directed and as required until completion and acceptance of final work.

F. Color Coding: Follow ENGINEER's direction for colors to be used for identification of mechanical and electrical piping, tubing and conduit. Provide designations per the following chart unless otherwise directed by the engineer.

Color Match

Types of Piping for Corresponding Color	Location	Tnemec Paint Color	Sherwin-Williams Paint Color	Example Of Color
Potable Water	Main Pipe	Clear Sky – 26BL	Flyway – SW 6794	
	Pipe Bands	None	None	
	Lettering Color	White	White	
	Labeling	"POTABLE WATER"		
Non-Potable Water	Main Pipe	Clear Sky – 26BL	Flyway – SW 6794	
	Pipe Bands	Safety Orange- 04SF	Safety Orange - SW 4083	
	Lettering Color	White	White	
	Labeling	"NON-POTABLE WATER"		
Plant Effluent Water (PEW)	Main Pipe	Purple – Pantone 522 Match	Purple – Pantone 522 Match	
	Pipe Bands	Safety Orange- 04SF	Safety Orange - SW 4083	
	Lettering Color	White	White	
	Labeling	"PEW" **and** "CAUTION:RECLAIMED WATER-DO NOT DRINK"		
Compressed, Instrument or Blower Air	Main Pipe	Spearmint Green/Safety – 09SF	Argyle – SW 6747	
	Pipe Bands	None	None	
	Lettering Color	Black	Black	
	Labeling	"COMPRESSED AIR" **or** "INSTRUMENT AIR" - **Note: Blower Air Not Labled**		
Natural Gas	Main Pipe	Chilean Red – 07SF	Heartthrob – SW 6866	
	Pipe Bands	None	None	
	Lettering Color	Black	Black	
	Labeling	"NATURAL GAS"		
Digester Gas (Carbon Steel Pipe)	Main Pipe	Stainless Steel - Unpainted		
	Pipe Bands	Red Bands with Black Lettering on them		
	Lettering Color			
	Labeling	"DIGESTER GAS"		

Digester Gas (Carbon Steel Pipe)	Main Pipe	Chilean Red – 07SF	Heartthrob – SW 6866	
	Pipe Bands	Black	Black	
	Lettering Color	Black	Black	
	Labeling	"DIGESTER GAS"		
Heating Water Supply	Main Pipe	Rainy Day – 44GR	Gray Screen – SW 7071	
	Pipe Bands	White	White	
	Lettering Color	White	White	
	Labeling	"HWS"		
Heating Water Return	Main Pipe	Rainy Day – 44GR	Gray Screen – SW 7071	
	Pipe Bands	Black	Black	
	Lettering Color	Black	Black	
	Labeling	"HWR"		
Return Activated Sludge (RAS)	Main Pipe	Desert Sands – 04BR	Bagel – SW 6114	
	Pipe Bands	None	None	
	Lettering Color	Black	Black	
	Labeling	"RAS"		
Waste Activated Sludge (WAS)	Main Pipe	Peach Tea – 34BR	Sensational Sand – SW 6094	
	Pipe Bands	None	None	
	Lettering Color	White	White	
	Labeling	"WAS"		
Dewatering	Main Pipe	Beige - 44 BR	Beige - SW2859	
	Pipe Bands	None	None	
	Lettering Color	Black	Black	
	Labeling	"DEWATERING"		
Digested Sludge	Main Pipe	Black Forest – 49RD	French Roast – SW 6069	
	Pipe Bands	None	None	
	Lettering Color	White	White	
	Labeling	"DIGESTED SLUDGE"		
Raw Sewage	Main Pipe	Frosty Region – 54BL	Storm Cloud – SW 6249	
	Pipe Bands	None	None	
	Lettering Color	White	White	
	Labeling	"RAW SEWAGE"		
Sludge Sample	Main Pipe	No. 2 Pencil – 47GR	Web Gray – SW 7075	
	Pipe Bands	Red	Red	

	Lettering Color	White	White	
	Labeling	"SLUDGE SAMPLING"		
Drain/Sump	Main Pipe	No. 2 Pencil – 47GR	Web Gray – SW 7075	
	Pipe Bands	None	None	
	Lettering Color	White	White	
	Labeling	"DRAIN"		
Polymer	Main Pipe	Safety Orange- 04SF	Invigorate - SW 6886	
	Pipe Bands	None	None	
	Lettering Color	Black	Black	
	Labeling	"POLYMER"		
Chlorine	Main Pipe	Safety Yellow-02SF	Daisy – SW6910	
	Pipe Bands	None	None	
	Lettering Color	Red	Red	
	Labeling	"CHLORINE"		
Sodium Hypochlorite(Steel Pipe)	Main Pipe	Safety Yellow-02SF	Daisy – SW6910	
	Pipe Bands	Red	Red	
	Lettering Color	Red	Red	
	Labeling	"SODIUM HYPOCHLORITE"		
Sodium Hypochlorite (PVC)	Main Pipe	Gray PVC or Similar		
	Pipe Bands	Yellow Bands with Black Lettering		
	Lettering Color			
	Labeling	"SODIUM HYPOCHLORITE"		
Sodium BisulfIte	Main Pipe	Gray PVC or Similar		
	Pipe Bands	Orange Bands with Black Lettering		
	Lettering Color			
	Labeling	"SODIUM BISULFITE"		
Caustic	Main Pipe	Safety Yellow-02SF	Safety Yellow – SW4084	
	Pipe Bands	Green	Green	
	Lettering Color	Green	Green	
	Labeling	"CAUSTIC"		

NOTES:

1. See Lettering Size table for lettering size recommendations.
2. Bands shall be 6-inches wide and be spaced along the pipe at 5 foot intervals.
3. Labeling shall be provided near the equipment served, adjacent to valves, at each branch or tee, and at least every 50 feet in straight runs of pipe.
4. For PEW labeling, the "CAUTION: RECLAIMED WATER-DO NOT DRINK" labels shall be at least every 50 feet and the "PEW" labels shall be evenly spaced between them.

5. Arrows showing the direction of flow shall also be included and shall be the color of the label lettering. Arrows shall be located 6-inches from the lettering
on the flow direction side (i.e. flow arrows shall point away from the lettering).

3.4 HEALTH AND SAFETY

A. Introduction

1. Products listed in this specification and used in high-performance coatings situations contain high volume solids; the aerosol droplets/particulates produced during airless spray of some of these materials may form an explosive mixture with air and additionally may contain materials which may necessitate personal protection against potential health hazards. A summary of the main precautions to be taken includes:

- Danger of explosion or fire
- Provision of a suitable breathing environment for workers.
- Prevention of skin irritation problems.
- Use of paints which have been specially formulated for use in tanks.

B. Consult with manufacturer prior to commencing work to review recommended Health and Safety procedures.

3.5 QUALITY CONTROL

A. General Coatings:

1. At least daily, check temperature, humidity, and Dew Point as to time and readings obtained. Submit "Paint Inspection: Daily Coating Inspection Report" to ENGINEER on a daily basis. See Supplement below.

2. Perform daily wet film thickness readings or spreading rate checks to make certain that proper film thickness is being achieved. If proper film thickness is not being achieved more frequent checks may be required by the ENGINEER at their discretion. Provide daily written report to ENGINEER. Correct any deficiencies in film thickness by application of additional paint. See Supplement below.

3.6 CLEANING AND FINAL TOUCH UP PAINTING

A. Touch up and restore any damaged finish. Remove paint or other finishes spilled, splashed or splattered from all surfaces taking care not to mar any surface or item being cleaned.

3.7 SUPPLEMENT

A. The supplement listed below is a part of this Specification:

1. Paint Inspection: Daily Coating Inspection Report

Paint Inspection:

Daily Coating Inspection Report

Project/Client:	Date: / / M T W Th F S Su	Pg. Of
Location:	Project #:	COPY To: ☐ QC Mgr ☐ Owner
Description:	Inspector:	☐ Contr ☐ _____
Requirements:		Attachments: ☐ DFT Sheet ☐ NCR/CAR ☐ _____
Contractor:	Spec #	Revision #

Description of Areas & Work Performed

Hold Point Inspections Performed

- ☐ 1 Pre Surface Pep/Condition & Cleanliness
- ☐ 2 Surface Preparation Monitoring
- ☐ 3 Post Surface Preparation/Cleanliness & Profile
- ☐ 4 Pre Application Prep/Surface Cleanliness
- ☐ 5 Application Monitoring/Wet Film Thickness (WFT)
- ☐ 6 Post Application/Application Defects
- ☐ 7 Post Cure/Dry Film Thickness (DFT)
- ☐ 8 Nonconformance/Corrective Actions Follow-up
- ☐ 9 Final Inspection

Approved By: _____

Surface Conditions

- ☐ New ☐ Maint ☐ Primer/Paint ☐ Age/Dry/Cure_____
- ☐ Steel ☐ Galvanize ☐ Concrete ☐ Other_____
- ☐ Hazard _____ ☐ Sample Report # _____
- ☐ Degree of contamination: _____
- Test: ☐ Cl_____ µg/cm² / ppm ☐ Fe ____ppm ☐ pH _____
- ☐ Degree of Corrosion: _____
- ☐ Scale ☐ Pitting/Holes ☐ Crevices ☐ Sharp Edges
- ☐ Weld_____ ☐ Moisture ☐ Oils ☐ Other_____
- ☐ Painted Surface Condition: _____
- Dry to: ☐ Touch ☐ Handle ☐ Recoat
- ☐ Dry/Over Spray ☐ Runs/Sags ☐ Pinholes ☐ Holidays
- ☐ Abrasion ☐ Fall Out ☐ Other _____

Surface Preparation

Start Time: Finish Time: Est Sq/ft:

- ☐ Solvent Clean ☐ Hand Tool ☐ Power Tool
- ☐ HP Wash PSI_____ ☐ Other _____
- ☐ Abrasive Blast ☐ Abrasive Type _____ ☐ Sample
- ☐ Blast Hose Size _____ ☐ Nozzle Size / PSI _____
- ☐ Air Supply CFM _____ ☐ Air Supply Cleanliness
- ☐ Water/Oil Trap Check ☐ Equipment Condition Check

Surface Cleanliness & Profile Measurement

- ☐ Job Specification ☐ SSPC/NACE - SP- _____
- ☐ SSPC/NACE Spec / Visual Stds ☐ _____
- Profile Check: _____ ☐ Disc ☐ Tape ☐ Gauge
- ☐ Specified_____mils avg. / Achieved _____mils
- ☐ Surface effect on DFT Gauge/BMR_____mils

Dry Film Thickness

Gage Type / Model	Gage Serial #	Gage Calib. Verified	Spec Avg. DFT	Total Avg DFT	DFT Last Coat	DFT This Coat

Ambient Conditions

Time (Indicate AM or PM)	:	:	:	:
Dry Bulb Temp° (C/F)	°	°	°	°
Wet Bulb Temp° (C/F)	°	°	°	°
% Relative Humidity	%	%	%	%
Surface Temp° (C/F) Min/Max	/ °	/ °	/ °	/ °
Dew Point Temp° (C/F)	°	°	°	°
Wind Direction/Speed				
Weather Conditions:				

Application

Start Time : Finish Time : Est. Sq/ft.

☐ Primer ☐ Intermediate ☐ Topcoat ☐ Touch-up

Generic Type:	Qty Mixed:	
Manuf.:	Mix Ratio:	
Prod Name:	Mix Method:	
Prod #:	Strain/Screen:	
Color:	Material Temp:	°F
Kit Sz/Cond.:	Sweat-in Time:	Min/Hrs
Shelf Life:	Pot Life:	Min/Hrs
Batch #'s	Reducer #:	
(A)	Qty Added:	Pt/Qt/Gal
(B)	% by Vol:	%
(C)	Specified WFT Avg:	Mils
Reducer:	Achieved WFT Avg:	Mils

☐ Airless/Conv. Spray ☐ Brush ☐ Roller ☐ Other _____

Pump Pot	Hose Dia.	Air Check
Ratio/Size	Hose Lng.	SEP/Trap
GPM/CFM	Spray Gun	Filter
PSI	Tip Sz.	Agitator

Inspector's Signature Date

END OF SECTION

SECTION 23 31 00

ODOR CONTROL AND VENT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Ductwork materials, construction, hangers and supports, Dampers and cleaning. For this Specification Section Ductwork implies Odor Control and Vent Piping.

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ASHRAE	-	ASHRAE Handbook - Fundamentals; Duct Design
2.	ASTM D 638	-	Test Method for Tensile Properties of Plastics
3.	ASTM D 790	-	Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
4.	ASTM D 2563	-	Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
5.	ASTM D 2996	-	Specification for Filament-Wound Fiberglass
6.	ASTM D 4024	-	Specification for Reinforced Thermosetting Resin Flanges
7.	ASTM E 84	-	Test Method for Surface Burning Characteristics of Building Materials
8.	NFPA 255/ ASTM E 84	-	Test Method for Surface Burning Characteristics of Building Materials
9.	SMACNA	-	Fibrous Glass Duct Construction Standards

1.3 SYSTEM DESCRIPTION

A. Design Requirements: The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following as specified in Division 1.

B. Shop Drawings: Submit 1/4 scale shop drawings indicating duct systems routing, sizes, fitting details, reinforcing, support, required clearances, and installed accessories and devices.

C. Installation Data: Submit manufacturer's installation instructions for glass fiber ducts. Submit manufacturer's certificate that installation of glass fiber ducts meets or exceeds recommended fabrication and installation requirements.

D. Samples: Submit representative laminate samples for (FRP) ductwork, prior to fabrication for approval of surface finish and visual defects.

E. Quality Control: Provide the FRP ductwork supplier's certification for the following:

1. The resin test results performed in accordance with ASTM C 581 certifying that the resin is compatible with an environment consisting of air, hydrogen sulfide gas, methane, various aromatic hydrocarbon vapors, droplets of salt water, droplets of ammonium sulfate, and droplets of water containing sodium hypochlorite, sodium hydroxide, hydrogen peroxide, sulfuric acid, and any other chemicals mentioned in the specifications sections.

2. The FRP ductwork has a flame spread rating of 25 or less and a smoke developed rating of 50 or less as measured in accordance with NFPA No. 255 ASTM E 84.

3. That the ductwork supplies meets the visual defects level and the deflection requirements under the vacuum pressure and hoop (point) loading specified.

1.5 QUALITY ASSURANCE

A. General: Provide materials from a company specializing in the design and manufacture of ductwork and duct fittings having a minimum of 5 years documented experience, which issues complete catalog data on these products.

B. Codes: Qualify welding processes and welding operators in accordance with AWS D1.1 for hangers and supports and AWS D9.1 Certify that each welder qualification is current.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver, store, and handle all products and materials as specified in Division 1:

B. Delivery: Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials. Deliver stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

C. Storage and Protection: Store and handle sealant fire-stopping materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes. Store ductwork and duct fittings in a clean dry place and protect from physical damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Fiberglass duct

a. ATS Products, Inc.

2.2 DUCTWORK

A. General: Provide ductwork and plenums conforming to the more stringent recommendations of the current editions of the ASHRAE Handbook and of the SMACNA "HVAC Duct Construction Standards", and "Accepted Industry Practice for Industrial Duct Construction". Spiral ductwork is not acceptable.

B. Corrosion-Resistant Ductwork: Provide corrosion-resistant ductwork where the ambient air or air conveyed may cause corrosion. Provide the type of corrosion-resistant ductwork in accordance with the following designations:

1. Type A: Fiberglass Reinforced Plastic (FRP) ductwork, see subsection headed "Fiberglass Reinforced Plastic (FRP) Ductwork - Type A".

C. Dimensions: The dimensions of the ducts shown are not to be considered absolute; however, any changes from dimensions indicated are subject to approval. Where it is necessary to change dimensions of ducts, do not exceed equivalent friction loss.

1. Duct sizes noted are the clear dimensions inside the duct

2.3 FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK - TYPE A

A. General: Provide Type A corrosion-resistant ductwork, constructed of glass fiber reinforced plastic (FRP), including plenums, casings, ducts, fittings, turning vanes, isolation and balancing dampers, splitters, access doors, hangers, supports and all other miscellaneous items required for a complete system.

B. Resin: Provide fiberglass duct constructed of fiberglass-reinforced resin, conforming to the applicable sections of ASTM C 581. Do not add a thixotropic agent to resin used on the interior surface of any duct in contact with scrubber exhaust.

C. Reinforcement: Fabricate FRP duct by the filament winding method or hand lay up, for tubular shapes, using a "helix angle" of 70 degrees plus or minus 5 degrees. Fabricate the corrosion liner of the duct using one "C" veil and one chopped strand mat (1-1/2 ounce) or one layer of chopped strand prior to filament winding. Provide the minimum liner thickness of 30 mils. Fabricate all nontubular shapes by the hand layup, chopped strand or a combination of both using the specified corrosion liner.

D. Fabrication: As a minimum, and unless otherwise specified, provide laminate materials of construction and fabrication of fiberglass ducts and plenums in accordance with the National Bureau of Standards "Voluntary Product Standard PB 15-69" for molded reinforced polyester chemical-resistant process equipment, Sections 3.1.1 through 3.4.9. and ASTM D 2996 for filament-wound pipe. Fabricate the exterior surface of the ducting suitable for a corrosive environment and to conform to Section 3.3.3.1 of PS 15-69. Fabricate all interior duct surfaces, with the inner veil of reinforcement overlapping, providing reinforcement base for 100 percent of the interior surface of the duct. Design the duct specifically to facilitate water drainage where indicated on the drawings, raised lips at duct are not accepted. Provide a final coat of intumescent paint to achieve a smoke development rating of less than 50 for ducts within buildings.

E. Duct Wall Thickness: Provide duct wall thickness minimum of 1/4-inch, 5/16-inch, and 3/8-inch for duct sizes 2 through 20 inches, 24 through 36 inches, and 42 inches and over, respectively, with the exception of isolated small spots which may be as thin as 1/4-inch. Additional thickness may be required to meet deflection requirements. Design ductwork to accommodate the following minimum conditions:

Vacuum	10 inches WC
Positive Pressure	10 inches WC
Temperature	-20 degrees to 120 degrees F
Humidity	100 percent

F. Duct Fittings: Design fittings, elbows, transitions, branch takeoffs and similar items installed in FRP duct systems for low pressure loss and good air flow in accordance with accepted ventilation practices in accordance with the current edition of the applicable SMACNA manual.

G. Duct Dimensions: The duct and plenum dimensions indicated on the drawings are net inside, indicating the clear space required inside the duct or plenum after lining is installed. Increase the actual duct dimensions to accommodate lining material, where lining is required.

H. Field Joints: Make the field joints by wrapping using RMRMR sequence with strips of reinforcement saturated with resin, the reinforcement being at least the thickness of the heaviest plastic section being joined. Extension to a sufficient distance on each side of the joint is required to make the joint at least as strong as the pieces joined. Fill the mating edges with resin paste to cover cut edges and voids. Seal the inside surface of the joint with one layer of reinforcement where accessible.

I. Flanges: Provide flanges in accordance with the specifications in ASTM D 4024, PS 15-69, Sections 3.4.7.1 to 3.4.5.

J. Flanged Joints: Provide flanged joints sealed watertight with minimum 1/8-inch thick Viton gaskets and assembled with 316 stainless steel bolts and washers.

K. Drains: Provide a 2-inch drain at each low point of FRP ductwork. Provide drains comprised of a gusseted flanged nozzle, 9-inch long transparent PVC pipe and 2-inch flanged PVC ball valve at the nozzle and at the end of the drain.

L. Duct Deflection: Design the ductwork to meet the following specification with respect to supports shown. Furnish additional supports at no extra cost. Provide round ducts which have a maximum deflection not exceeding two percent or 1/4 inch of the duct diameter under an imposed hoop (point) loading of 550 pounds. Provide horizontally installed round ducts which have a maximum sag not exceeding two percent of the diameter. Design duct supports and install such that the maximum deflections and sags specified are not required to meet the deflection requirements. Design any internal support components of the ductwork such that they do not increase the system pressure drop.

M. Workmanship: Provide the finished laminate free from visual defects, such as foreign inclusions, dry spots, air bubbles, pin holes, pimples, delamination, exposed reinforcement (glass fibers) and runoff and to conform to ASTM D 2563,

Level II, for visual defects. Fabricate ductwork with the smooth surface and no sharp projections. Fill voids and crevices at joints and fittings.

Provide qualified, experienced mechanics to fabricate all FRP ductwork who have a minimum of five years experience with lay-up, fabrication and joining of this type of materials, including resins, as specified herein.

N. Hangers and Supports: Adequately support FRP ductwork from the building structure to prevent sagging. Space the hangers for ducts up to 48 inches maximum side at maximum of 6 feet 0 inches on centers. Space hangers for ducts larger than 48 inches maximum side at maximum of 4 feet 0 inches on centers. Space hangers closer if required to meet the sag requirements specified. Furnish calculations for alternative spacing. Support FRP ductwork by trapeze type hangers with minimum 3/8-inch diameter Type 316 stainless steel hanger rods. Support the bottom of the duct with minimum 2-inch by 2-inch by 1/4-inch Type 316 stainless steel angles securely bolted. Provide complete assemblies with 3/8-inch Type 316 stainless steel bolts, nuts and washers against the duct.

O. Volume Dampers: Provide volume dampers complete with locking quadrant controls and of closed end type designed for use on high pressure ducts. Provide multiple opposed blade type volume dampers if the duct dimension perpendicular to the damper shaft exceeds 10 inches. All dampers shall be constructed of FRP material.

PART 3 EXECUTION

3.1 APPLICATION

A. General: Except as otherwise indicated construct all ductwork as specified of galvanized steel in accordance with SMACNA standards.

B. Type A Ductwork: The following systems require Type A corrosion-resistant ductwork (fiberglass reinforced plastic):

1. All ductwork.

3.2 DUCT INSTALLATION, GENERAL

A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification as required.

B. Joints: Install ducts with the fewest possible joints.

C. Fittings: Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

D. Duct Openings: Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

E. Duct Location: Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

F. Construction Penetrations: Determine the exact location and size of floor opening required for ductwork. Core drill all penetrations through existing floors, walls or ceilings. Chipping is not allowed in lieu of core drilling. Obtain written approval prior to making any new penetrations through existing floors, walls or ceilings. Drill pilot holes before core drilling to locate any interference with existing conduits, equipment, etc. Neatly patch and seal opening after installation of new equipment to match existing walls, floors, ceilings, etc.

G. Clearances: Where ducts pass through walls, floors, or partitions, provide the opening in the construction not exceeding 1-inch clearance on all sides. Where ducts pass through walls, floors, or partitions required to have a fire-resistance rating and fire dampers are not required, provide the opening in the construction not exceeding 1-inch clearance on all sides, filled solidly with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subject to the same NFPA 251 time-temperature fire conditions required for fire barrier penetration.

H. Flexible Connections: Support at free end within 12 inches of flexible connection all ducts at flexible connections with air-handling equipment and fans.

I. Shafts and Enclosures: Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

J. Layout: Coordinate layout with ceiling and lighting layouts and similar finished Work.

K. Nonfire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal the space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap openings on four sides by at least 1-1/2 inches.

L. Seal: Seal externally insulated ducts prior to insulation installation.

M. Temporary Closures: During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

N. Hanging and Supporting: Support ductwork as follows:

1. Make provisions for supporting all ductwork, dampers, and other ductwork accessories, where necessary.

2. Construct, reinforce, support and brace ductwork to prevent buckling, warping, sagging, flexing and vibrating and be quiet in operation under all operating conditions and airtight at the fan static pressures scheduled.

3. Securely support horizontal ducts from the building structure by means of hanger rods or angle supports not more than 8 feet apart. Size hanger rods for the weight carried, thread at both ends, and equip with nuts and washers.

4. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

5. Support and fasten horizontal ducts on the roof of the building to roof equipment mounting supports.

6. Support vertical ducts at a maximum interval of 16 feet and at each floor.

3.3 FRP DUCT INSTALLATION

A. General: Obtain manufacturer's inspection and acceptance of fabrication and installation of FRP ductwork at beginning of installation. Install in the strict accordance with manufacturer's instructions.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Furnish the services of a qualified representative of the manufacturer to provide instruction on proper installation of the equipment, inspect the completed installation, make any necessary adjustments, as specified in Division 1.

B. Tests: After installation of the FRP duct system, control equipment and all appurtenances, subject each unit to a field running test as specified in Division 1, under actual operating conditions.

3.5 CLEANING

A. General: Perform cleaning Work in accordance with the following:

1. Keep each duct system internally clean by installing only clean materials and by providing temporary closures during the installation.

2. Remove all loose materials and obstructions from interior of ducts.

3. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

4. Clean large duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: General requirements for providing basic electrical materials and methods.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Certain equipment, control devices, conduit and wiring are shown on electrical drawings, but are specified in other sections pertaining to plumbing, valves, process control systems and instrumentation. Install and connect these items to the electrical system as indicated or required in accordance with the Contract Documents.

C. Overall Application of Specifications: This Section applies to all Division 26 sections and to other sections that include requirements for electrical equipment. Irrespective of where the electrical requirements are specified, provide and install all materials necessary for a complete operational system.

1.2 DEFINITIONS

A. Hazardous Areas: Hazardous areas as defined by the NEC as Class I, Division 1, Group D, or Class I, Division 2, Group D. The following areas are designated hazardous:

1. Class 1, Division 1, Group D

a. Screen Room
b. Influent Wet Well

2. Class 1, Division 2, Group D

a. Pump Room
b. Mechanical Room

B. Corrosive Areas: The following areas are designated corrosive areas:

1. Underground
2. Wet Areas

3. Below-grade areas.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Design requirements are specified in the applicable sections.

B. Performance Requirements: Performance requirements are specified in the applicable sections.

1.4 SUBMITTALS

A. General: Furnish all submittals, including the following,

B. Product Data and Information: Furnish a complete list of electrical equipment and materials to be furnished that shows the manufacturer, catalog number, size, type, capacity, voltage rating and other pertinent information related to each item on the list.

1. Furnish catalog data for the manufacturer's standard equipment and materials. Clearly identify the equipment and devices specifically being proposed on manufacturers' catalog data sheets.

2. Identification: Furnish a complete schedule or listing of system and equipment identification labels with legends.

C. Contractor's Shop Drawings: Furnish shop drawings on items manufactured for the Contract.

1. Furnish connection and schematic diagrams for each piece of electrical equipment where applicable. A manufacturer's standard connection or schematic diagram showing more than one method of wiring is not acceptable unless, the intended method is clearly marked.

2. Furnish diagrams that show connections to field equipment. Clearly differentiate between manufacturer's and field wiring.

3. Furnish raceway layout drawings that show conduits, boxes, and panels which contain the conductors to be provided. Include schedules listing conduit sizes, conductor content and identification.

4. Where additions and modifications are made to existing equipment, furnish drawings which clearly identify remaining existing equipment and the new Work.

D. Record Documents: Furnish record documents indicate installed conditions for:

1. Interior and exterior major raceway systems' sizes and locations; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker sizes and arrangements.

2. Exposed equipment locations dimensioned from prominent building lines.

3. Approved substitutions, and actual equipment and materials installed.

E. Maintenance Manuals: Furnish maintenance manuals, include the following information for equipment items:

1. Functional description, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and catalog numbers of replacement parts. Where a Bill of Materials is provided, include a manufacturers' data sheet for each component and device listed therein.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

1.5 QUALITY ASSURANCE

A. Codes: Provide all electrical Work in accordance with applicable local codes, regulations and ordinances. If there is a conflict between the requirements specified in the Contract Documents and the codes, follow the more stringent requirements as determined and approved.

B. Testing: As a minimum, provide standard factory and field tests for each type of equipment.

C. Labeling: Provide electrical equipment and materials that are listed and approved by Underwriters Laboratories or other OSHA recognized testing laboratories with the testing agency's label attached.

D. Standard Products: Unless otherwise indicated, provide electrical materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to these Specifications. Provide the products of the

same manufacturer when two or more units of the same class of material and equipment are required.

1.6 DELIVERY, STORAGE AND HANDLING

A. Shipping and Packing: Provide materials and equipment suitably boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Clearly label such boxes, crates or enclosures with manufacturer's name, and name of material or equipment enclosed.

B. Acceptance at Site:

1. Repair or replace all materials and equipment damaged by handling and storage as directed at no additional cost to Owner

C. Storage and Protection: Protect materials and equipment from exposure to the elements and keep them dry at all times. Handle and store to prevent damage and deterioration in accordance with manufacturer's recommendations. Provide temporary power to space heaters where provided with equipment to prevent condensation from developing.

1.7 PROJECT CONDITIONS

A. General: The Drawings indicate the extent and general arrangement of the principal electrical elements, outlets, devices and circuit layouts. Install and connect all electrical elements and devices to form a complete workable system as required by the Contract Documents. Provide necessary materials and installation wherever required to conform to the specific requirements of the furnished equipment and for proper installation of the Work.

B. Physical Layouts: In general, the routing of feeders show general arrangement and are not intended to show exact routing and locations of raceways. Verify actual and final arrangement, equipment locations, and prepare circuit and raceway layouts before ordering materials and equipment. Equipment locations are approximate and are subject to modifications as determined by approved equipment dimensions and existing conditions.

C. Coordination of Work: Coordinate the Work so that the electrical equipment may be installed without altering building components, other equipment or installations.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 ROUGH-IN

A. Final Location: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by taking field measurements.

3. Arrange for chases, slots, and openings in other building components as construction progresses to provide for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in cast-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom. Detailed dimensions to be submitted for approval to Engineer.

7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, submit RFI to the Engineer for resolution.

9. Where installed exposed in finished spaces, install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

10. Provide electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect

equipment for ease of disconnecting, with minimum of interference with other installations.

11. Install systems, materials, and equipment providing right-of-way priority to systems required to be installed at a specified slope.

12. All wiring specified, scheduled, noted or shown is to be installed in conduit unless identified otherwise.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching as required including the following requirements:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

a. Uncover Work to provide for installation of ill-timed Work.

b. Remove and replace defective Work.

c. Remove and replace Work not conforming to requirements of the Contract Documents.

d. Remove samples of installed Work as specified for testing.

e. Install equipment and materials in existing structures.

f. Locate existing structural reinforcing with a pachometer where core drilled penetrations are required so as not to cut the steel reinforcing.

2. Cut, remove, and properly dispose of selected electrical equipment, components, and materials as indicated. Deliver all removed serviceable apparatus to the Owner as directed.

3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

4. Provide and maintain adequate temporary partitions or dust barriers that prevent the spread of dust and dirt to adjacent areas.

5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

6. Patch finished surfaces and building components using new materials that are compatible with the original installation and applied by experienced installers.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 19

WIRES AND CABLES - 600 VOLTS AND BELOW

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing all wires and cables rated at 600 volts and below for electrical installation as shown.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods
2. Section 26 05 53 - Electrical Identification

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM B 3 - Standard Specifications for Soft or Annealed Copper Wire
2. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
3. TIA/EIA 568-B - Commercial Building Telecommunications Cabling Standard
4. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Section 26 05 00.

B. Product Data and Information: Furnish manufacturer's catalog data for each type of wire and cable furnished.

1.4 QUALITY ASSURANCE

A. General: Furnish wire and cable in accordance with applicable IEEE and NEMA standards and meeting the applicable requirements of the NEC and UL.

B. Tests: Furnish factory tested cables prior to shipment in accordance with ICEA standards for the insulation specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle wire and cable in accordance with the manufacturer's instructions.

B. Storage: Store cable reels on concrete, 2x4 wood laggings or other hard surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Wire and Cable

   a. Southwire Company
   b. The Okonite Company
   c. General Cable Corporation

2. Instrumentation Cable

   a. Belden
   b. Dekoron Wire and Cable
   c. The Okonite Company

3. Multiconductor Cable

   a. The Okonite Company
   b. Southwire Company

4. Wire Connectors

   a. Thomas & Betts/ABB Group
   b. 3 M/Electrical Products Division
   c. Ideal Industries

5. Color Coding Marker

   a. W. H. Brady Company
   b. Thomas & Betts/ABB Group

2.2 MATERIALS

A. Conductors: Provide soft drawn or annealed copper conductors with 98 percent minimum conductivity, meeting requirements of ASTM B 3 (solid) or ASTM B 8 (stranded). Use stranded conductors except solid No. 12 and No. 10 AWG may be used in lighting fixture and convenience outlet wiring.

B. Insulation: Provide wires and cables with insulation as follows:

1. Power, control and lighting wiring

a. Single Conductor: Provide insulation as follows:

NEC Type Letter	Insulation Material
XHHW-2	Cross-linked Polyethylene

b. Multiconductor Cables: Insulate individual conductors with 15 mils of polyethylene or PVC and 4-mil nylon jacket. Wrap the conductors with type binder and an outer jacket not less than 45 mils of PVC. Use ICEA Method 1 for color coding wires.

2. Instrumentation Wiring: The manufacturers' name and catalog number shown below are for the purpose of establishing quality and general configuration.

a. Two conductor or single pair: Stranded No. 16 AWG wire, 600 volt polyethylene insulation, twisted conductors, tinned copper drain wire, overlapped metalized tape overall shield providing 100 percent shield coverage and outer jacket of PVC. Belden Cat. No. 8719.

C. Printed Data on Covering: Provide the following information printed on the surface of all wires and cables at regular intervals throughout the entire length.

1. Manufacturer or trade name.
2. Size of conductor.
3. Type of insulation.
4. Voltage classification.

2.3 WIRE CONNECTIONS AND CONNECTING DEVICES

A. Connectors for No. 10 AWG and Smaller: Provide insulated compression type butt connectors.

B. Connectors for No. 8 AWG and Larger: Provide UL, Inc. listed compression type tube connectors for parallel or butt splices. Provide companion preformed plastic insulating covers or tape to provide insulation equal to conductor insulation.

C. Miscellaneous Connectors: Provide preinsulated spring connectors for lighting and receptacle splices and pigtails.

D. Solderless Lugs: Provide solderless terminal lugs for stranded and multiple solid conductors at connection to terminals or use UL listed crimp tool compression style lugs.

E. Control Wire Terminations: Provide spade lug or pressure type control conductor connection terminations for control wiring terminations. Provide lug bolting at devices or bus bars with a flat washer, a Belleville washer and a locknut.

2.4 COLOR CODING

A. General: Use a vinyl impregnated cloth tape resistant to oil, dirt and heat for conductor color coding.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Swab new and existing conduits to be used to clear debris and remove moisture before conductor installation. Install conductors in raceways with no splices between boxes.

B. Pulling Equipment: Pull conductors using proper equipment without exceeding manufacturer's recommendation for maximum pulling tension. Protect conductor insulation jacket at all times from twists, kinks, scrapes, punctures and other damage. Replace damaged conductors. Pull wires and cables into ducts and conduit without the use of lubricants, except where such use is necessary and approved by the cable manufacturer and the Engineer. Use UL listed lubricating compound compatible with the conductor insulated jacket and with the raceway.

Use lines of nylon or polypropylene, propelled by carbon dioxide, or compressed air, to snake or pull wire and cable into conduits. Do not use flat steel tapes or steel cables.

C. Conductor Support: Support conductors in vertical risers with woven grips to prevent loading on conductor connectors.

D. Seals: Provide a seal between the conductor and conduit for conduits entering buildings or from areas where the temperature change may cause condensation or moisture. Seal the conduits after the conductors are in place.

E. Identification: Identify all cables as specified in Section 26 05 53.

F. Color Coded Tape: Apply color coding tape at all terminations and splices with overlapping turns for a minimum length of two inches, starting two inches back from the termination point. Provide color code tape in all boxes and manholes.

Provide color coding throughout the entire network for service, feeder, branch, control and low energy signal circuit conductors. Use the following color code for conductors.

	COLOR CODING				
SYSTEM	PHASE A	PHASE B	PHASE C	NEUTRAL	GROUND
480/277 three phase	Brown	Orange	Yellow	White	Green
Control and low-energy signal	Red	---	---	White	Green
Instru-mentation	Gray	---	---	---	---

G. Terminations: Leave a minimum of six inches of free conductor at each connected outlet and a minimum of nine inches at unconnected outlets.

H. NEC Requirements: Install wiring in accordance with applicable provisions of National Electrical Code, local codes having jurisdiction and as indicated.

I. Conductor Sizing: Size conductors in accordance with the NEC, local codes having jurisdiction and the following:

1. Size conductors to limit the maximum conductor temperature to less than 75 degrees C, except where specifically stated otherwise.

2. Use minimum conductor sizes as follows:

a. Power and lighting branch circuits, No. 12 AWG.

b. 120-volt control circuits, No. 14 AWG.

c. Instrumentation and signal wiring, 2 or 3 conductors No. 16 AWG stranded shielded.

3. Size conductors as shown or as required by the actual load to be served, whichever is larger.

J. Splicing: Install continuous cables without splices in all duct systems.

K. Instrumentation wiring: Install instrumentation wiring as follows:

1. Wherever possible provide continuous instrumentation wiring without splices from field device to instrument. Where connections are required, make all connections in terminal boxes.

2. Terminate instrumentation wiring at terminal blocks only.

3. Where instrumentation wire is required to be connected in a terminal box, provide an isolated terminal for each shield.

4. Ground instrumentation shields and drain wires only at the panel end of loop.

5. Install clear, heat-shrink, seamless tubing over exposed shields and drain wires in all terminal boxes, junction boxes, panels and field devices.

3.2 CONDUCTOR IDENTIFICATION

A. Labeling: Label each wire at both termination points and at each splice point in junction boxes. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards.

B. Identification: Where the total number of control and signal wires is three or more and no terminal board is provided, identify each wire in junction boxes and cabinets by means of plastic slip-on wire marker.

C. Plastic Tags: In manholes, identify each wire by laminated plastic tag located so it can be easily seen.

D. Color Coordination: Connect circuit conductors of the same color to the same phase throughout the installation.

3.3 WIRE AND CABLE CONNECTIONS TO EQUIPMENT

A. General: Provide electrical connections to all equipment in strict accordance with the manufacturer's approved wiring diagrams, the Plans, or as approved. Repair or replace any damaged equipment resulting from erroneous connections.

3.4 CONNECTOR AND TERMINAL LUG INSTALLATION

A. UL Requirements: Install all connectors and terminal lugs in accordance with UL requirements and manufacturer's recommendations.

3.5 QUALITY ASSURANCE

A. Field Tests: Test the following 600-volt wires and cables after installation but before final connections are made up:

1. For the above listed cables, apply a test voltage of 1,500 volts AC for a period of 1 minute between all conductors in the same conduit, and between each conductors and ground.

B. Test Results: Make all tests and submit certified test results. Replace any cables that fail the tests.

C. Continuity Test: Perform continuity test to demonstrate proper cable connection.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 26

GROUNDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing a complete grounding system as specified and shown. Grounding includes but is not limited to: electric equipment enclosures and raceway systems,

B. Related Work Specified in Other Sections Includes, but is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods
2. Section 26 05 33 - Electrical Raceway Systems
3. Section 26 05 19 - Wires and Cables - 600 Volts and Below

1.2 REFERENCES

A. Codes and Standards: The following codes and standards are referred to in this Section:

1. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following.

B. Product Data and Information: Furnish manufacturer's catalog data for the following:

1. Grounding and grounded conductors
2. Grounding connectors, clamps and bushings
3. Bonding jumpers

1.4 QUALITY ASSURANCE

A. Codes and Standards: Construct a complete grounding system in accordance with applicable ANSI, IEEE Standards, the NEC and local codes.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in the City of Tulsa Standard Specifications.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Grounding and Grounded Conductors

a. Okonite Company
b. Southwire Company

2. Grounding Clamps ad Connectors

a. Burndy/Hubbell Electrical Systems
b. nVent/Erico
c. ABB Installation Products (Thomas & Betts)

2.2 MATERIALS

A. General: Provide conductor sizes as shown or required.

B. Materials: Provide conductors in accordance with the requirements specified in Section 26 05 19 – wires and cables.

C. Bare conductors: Provide bare copper conductor where buried in earth, embedded in concrete or exposed.

D. Insulated Conductors: Provide copper conductor with green color insulation rated at 600 volts where installed in conduits or other enclosed raceways.

2.3 CONNECTORS

A. Grounding Clamps and Bolted Connectors: Provide grounding clamps and bolted connectors suitable for devices or cables being connected.

B. Bolted Connectors: Provide bolted connectors for grounding to ground buses and equipment.

C. Pipe Grounding: Provide copper, brass, or bronze grounding clamps for grounding pipes. Do not provide strap type clamps.

D. Grounding Bushings: Provide grounding bushings for conduits where conduits are not effectively grounded by firm contact to the grounded enclosure.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Install conductors to preclude exposure to physical damage.

2. Install connections firm and tight.

3. Arrange conductors and connectors without placing strain on the connections.

4. Bury equipment grounding conductors as shown, or at a minimum of 12 inches below grade.

5. Install an insulated grounding conductor in all conduits.

6. When raceways are used to contain and protect grounding conductors, install in accordance with Section 26 05 33 and NEC.

B. Equipment Grounding: Ground each piece of electrical equipment using a conductor in the raceway feeding the equipment in accordance with NEC.

C. Grounding Conductors: Connect the grounding conductor between the equipment and the grounding system. Where a ground bar is furnished with the panelboard, connect the grounding conductor to the bar.

D. Miscellaneous Grounding: Provide grounding for the following:

Ground racks, supports, frames, covers and metal parts in valve vaults exposed noncurrent carrying metal, mechanical equipment.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 26 05 33

ELECTRICAL RACEWAY SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing electrical raceway systems as indicated, in accordance with the Contract Documents.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods
2. Section 26 05 43 - Underground Electrical Distribution System

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ANSI C80.5 - Electrical Rigid Metal Conduit - Aluminum (ERMC-A)

2. ANSI/NFPA 70 - National Electrical Code

3. Federal Specification WW-C-540C - Interim Federal Specification, Conduit, Metal, Rigid: and Coupling, Elbow, And Nipple, Electrical Conduit: Aluminum

4. UL 6A - Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel

5. UL 360 - Standard for Liquid-Tight Flexible Steel Conduit

6. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

A. General: Furnish all submittals as specified in Section 26 05 00.

1.4 QUALITY ASSURANCE

A. Codes: Provide all materials and workmanship in accordance with the requirements of the National Electrical Code and local codes having jurisdiction.

B. Regulatory Requirements: Provide UL listed components.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials per 26 05 00

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Rigid steel and intermediate metal conduits and electrical metallic tubing:

   a. Atkore – Allied Tube
   b. Wheatland Tube Company/JMC Steel Group
   c. Sapa Extrusions North America

2. Liquidtight and flexible steel conduit:

   a. Electri-Flex Company
   b. The International Metal Hose Co.
   c. Southwire
   d. Anamet Electrical, Inc.
   e. Thomas & Betts /ABB Group

3. Conduit Fitting and Connectors

   a. Appleton /Emerson Industrial Automation
   b. Thomas & Betts/ABB Group
   c. Eaton's Cooper Crouse-Hinds
   d. O-Z Gedney/Emerson Industrial Automation
   e. Hubbell - Killark
   f. AdaletPLM/Scott Fetzer Company

4. Boxes and Enclosures:

   a. Appleton /Emerson Industrial Automation
   b. Raco/A Hubbell Company

c. Eaton's Cooper Crouse-Hinds
d. Thomas & Betts/ABB Group
e. Hoffman
f. Hope Electrical Products CompanyO-Z Gedney/Emerson Industrial Automation

5. Strut Channel and Fittings

a. Allied Tube and Conduit
b. Eaton's Cooper B-Line Systems, Inc.
c. Thomas & Betts /ABB Group-SuperstrutEnduro Composites Inc.
d. Strut Tech Systems
e. Unistrut

6. Fire Stop System

a. 3M/Electrical Products Division
b. Acoustical Solutions Inc.
c. Nelson Fire Stop Products/Emerson Industrial Automation

7. Terminal Blocks

a. Phoenix Contact
b. ABB - Entrelec
c. Weidmuller

2.2 RACEWAYS

A. General: Provide minimum 3/4-inch raceways.

B. Raceway Requirements: Provide raceways meeting the following requirements:

1. Provide rigid aluminum alloy 6063T-1, in accordance with the requirements of UL 6A, Federal Specification WW-C-540C, and ANSI C80.5.

2.3 FITTINGS

A. General: Provide fittings of similar material as raceways.

B. Fittings Requirements: Provide fittings meeting the following requirements:

1. Set screw or indenter type fittings are not acceptable. Provide threaded connectors for all rigid or intermediate metal conduits.

2. Provide insulated connectors for liquid tight flexible conduit.

3. Expansion/Deflection Fittings:

a. Provide a deflection and expansion coupling for rigid and intermediate metal conduits that have a ¾ inch movement in all directions from normal and a 30 degree angular deflection. Provide coupling that includes internal bonding jumper. Provide at building walls.

b. Provide a nonmetallic expansion coupling for nonmetallic conduits that have a 4-inch maximum expansion.

4. Bushings

a. Provide insulated nonmetallic bushing rated 105 degrees C for all installations where bonding is not required.

b. Provide insulated metallic grounding and bonding bushing rated 150 degrees C where bonding is required.

2.4 WALL AND FLOOR PENETRATIONS

A. Watertight:

1. For conduit penetrations in new exterior walls or floors provide watertight sealing sleeves consisting of a steel sleeve with pressure ring and clamps.

2. For conduit penetrations in existing walls or floors, provide watertight sealing bushing consisting of a neoprene sealing ring between two PVC coated steel pressure discs. Provide stainless steel captive screws for sealing ring compression.

B. Fire-proofing Through Fire Rated Construction:

1. Provide a permanent fire stop system for all penetrations through fire-rated walls, partitions and floors.

2. Design fire stop system to maintain the integrity of the wall or floor assembly for its rated time period.

3. Arrange fire stop system to allow normal pipe movement without being displaced.

4. Do not utilize asbestos in fire stop systems.

2.5 BOXES AND CABINETS

A. Junction and Pull Box Requirements:

1. Provide cast aluminum boxes with mounting lugs, threaded hubs and gasket covers for surface mounted boxes

2. Provide fabricated sheet metal boxes when cast metal box weight exceeds 50 pounds. Construct box from 1/8-inch thick galvanized aluminum with sides return channel flanged around cover opening. Provide angle or channel supporting frame. Provide continuously welded and ground smooth seams. Provide mounting lugs and threaded conduit hubs.

3. Provide watertight gasketed covers held with stainless-steel captive screw slot bolts.

4. Provide steel barriers in all boxes that isolates instrumentation wiring from all other wiring systems

5. Provide all boxes located outdoors, in corrosive areas or where otherwise indicated meeting NEMA 4X, 316 stainless steel requirements.

B. Terminal Box Requirements:

1. Provide minimum 12 gauge stainless steel fabricated box with mounting lugs, floor stand, and hinged doors.

2. Provide the door with continuous piano hinge and 3 point lockable latch. Provide print pocket on inside of door.

3. Provide back plate fabricated from 12 gauge minimum steel with white enamel finish for mounting terminals and wire troughs.

4. Provide wire troughs consisting of plastic ducts with snap slot design and removable covers. Run all wiring within wire troughs.

5. Furnish a schedule of terminals with the following information

   a. Source
   b. Type of Signal
   c. Function

6. Provide removable jumpers to allow operation of the equipment.

7. Separate analog terminals from all other terminals.

8. Provide number of terminals shown. Where the number of terminals are not shown, provide sufficient terminals for each wire entering the terminal box plus 20 percent but not less than 10 spare terminals.

9. Terminals:

a. All catalog numbers refer to Phoenix Contact Type for the purpose of establishing the standard of quality and general configuration desired.

b. Provide symmetrical type steel mounting rails, NS-35.

c. Analog Signals: Provide terminals in enclosed housing suitable for wires from 22 to 12 AWG rated 600 volts with gray body, knife disconnect and test connection socket on both sides of disconnect, Phoenix Contact Type UK 5-MTK-P/P.

d. Control and Alarm Signals: Provide terminals suitable for wires from 24 to 10 AWG rated 18 amperes at 600 volts, blue body, Phoenix Contact Type UK5N BU.

e. 120-Volt Power Wiring: Provide terminals suitable for wires from 18 to 10 AWG rated 30 amperes at 600 volts, hot (black body), neutral (white body), ground (green body) , Phoenix Contact Type UK5N BK, UK5N WH & UK5N GN, respectively.

10. Enclosures: Provide enclosures meeting the same NEMA criteria for the various areas as specified under Junction and Pullboxes.

2.6 SUPPORTING DEVICES

A. Raceway Supports: Provide raceway supports meeting the following requirements:

1. Do not use perforated straps or plumbers tape for conduit supports.

2. Provide expansion bolts or inserts for fasteners in concrete, toggle bolts for hollow masonry or frame construction, and preset inserts for prestressed concrete.

3. Conduit Straps and Backs:

a. For metallic conduits, provide straps of metal compatible with raceway.

4. Conduit Hangers

a. For metallic conduits, provide metal adjustable conduit hangers or clevis hangers of metal compatible with raceway.

5. Beam Clamps:

a. For metallic conduits, provide malleable iron with steel bolt.

6. Trapeze Hangers:

a. For metallic conduits provide 12 gauge 1-1/2-inch square steel channels with steel channel straps to secure conduits.

b. Provide addition channels welded together to limit the deflection to 1/240th of span.

7. Threaded Rod

a. Provide threaded rod with the minimum size as follows:

(1) Conduit Hangers

(a) 3/4-inch to 1-1/2-inch conduit: 1/4-inch thread rod

(b) 2-inch to 3-1/2-inch conduit: 3/8-inch thread rod

(c) 4-inch and larger: 1/2-inch thread rod

(2) Trapeze Hangers: Provide thread rod of sufficient size to support the load. Provide a minimum of 3/8-inch thread rod.

b. For Metallic Conduit Systems: Provide continuous threaded galvanized steel rod.

PART 3 EXECUTION

3.1 PREPARATION

A. General: Install electrical equipment and material of the size, type and general routing as shown or required.

B. Coordination with Reinforcing: Install raceway, fittings, boxes and cabinets free from direct contact with reinforcing steel.

C. Alignment: Provide fasteners, anchor bolts, anchorage items and supports as required to insure proper and rigid alignment. Attach equipment with fasteners sized according to size and weight of the equipment and the thickness of the supporting surface.

D. Aluminum Coating: Where aluminum is placed in contact with dissimilar metal or concrete, separate contact surfaces with gasket, nonabsorptive tape or coating as specified in Section 09 96 00 to prevent corrosion.

E. Grounding: Make metallic raceways electrically and mechanically continuous and ground as required. Install conduits continuous between outlets, boxes, cabinets and panels.

3.2 INSTALLATION

A. General: Unless otherwise indicated, install conduits exposed, parallel or perpendicular to building floors, ceilings and walls, to avoid interference with other work. In architecturally finished areas, conceal conduits within finished walls, ceilings and floors. Cut conduits square and deburr the cuts to the same degree as the conduit manufacturer. Fasten conduit securely to outlets, junction, pull and terminal boxes. Provide caps and seals to prevent the entrance of foreign material and moisture during installation and before pulling wire.

1. Where conduit size is not shown, provide conduits one size larger than indicated in Table 4, Chapter 9 of the NEC.

2. Saw cut aluminum conduit to prevent reduction in internal area.

3. Keep conduit at least six inches away from piping, ducts and surfaces. For mounting on concrete and masonry surfaces provide a minimum of 1/4 inch air space between conduit and mounting surface. Support and fasten conduit to building structural members spaced in accordance with electrical codes. Support conduit at least every eight feet or less in accordance with NEC requirements.

4. When two or more exposed conduits are in the same general routing, provide parallel installation with symmetrical bends and for three or more provide trapeze hangers. Size trapeze hangers with space for 25 percent additional conduits.

5. Make changes in direction with bends or fittings. Use factory-made bends or elbows wherever possible. Make field bends and offsets with a hand bender or conduit-bending machine.

6. Run conduit in buildings with no more than the equivalent of three 90 degree bends between pull points. Provide no more than 125 feet of conduit runs between pull points. Provide pull boxes where shown, specified or wherever required to install conductors and to meet the above requirement.

7. Install pull and junction boxes in accessible locations with working space in front of and around the installation.

8. Install an expansion fitting when a conduit crosses a structural expansion joint.

9. Unless otherwise approved, install conduits to cross at right angles to building structural expansion joints.

10. Where approved for encased installation, install conduits in slabs as close to the middle of concrete slabs as practicable without disturbing reinforcement. Do not use conduit with an outside diameter exceeding one-third of the slab thickness. Do not place conduits closer than three diameters on centers, except at cabinet locations where the slab thickness is increased.

11. Pitch conduits to outlet boxes to avoid trapping moisture. Where dips are unavoidable in exposed conduit runs, install drain fitting at low point.

12.

B. Conduit Material Types: Provide conduit as follows:

1. Provide rigid aluminum conduits in all installations concealed in structures, concrete encased within structures or under structures.

2. Provide rigid aluminum conduits for all instrumentation, and electronic equipment signal wiring in all exposed or concealed noncorrosive installations.

C. Connections to Equipment

1. Provide double locknuts and bushing for all boxes, enclosures and cabinets located in dry areas.

2. Provide watertight hub fittings for all boxes, enclosures and cabinets located below grade or in wet, damp or corrosive areas.

3. Provide rigid conduit connection where equipment is fixed and not subject to adjustment, mechanical movement or vibration. Provide union fittings to permit removal of equipment without cutting or breaking conduit.

4. Provide liquid tight flexible conduit connection where equipment is subject to adjustment, mechanical movement or vibration.

5. Coat all threads in steel conduit runs with zinc dust in oil or other corrosion-preventive compound before making connections.

D. Underground Conduits: Provide underground conduits meeting the requirements of this Section.

E. Penetrations: Make concealed penetrations for single conduits not more than 1/4-inch larger than the diameter of the conduit. Make penetrations through walls, ceilings and floors other than concrete for exposed conduits not more than 1/4-inch larger than the diameter of the conduit. Fill the voids around conduit with caulking compound and finish the surface the same as the wall, ceiling or floor.

1. Where a conduit enters through a concrete roof or membrane waterproofed wall, floor or ceiling, provide a watertight sealing sleeve that can be tightened from one or both sides. If the sealing sleeve is not placed with the concrete, core drill the proper size hole to provide a mechanically watertight installation.

2. Where a conduit enters through a concrete non-waterproofed wall, floor or ceiling, provide a galvanized steel sleeve and fill the space between the conduit and sleeve with a plastic expandable compound. If the sleeve is not placed with the concrete, drill the hole not less than 1/2-inch and not more than one inch larger than the sleeve, center the sleeve and grout the sleeve for the total depth of penetrated concrete with non-shrink grout, polyurethane or silicone sealant.

F. Boxes: Provide boxes of the proper dimensions for the size and quantity of conductors enclosed.

1. For boxes mounted on steel, concrete and masonry surface, provide a minimum 1/4-inch non-metallic spacer to hold the box away from the surface.

2. Provide separate support for boxes and bolt units to buildings with expansion anchors, toggle bolts or appropriate screws. For lighting fixture outlet boxes, provide supports adequate to support the weight of the fixture to be mounted on the box.

3. Remove debris including dust, dirt, wire clippings and insulation from the interior of boxes. Replace boxes with open conduit holes. Repair or replace damaged boxes as directed.

END OF SECTION

SECTION 26 05 43

UNDERGROUND ELECTRICAL DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing underground electrical raceway system consisting of concrete encased conduits, direct buried conduits, cables, manholes, handholes, and outdoor electrical equipment pads as shown.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods
2. Section 26 05 19 - Wire and Cable - 600 Volts and Below
3. Section 26 05 26 – Grounding
4. Section 26 05 33 - Electrical Raceway Systems

1.2 SYSTEM DESCRIPTION

A. Performance Requirements: Arrange and route conduits as shown to allow pulling-in of conductors without exceeding the conductor's tension limits.

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Section 26 05 00.

B. Product Data and Information: Furnish manufacturer's data for conduits, manholes, handholes and all accessories.

C. Contractors' Shop Drawings: Furnish working drawings for underground electrical raceway system showing conduits, concrete encasement, . Indicate the designation, type, size, location, elevations and slopes of the system. Provide scaled profile drawings as needed to resolve conflicts among the various disciplines and existing infrastructure. Profile drawings are to be scaled 1"=10'-0" horizontal and 1"=2'-0" vertical.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in the City of Tulsa Standard Specifications.

1.5 PROJECT CONDITIONS

A. Existing Conditions: Examine record drawings to determine the location of all obstructions along the conduit or cable route and at the sites of manholes, handholes and outdoor electrical equipment pads. Contact the local underground utility locator service and confirm the location of all existing utilities prior to excavating for new work. Verify prior to commencing work.

B. Field Measurements: Field survey, and in critical areas, excavate test pits to verify locations of probable obstacles along the conduit or cable route and at the sites of manholes, handholes and outdoor electrical equipment pads.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Conduit Spacers

a. Carlon -Thomas & Betts/ABB Group
b. Underground Devices, Inc.

2. Buried warning tape

a. Ezcode - Thomas & Betts/ABB Group
b. W. H. Brady Company

2.2 MATERIALS

A. Conduit: Provide conduits meeting the requirements of Section 26 05 33.

B. Spacers: Provide rigid plastic, conduit spacers to maintain conduit separation as indicated.

PART 3 EXECUTION

3.1 CONDUIT INSTALLATION

A. General: Install underground, concrete encased conduits as indicated.

B. Conduit Route: Establish and mark exactly conduit or cable routing. Resolve routing near existing obstacles and coordinate with other site work. Maintain a 12-inch minimum longitudinal clearance from the conduit bank encasement or direct buried conduit to adjacent utility lines. Maintain a 6-inch minimum vertical clearance from the conduit bank encasement or direct buried conduit to utility lines at crossovers. Adhere to lines, grades, elevations and dimensions as shown.

C. Trench Excavation: Perform excavation work in coordinated with the requirements for pipe excavation.

D. Bedding: Provide a sand cover on trench bottoms to create a firm and smooth surface for direct buried conduits.

E. Spacers: Locate spacers at intervals of approximately four feet and stagger locations at each conduit tier to provide not less than 12-inches of longitudinal separation.

F. Conduit: Place conduit in straight lines and with a minimum slope of 0.25 percent (3 inches per 100 feet). Slope conduit down to handholes and structures. Install expansion fittings in straight runs exceeding 100-feet. Secure conduits in place to prevent floating and movement. Provide innerducts with pull strings installed in all conduits scheduled for the routing of instrumentation wiring (Cat 5E, fiber optic, twisted shielded, etc.) Provide spare innerducts to the maximum allowable capacity of the conduit size being used. Spare innerducts are to be of the same size used for the scheduled wiring.

G. Bends: Install 12-foot minimum radius bends in horizontal turns and vertical deflections. For bends used at ends of conduit runs install elbows with 4-foot minimum radius for 6-inch and 5-inch conduits, and elbows with 3-foot minimum radius for 4-inch and smaller conduits.

H. Inside Cleaning: Pull a standard flexible mandrel not less than 12-inches long, having a diameter approximately 1/4-inch less than the inside diameter of the conduit, through each conduit, then pull a brush with stiff bristles through each conduit. Replace conduit runs that do not allow the passage of the mandrel at no increase in Contract Price. Use the pneumatic method to draw into conduit the nylon or polypropylene pull line. Plug and seal all conduits after cleaning.

I. Concrete Reinforcing: Install concrete reinforcing meeting the requirements of Section 03 20 00. Provide duct banks with No. 5 reinforcing, spaced 12 inches on centers, top and bottom, with No. 3 ties at 18 inches, unless otherwise shown.

J. Backfilling: Backfill meeting the requirements of Section 31 23 23. Provide a cover layer of sand that is 6 inches deep above direct buried conduits or cables. Provide 4" minimum top soil at surface.

K. Underground Warning Tape: Provide one underground warning tape for each trench up to 18 inches wide. For trenches wider than 18 inches provide two underground warning tapes installed at each edge of the trench. Place the tape or tapes 12 inches below the finished grade.

L. Markers: Provide 4-inch round, 6-inch thick, concrete markers identified with the letter "E" and directional arrows. Place these markers approximately every 200 feet along straight portions of conduit and cable runs, at each change in direction and at the conduit run end. Install markers to protrude 1-inch above adjacent ground. Allow markers to protrude 1/2-inch in finished lawns. Do not place conduit markers at structures and at conduit risers.

M. Surface Finish: Restore existing pavements and curbs with materials and construction to match existing. Restore landscaped/ grass covered areas with top soil, rake smooth to meet existing grade, seed, and protect.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing materials for the identification of electrical equipment, components, conduits, cables and wiring, and furnishing and installing safety signs.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 00 - Basic Electrical Materials and Methods

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ANSI C2	-	National Electrical Safety Code (NESC)
2.	ANSI Z535.1	-	Safety Color Code
3.	ANSI Z535.2	-	Environmental and Facility Safety Signs
4.	ANSI Z535.3	-	Criteria for Safety Symbols
5.	OSHA	-	Occupational Safety and Health Act

1.3 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Section 26 05 00.

B. Product Data and Information: Furnish manufacturers' catalog data for safety signs, nameplates, labels and markers.

1. Furnish manufacturers' instructions indicating applicable conditions and limitations of use, storage, handling, protection, examination and installation of product.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in the City of Tulsa Standard Specifications.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. W. H. Brady Company
2. Seton
3. Thomas & Betts/ABB Group

2.2 MATERIALS AND COMPONENTS

A. General: Provide identification materials listed and classified by UL or tested by an acceptable Electrical Testing Company certifying the equivalence of the materials to UL listing requirements and OSHA approved.

B. Laminated Plastic Nameplates: Provide engraved three layer laminated plastic nameplates with black letters on white background and fastened with corrosion-resistant screws. Do not use mounting cement for fastening nameplates.

1. Provide nameplates with 1/2-inch high lettering for individual components of a group such as main breakers, switchgear units, switchboard units, motor control center units and similar devices.

2. Provide nameplates with 1/4-inch high lettering for remote motor controllers, control stations, relays and similar equipment.

3. Provide smaller lettering for a neat, legible nameplate where the amount of lettering causes excessively large nameplates.

C. Wire Markers: Identify wire bundles and each individual wire.

1. Wire bundles: Provide a brass or rigid fiber identifying tag attached with nylon self locking "Ty-Raps".

2. Wire identification markers: Provide a printed white, heat-shrink, seamless tubing type with black bold lettering for wires size No. 10 AWG and smaller. Provide a printed self-laminating white, vinyl type with black bold lettering for wires No. 8 AWG and larger.

D. Underground Warning Tape

1. Provide underground warning tape for underground cables, conduits and duct banks.

2. Use 6 inch wide, 0.004 inch thick, polyethylene underground warning tape with black lettering and background colors as follows:

   a. Electric: Red.
   b. Telephone/Data: Orange.

3. Provide lettering that indicates the type of buried service.

   a. Electric: "CAUTION ELECTRIC LINE BURIED BELOW"
   b. Telephone/data: "CAUTION TELEPHONE LINE BURIED BELOW"

4. Manufacturer: Utility Safeguard, LLC.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation: Degrease and clean surfaces to receive nameplates, labels and marking paint.

3.2 INSTALLATION

A. General: Install nameplates on the front of equipment, parallel to the equipment lines and secured with corrosion resistant screws. Caulk all screw holes with clear silicone caulk prior to attaching nameplates on NEMA 4X enclosures.

1. Install laminated nameplates identifying:

   a. Each electrical equipment enclosure
   b. Individual equipment and devices

B. Wire Markers: Identify wire bundles and each individual wire with identification tags as follows:

1. Wire Bundles: Install an identifying tag engraved with the conduit number where conduits enter motor control centers, switchgear, switchboards, control panels, terminal boxes and the like.
2. Wire identification markers: Provide wire identification markers on each wire at all termination points.

   a. On power and lighting circuits: The branch circuit or feeder number as indicated on drawings

   b. On control circuits terminated in motor control centers, switchgears, control panels and alike: The field device and terminal number of the opposite end connection.

c. On control circuits at each field device: The panel or compartment number and terminal number of the opposite end connection.

3. Oversize wire markers so that after heat shrinking the wire marker can be rotated on the wire. Rotate wire markers so that wire identification number is visible.

C. Underground Warning Tape

1. Install underground warning tape in the trench above underground conduit(s), 1 foot below the finished grade.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing distribution panelboards including circuit breakers and cabinets.

B. Related work specified in other sections includes, but is not limited to, the following:

1. Section 09 96 00 – High Performance Coatings
2. Section 26 05 00 - Basic Electrical Materials and Methods
3. Section 26 05 53 - Electrical Identification
4. Section 26 05 26 – Grounding

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. NEMA PB 1 - Panelboards
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
3. UL 67 - Panelboards
4. Fed. Spec. W-P-115 - Power Distribution Panel
5. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors
6. NFPA 70 - National Electrical Code (NEC)

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 01 and Section 26 05 00.

B. Product Data and Information: Provide the manufacturer's catalog data for panelboards, circuit breakers and accessories.

C. Shop Drawings: Provide drawings of all the different type of panels and cabinets to be provided. Clearly indicate all gutter sizes, bus locations, main breaker or lug locations and any special construction required. Provide individual breaker layouts and schematics for each panel.

D. Operations and Maintenance Manuals: Furnish operation and maintenance manuals for the panelboards as specified in Division 01.

1.4 QUALITY ASSURANCE

A. Codes: Provide all materials and workmanship meeting the requirements of the NFPA, the National Electrical Code and local codes.

1. Design, fabricate and test the panelboards in accordance with applicable ANSI, IEEE and NEMA standards.

2. Provide panelboards suitable for operation at their standard nameplate ratings in accordance with ANSI standards.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.

1. Panelboards

a. ABB
b. Square D/Schneider Electric
c. Eaton/Cutler-Hammer
d. Siemens

2.2 MATERIALS

A. General: Provide factory-assembled fully rated dead-front type, panelboards, suitable for surface or flush mounting with branch circuit breakers and a main circuit breaker or main lugs as indicated.

1. Provide panelboards with a full capacity separate ground bus and connected to a three-phase four-wire or a single-phase three-wire service with insulated neutral buses as indicated.

2. Provide panelboards with the voltage, frequency and current ratings as indicated conforming to NEMA Standard PB 1, Fed. Spec. W-P-115, UL 67, the NEC and local codes.

3. Provide panelboards with copper main, neutral and ground buses as indicated.

4. Where required, label panelboards suitable for use as service entrance equipment.

B. Bracing: Provide main bus bracing exceeding the lowest interrupting rating of any circuit breaker installed.

C. Fabrication: Fabricate panelboards using galvanized steel, continuously welded. Provide cabinet fronts with doors over the circuit breakers. Provide doors fastened with concealed hinges and equipped with flush type catches.

1. Provide panelboards at least 20 inches wide, 5-3/4 inches deep, with wiring gutters on both sides.

2. Provide all panelboard trims exceeding five square feet in area with an inside permanently secured angle to support the trim during fastening.

3. Panelboards shall be suitable for industrial service and for the environment where they are located.

4. Provide panelboard with enclosures meeting NEMA 250 and having the enclosure type indicated.

2.3 COMPONENTS

A. Circuit Breakers: Provide bolt-on type branch and main circuit breakers.

1. Furnish the frame sizes, trip settings and number of poles as indicated. Clearly identify the ampere trip rating on the circuit breakers.

a. For distribution panelboards, provide 20-ampere, three-pole, 600-volt circuit breakers, unless otherwise shown or scheduled.

2. Provide all breakers with quick-make, quick-break, toggle mechanisms with automatic thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless otherwise indicated. Indicate automatic tripping by the breaker handle assuming a clearly distinctive

position from the manual ON and OFF position. Design the breaker handle to be trip-free on overloads.

3. Interrupting Rating: 65,000 rms symmetrical amperes for circuit breakers on 277 or 480 volt systems.

4. Provide multipole breakers that utilize a common tripping bar.

5. Provide circuit breakers 100 amperes and smaller with a 60/75 degree C cable temperature rating.

2.4 ACCESSORIES

A. Directories: Provide directories in accordance with Section 26 05 53.

B. Keying: Key all panelboards alike.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install all panelboards in accordance with manufacturer's recommendations and approved shop drawings and as specified in Division 1 and in compliance with the requirements of NEMA standards, NEC, and applicable ANSI Publications.

B. Mounting Height: Mount all panelboards either surface or flush mounted as shown such that the height of the top operating handle does not exceed 6 feet 6 inches from the floor.

C. Coordination: Coordinate with other Work including cabling and wiring work to interface the installation of the panelboards.

D. Torque Requirements: Tighten electrical connectors and terminals, including screws and bolts, in accordance with the equipment manufacturer's published torque tightening values for the equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals in accordance with UL 486A.

E. Directory: Provide a laminated typewritten directory with the following information:

1. Circuit number
2. Area served
3. Utilizing equipment

3.2 CLEANING AND PAINTING

A. Shop Painting: Paint the panelboards as specified in Section 09 96 00.

B. Field Painting: Touch up scratched and marred surfaces to match the original finish.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 31 23 16

EXCAVATION - EARTH AND ROCK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for performing opencut excavations to the widths and depths necessary for constructing structures, pipelines and conduits including excavation of any material necessary for any purpose pertinent to the construction of the Work.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 03 31 00 - Cast-in-Place Concrete
2. Section 31 10 00 - Site Clearing
3. Section 31 23 23 - Backfilling
4. Section 31 41 00 - Shoring, Sheeting and Bracing

1.2 DEFINITIONS

A. Earth: "Earth" includes all materials which, in the opinion of the ENGINEER, do not require blasting, barring, or wedging for their removal from their original beds. Specifically excluded are all ledge and bedrock and boulders or pieces of masonry larger than one cubic yard in volume.

B. Rock: "Rock" includes all materials which, in the opinion of the ENGINEER, require blasting, barring or wedging for removal from their original beds and which have compressive strengths in their natural undisturbed state in excess of 300 psi. Boulders or masonry larger than one cubic yard in volume are classed as rock excavation.

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Dewatering Excavation Plan: Develop an excavation dewatering plan that considers site ground and groundwater conditions, the type and arrangement of the equipment to be used and the proper method of groundwater disposal. Prepare the dewatering plan before beginning excavations below groundwater. Maintain one

copy of the dewatering plan at the project site to be available for inspection while all dewatering operations are underway.

1.4 SITE CONDITIONS

A. Actual Conditions: Make any geotechnical investigations deemed necessary to determine actual site conditions.

B. Underground Utilities: Locate and identify all existing underground utilities prior to the commencement of Work.

C. Quality and Quantity: Make any other investigations and determinations necessary to determine the quality and quantities of earth and rock and the methods to be used to excavate these materials.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL

A. Clearing: Clear opencut excavation sites of obstructions preparatory to excavation. Clearing in accordance with Section 31 10 00, includes removal and disposal of vegetation, trees, stumps, roots and bushes, except those specified to be protected during trench excavation.

B. Banks: Shore or slope banks to the angle of repose to prevent slides or cave-ins in accordance with Section 31 41 00.

C. Hazardous Materials: If hazardous materials not specifically shown or noted are encountered, proceed in accordance with General Conditions Article 4.06, Hazardous Environmental Condition at Site.

3.2 STRUCTURE EXCAVATION

A. Excavation Size: Provide excavations of sufficient size and only of sufficient size to permit the Work to be economically and properly constructed in the manner and of the size specified.

B. Excavation Shape: Shape and dimension the bottom of the excavation in earth or rock to the shape and dimensions of the underside of the structure or drainage blanket wherever the nature of the excavated material permits.

C. Compaction: Before placing foundation slabs, footings or backfill, proof roll the bottom of the excavations to detect soft spots.

1. For accessible areas, proof roll with a ten wheel tandem axle dump truck loaded to at least 15 tons or similarly loaded construction equipment.

2. For small areas, proof roll with a smooth-faced steel roller filled with water or sand, or compact with a mechanical tamper.

3. Make one complete coverage, with overlap, of the area.

4. Overexcavate soft zones and replace with compacted select fill in accordance with Section 31 23 16.

3.3 TRENCH EXCAVATION

A. Preparation: Properly brace and protect trees, shrubs, poles and other structures which are to be preserved. Unless shown or specified otherwise, preserve all trees and large shrubs. Hold damage to the root structure to a minimum. Small shrubs may be preserved or replaced with equivalent specimens.

B. Adequate Space: Keep the width of trenches to a minimum, however provide adequate space for workers to place, joint and backfill the pipe properly.

1. Do not allow the clear width of the trench at the level of the top of the pipe to exceed the sum of the outside diameter of the pipe barrel plus 20 inches for pipe 4 through 24 inches in diameter nor the outside diameter of the pipe barrel plus 2 feet for pipe more than 24 inches in diameter, unless otherwise approved.

2. In sheeted trenches, measure the clear width of the trench at the level of the top of the pipe to the inside of the sheeting.

3. Should the maximum trench widths specified above be exceeded without written approval, provide concrete cradle or encasement for the pipe as directed. No separate payment will be made for such concrete cradle or encasement.

C. Depth: Excavate trenches to a minimum depth of 6 inches below the bottom of the pipe or the bottom of encasement for electrical ducts, unless otherwise shown, specified or directed, so that bedding material can be placed in the bottom of the

trench and shaped to provide a continuous, firm bearing for duct encasement, pipe barrels and bells.

D. Unstable Materials: If unstable material is exposed at the level of the bottom of the trench excavation, excavate the material in accordance with the subsection headed "Authorized Additional Excavation".

1. When in the judgment of the ENGINEER the unstable material extends to an excessive depth, the ENGINEER may advise, in writing, the need for stabilization of the trench bottom with additional select fill material or a crushed stone or gravel mat or the need to provide firm support for the pipe or electrical duct by other suitable methods.

2. Payment for such trench stabilization will be made under the appropriate Contract Items or where no such items exist, as a change in the Work.

E. Length of Excavation: Keep the open excavated trench preceding the pipe or electrical duct laying operation and the unfilled trench, with pipe or duct in place, to a minimum length which causes the least disturbance. Provide ladders for a means of exit from the trench as required by applicable safety and health regulations.

F. Water: Allow no water to rise in the trench excavation until sufficient backfill has been placed to prevent pipe or duct flotation.

3.4 SHORT TUNNEL EXCAVATION

A. Short Tunnel Requirements: In some instances, trees, shrubs, utilities, sidewalks and other obstructions may be encountered, the proximity of which may be a hindrance to opencut trench excavation. In such cases, excavate by means of short tunnels in order to protect such obstructions against damage.

1. Construct the short tunnel by hand, auger or other approved method approximately 6 inches larger than the diameter of pipe bells or outer electrical duct encasement.

2. Consider such short tunnel work incidental to the construction of pipelines or conduits and all appurtenances. The need for short tunnels will not be grounds for additional payment.

3.5 EXCAVATION FOR JACKING AND AUGERING

A. Jacking and Augering Requirements: Allow adequate length in jacking pits to provide room for the jacking frame, the jacking head, the reaction blocks, the jacks, auger rig, and the jacking pipe. Provide sufficient pit width to allow ample

working space on each side of the jacking frame. Allow sufficient pit depth such that the invert of the pipe, when placed on the guide frame, will be at the elevation desired for the completed line. Tightly sheet the pit and keep it dry at all times.

3.6 ROCK EXCAVATION

A. Rock Excavation: Excavate rock within the boundary lines and grades as shown, specified or required.

1. Rock removed from the excavation becomes the property of the CONTRACTOR. Transport and dispose of excavated rock at an off site disposal location. Obtain the off site disposal location.

2. Remove all shattered rock and loose pieces.

B. Structure Depths: For cast-in-place structures, excavate the rock only to the bottom of the structure, foundation slab, or drainage blanket.

C. Trench Depth: For trench excavation in which pipelines or electrical ducts are to be placed, excavate the rock to a minimum depth of 6 inches below the bottom of the pipe or duct encasement and refill the excavated space with pipe bedding material. Include placing, compacting and shaping pipe bedding material in the appropriate Contract Items.

D. Manhole Depths: For manhole excavation, excavate the rock to a minimum depth of 8 inches below the bottom of the manhole base for pipelines 24 inches in diameter and larger and 6 inches below the bottom manhole base for pipelines less than 24 inches in diameter. Refill the excavated space with pipe bedding material. Include placing, compacting and shaping pipe bedding material for manhole bases in the appropriate Contract Items.

E. Over-excavated Space: Refill the excavated space in rock below structures, pipelines, conduits and manholes, which exceeds the specified depths with Class D concrete, crushed stone or other material as directed. Include refilling of over-excavated space in rock as part of the rock excavation.

F. Other Requirements: Follow, where applicable, the requirements of the subsections on "Trench Excavation" and "Structure Excavation".

G. Payment: Rock excavation, including placing, compacting and shaping of the select fill material, will be paid for under the appropriate Contract Items or where no such items exist, as a change in the Work.

H. Blasting: Perform authorized blasting by authorized and qualified workers as approved as to the number, length, placing and direction, and loading of holes. Do

not use charges which will make the excavation unduly large or irregular, nor shatter the rock upon or against which masonry is to be built, nor injure masonry or existing structures at the site or in the vicinity.

1. Cover each blast with a woven wire cable mat weighted with heavy timbers. Blasting will not be permitted within 25 feet of existing or of the completed pipeline or structure. Control blasts in tunnels so that the material surrounding the tunnel base proper is not loosened or displaced.

2. Discontinue blasting whenever it is determined that further blasting may injure or damage adjacent rock, masonry, utility lines, or other structures. In such cases, excavate the remaining rock by barring, wedging, or other approved methods.

3. Where sewers, gas, water, steam, or other utility ducts or lines, catch basin connections, or other structures have been exposed during excavation, adequately protect such structures from damage before proceeding with the blasting. Promptly repair any structure damaged by blasting at no addition to the Contract Price.

4. Take due precautions to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, lightning, adjacent powerlines, dust storms or other sources of extraneous electricity.

5. Keep a sufficient quantity of explosives on hand to avoid delay to the Work on the site when rock excavation is in progress. At no time keep a quantity in excess of that which will be required for use within the following 12 hours.

6. Store, handle and use such explosives in conformity with all laws, ordinances, and regulations of the City or governing body governing the storage and use of explosives at the construction site.

7. Provide a magazine keeper to keep accurate daily records and account for each piece of explosive, detonator and equipment from time of delivery at the magazine until used or removed from the site. Abandon no explosives or blasting agents.

8. Take sole responsibility for the methods of handling, use, and storage of explosives and any damage to persons or property resulting therefrom. Approval of these methods or failure to order that blasting be discontinued does not relieve the CONTRACTOR of any of this responsibility.

3.7 FINISHED EXCAVATION

A. Finish: Provide a reasonably smooth finished surface for all excavations, which is uniformly compacted and free from irregular surface changes.

B. Finish Methods: Provide a degree of finish which is ordinarily obtainable from blade-grade operations, except as otherwise specified in Section 31 23 23.

3.8 PROTECTION

A. Traffic and Erosion: Protect newly graded areas from traffic and from erosion.

B. Repair: Repair any settlement or washing away that may occur from any cause, prior to acceptance. Re-establish grades to the required elevations and slopes.

C. Other Requirements: Conduct all Work in accordance with the environmental protection requirements specified in Division 1.

3.9 AUTHORIZED ADDITIONAL EXCAVATION

A. Additional Excavation: Carry the excavation to such additional depth and width as authorized in writing, for the following reasons:

1. In case the materials encountered at the elevations shown are not suitable.

2. In case it is found desirable or necessary to go to an additional depth, or to an additional depth and width.

B. Refill Materials: Refill such excavated space with either authorized Class D concrete or compacted select fill material.

C. Compaction: Where necessary, compact fill materials to avoid future settlement.

D. Payment: Additional earth excavations so authorized and concrete or select fill materials authorized for filling such additional excavation and compaction of select fill materials will be paid for under the appropriate Contract Items or where no such items exist, as a change in the Work.

3.10 UNAUTHORIZED EXCAVATION

A. Stability: Refill any excavation carried beyond or below the lines and grades shown, except as specified in the subsection headed "Authorized Additional Excavation", with such material and in such manner as may be approved in order to provide for the stability of the various structures.

B. Refill Materials: Refill spaces beneath all manholes, structures, pipelines, or conduits excavated without authority with Class D concrete or compacted select fill material, as approved.

C. Payment: Refill for unauthorized excavation will not be measured and no payment will be made therefor.

3.11 SEGREGATION STORAGE AND DISPOSAL OF MATERIAL

A. Stockpiling Suitable Materials: Stockpile topsoil suitable for final grading and landscaping and excavated material suitable for backfilling or embankments separately on the site in approved locations.

B. Stockpile Locations: Store excavated and other material a sufficient distance away from the edge of any excavation to prevent its falling or sliding back into the excavation and to prevent collapse of the wall of the excavation. Provide not less than 2 feet clear space between the top of any stockpile and other material and the edge of any excavation.

C. Excess Materials: Transport and dispose of surplus excavated material and excavated material unsuitable for backfilling or embankments at an off site disposal location. Obtain the off site disposal location.

3.12 REMOVAL OF WATER

A. Water Removal: At all times during the excavation period and until completion and acceptance of the WORK at final inspection, provide ample means and equipment with which to remove promptly and dispose of properly all water entering any excavation or other parts of the WORK.

B. Dry Excavations: Keep the excavation dry.

C. Water Contact: Allow no water to rise over or come in contact with masonry and concrete until the concrete and mortar have attained a set and, in any event, not sooner than 12 hours after placing the masonry or concrete.

D. Discharge of Water: Dispose of water pumped or drained from the Work in a safe and suitable manner without damage to adjacent property or streets or to other work under construction.

E. Protection: Provide adequate protection for water discharged onto streets. Protect the street surface at the point of discharge.

F. Sanitary Sewers: Discharge no water into sanitary sewers.

G. Storm Sewers: Discharge no water containing settleable solids into storm sewers.

H. Repair: Promptly repair any and all damage caused by dewatering the Work.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 31 23 23

BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Backfill all excavation to the original surface of the ground or to such other grades as may be shown or required. For areas to be covered by topsoil, leave or stop backfill (12) inches below the finished grade or as shown. Obtain approval before backfilling against masonry structures. Remove from all backfill, any compressible, putrescible, or destructible rubbish and refuse and all lumber and braces from the excavated space before backfilling is started. Leave sheeting and bracing in place or remove as the work progresses.

B. Equipment Limitations: Do not permit construction equipment used to backfill to travel against and over cast-in-place concrete structures until the specified concrete strength has been obtained, as verified by concrete test cylinders. In special cases where conditions warrant, the above restriction may be modified providing the concrete has gained sufficient strength, as determined from test cylinders, to satisfy design requirements for the removal of forms and the application of load.

C. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 31 10 00 - Site Clearing

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

1.3 SUBMITTALS

A. Provide all submittals, including the following in accordance with Division 1.

1. Certified laboratory reports of all proposed backfill material.

PART 2 PRODUCTS

2.1 BACKFILL MATERIAL - GENERAL

A. General: Backfill with sound materials, free from waste, organic matter, rubbish, boggy or other unsuitable materials.

B. General Materials Requirements: Conform materials used for backfilling to the requirements specified. Follow common fill requirements whenever drainage or select fill is not specified. Determine and obtain the approval of the appropriate test method where more than one compaction test method is specified.

C. Frozen Materials: Do not use frozen material for backfilling.

2.2 DRAINAGE FILL

A. Materials for Drainage Fill: Use clean gravel, crushed stone, or other suitable material conforming to the gradation specified for drainage fill. Clay and fine particles are unacceptable in drainage fill. Provide drainage fill of a grade between the following limits:

U.S. Standard Sieve	Percent Passing by Weight
1-1/2 inch	100
1 inch	95-100
1/2 inch	45-65
#4	5-15
#16	0-4

2.3 SELECT FILL

A. Materials for Select Fill: Use gravel, crushed stone, limestone screenings or other granular or similar material as approved which can be readily and thoroughly compacted to 95 percent of the maximum dry density obtainable by ASTM D 1557.

1. Grade select fill between the following limits:

U.S. Standard Sieve	Percent Passing by Weight
2 inch	100
1-1/2 inch	90-100
1 inch	75-95

1/2 inch	45-70
#4	25-50
#10	15-40
#200	5-15

2. Very fine sand, uniformly graded sands and gravels, or other materials that have a tendency to flow under pressure when wet are unacceptable as select fill.

2.4 COMMON FILL

A. Materials for Common Fill: Material from on-site excavation may be used as common fill provided that it can be readily compacted to 90 percent of the maximum dry density obtainable by ASTM D 1557, and does not contain unsuitable material. Select fill may be used as common fill at no change in the Contract Price.

B. Granular Materials On-Site: Granular on-site material, which is fairly well graded between the following limits may be used as granular common fill:

U.S. Standard Sieve	Percent Passing by Weight
3 inch	100
#10	50-100
#60	20-90
#200	0-20

C. Cohesive Materials On-Site: Cohesive site material may be used as common fill.

1. The gradation requirements do not apply to cohesive common fill.

2. Use material having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20.

D. Material Approval: All material used as common fill is subject to approval. If there is insufficient on-site material, import whatever additional off-site material is required which conforms to the specifications and at no additional cost.

2.5 PIPE BEDDING

A. Gradation for Small Piping: For pipe 18 inches or less in diameter, comprise pipe bedding of material 90 percent of which will be retained on a No. 8 sieve and 100

percent of which will pass a 1/2-inch sieve and be well graded between those limits.

B. Gradation for Large Piping: For pipe larger than 18 inches in diameter, use the same pipe bedding material as specified for smaller pipe or use a similar well graded material 90 percent of which will be retained on a No. 8 sieve and 100 percent of which will pass a 1-inch sieve.

PART 3 EXECUTION

3.1 ELECTRICAL DUCT AND PRECAST MANHOLE BEDDING

A. Bedding Compaction: Bed all electrical ducts and precast manholes in well graded, compacted, select fill conforming to the requirements except as otherwise shown, specified, or required. Extend electrical duct bedding a minimum of 6 inches below the bottom of the duct encasement for the full trench width. Compact bedding thickness no less than 6 inches for precast concrete manhole bases.

B. Concrete Work Mats: Cast cast-in-place manhole bases and other foundations for structures against a Class D concrete work mat in clean and dry excavations, unless otherwise shown, specified or required.

C. Bedding Placement: Place select fill used for bedding beneath electrical ducts and precast manhole bases, in uniform layers not greater than 9 inches in loose thickness. Thoroughly compact in place with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

D. Use of Select Fill: Bed existing underground structures, tunnels, conduits and pipes crossing the excavation with compacted select fill material. Place bedding material under and around each existing underground structure, tunnel, conduit or pipe and extend underneath and on each side to a distance equal to the depth of the trench below the structure, tunnel, conduit or pipe.

3.2 PIPE BEDDING

A. Hand Placement: Place select fill pipe bedding by hand from the bottom of the excavation to 1 foot over the top of the pipe in uniform layers not greater than 6 inches in loose thickness. Tamp under pipe haunches and thoroughly compact pipe bedding in place with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D 1557 (Modified Proctor).

B. Stone Placement: Do not place large stone fragments in the pipe bedding or backfill to 1 foot over the top of pipes, nor nearer than 2 feet at any point from any pipe, conduit or concrete wall.

C. Unallowed Materials: Pipe bedding containing very fine sand, uniformly graded sands and gravels, or other materials that have a tendency to flow under pressure when wet is unacceptable.

3.3 BEDDING PLACEMENT AND BACKFILL FOR PIPE IN SHORT TUNNEL

A. Bed pipelines or electrical ducts placed in short tunnels in select fill or Class D concrete. Completely fill the remainder of the annular space between the outside of the pipe wall and the tunnel wall with select fill, suitable job-excavated material, or Class D concrete, as approved. Suitably support pipelines or ducts in short tunnels to permit placing of backfill suitably tamped in place.

3.4 TRENCH BACKFILL

A. General: Backfill trenches from 1 foot over the top of the pipe, from the top of electrical duct bedding or as shown to the bottom of pavement base course, subgrade for lawns or lawn replacement, to the top of the existing ground surface or to such other grades as may be shown or required.

B. Materials: Provide select fill, suitable job-excavated material or other material, as specified and as approved for trench backfill.

C. Depth of Placement - General: Except under pavements, walkways, railroad tracks, and street or highway appurtenances, or as otherwise specified, place trench backfill in uniform layers not greater than 9 inches in loose thickness and thoroughly compact in place using suitable mechanical or pneumatic equipment. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

D. Depth of Placement - Traffic Areas and Under Utilities: Where pavements, walkways, railroad tracks and street or highway appurtenances are to be placed over trenches and under utilities or utility services crossing the trench, provide trench backfill using select fill placed in uniform layers not greater than 9 inches in loose thickness and thoroughly compacted in place with equipment as specified above. Compact backfill to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

E. Depth of Placement - Undeveloped Areas: In nondeveloped areas and where select fill material or hand-placed backfill are not specified or required, place suitable job-excavated material or other approved backfill in lifts not exceeding 12 inches in loose thickness. When the trench is full, consolidate the backfill by jetting, spading, tamping or puddling to ensure complete filling of the excavation.

Mound the top of the trench approximately 12 inches to allow for consolidation of backfill.

F. Dropping of Material on Work: Do trench backfilling work in such a way as to prevent dropping material directly on top of any conduit or pipe through any great vertical distance. Do not allow backfilling material from a bucket to fall directly on a structure or pipe and, in all cases, lower the bucket so that the shock of falling earth will not cause damage.

G. Distribution of Large Materials: Break lumps up and distribute any stones, pieces of crushed rock or lumps which cannot be readily broken up, throughout the mass so that all interstices are solidly filled with fine material.

3.5 STRUCTURE BACKFILL

A. Use of Select Fill: Use select fill underneath all structures, and adjacent to structures where pipes, connections, electrical ducts and structural foundations are to be located within this fill. Use select fill beneath all pavements, walkways, and railroad tracks, and extend to the bottom of pavement base course or ballast.

1. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable approved mechanical or pneumatic equipment.

2. Compact backfill to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

B. Use of Common Fill: Use common granular fill adjacent to structures in all areas not specified above, unless otherwise shown or specified. Select fill may be used in place of common granular fill at no additional cost.

1. Extend such backfill from the bottom of the excavation or top of bedding to the bottom of subgrade for lawns or lawn replacement, the top of previously existing ground surface or to such other grades as may be shown or required.

2. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable equipment, as specified above.

3. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

C. Use of Clay: In unpaved areas adjacent to structures for the top 1 foot of fill directly under lawn subgrades use clay backfill placed in 6-inch lifts. Compact clay backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

1. Use clay having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20.

3.6 DRAINAGE BLANKET

A. Drainage Fill Placement: Provide a drainage blanket where shown consisting of drainage fill.

1. Place drainage fill underneath all structures and adjacent to structures where pipes, connections, electrical ducts and structural foundations located within this fill, in uniform layers not greater than 8 inches in loose thickness. Compact drainage fill with suitable mechanical or pneumatic equipment to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

2. Place drainage fill adjacent to structures in all areas not specified above in uniform layers not greater than 8 inches in loose thickness. Compact drainage fill with suitable mechanical or pneumatic equipment to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

3.7 EARTH EMBANKMENTS

A. Use of Cohesive Materials: Make all earth embankments of approved cohesive common fill material.

1. Place fill in uniform layers not greater than 10 inches in loose thickness. Compact in place with suitable approved mechanical equipment.

2. Compact earth embankments to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

3. Do not use cohesionless, granular material as earth embankment backfill, unless otherwise shown or required.

3.8 COMPACTION EQUIPMENT

A. Equipment and Methods: Carry out all compaction with suitable approved equipment and methods.

1. Compact clay and other cohesive material with sheep's-foot rollers or similar equipment where practicable. Use hand held pneumatic tampers elsewhere for compaction of cohesive fill material.

2. Compact low cohesive soils with pneumatic-tire rollers or large vibratory equipment where practicable. Use small vibratory equipment elsewhere for compaction of cohesionless fill material.

3. Do not use heavy compaction equipment over pipelines or other structures, unless the depth of fill is sufficient to adequately distribute the load.

3.9 FINISH GRADING

A. Final Contours: Perform finish grading in accordance with the completed contour elevations and grades shown and blend into conformation with remaining natural ground surfaces.

1. Leave all finished grading surfaces smooth and firm to drain.

2. Bring finish grades to elevations within plus or minus 0.10 foot of elevations or contours shown.

B. Surface Drainage: Perform grading outside of building or structure lines in a manner to prevent accumulation of water within the area. Where necessary or where shown, extend finish grading to ensure that water will be carried to drainage ditches, and the site area left smooth and free from depressions holding water.

3.10 RESPONSIBILITY FOR AFTERSETTLEMENT

A. Aftersettlement Responsibility: Take responsibility for correcting any depression which may develop in backfilled areas from settlement within one year after the work is fully completed. Provide as needed, backfill material, pavement base replacement, permanent pavement, sidewalk, curb and driveway repair or replacement, and lawn replacement, and perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as approved.

3.11 INSPECTION AND TESTING OF BACKFILLING

A. Sampling and Testing: Sampling and testing of all in-place backfill will be provided by the OWNER as specified in Division 1. If initial testing reveals non-compliance with Contract requirements, all additional testing will be made at the Contractor's expense.

B. Correction of Work: Correct any areas of unsatisfactory compaction by removal and replacement, or by scarifying, aerating or sprinkling as needed and recompaction in place prior to placement of a new lift.

END OF SECTION

SECTION 31 41 00

SHORING, SHEETING AND BRACING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Work required for protection of an excavation or structure through shoring, sheeting, and bracing.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 31 23 16 - Excavation - Earth and Rock
2. Section 31 23 23 - Backfilling

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. CONTRACTOR's Submittals: Submit a CERTIFICATE (ONLY), signed and sealed by a Licensed Professional Engineer experienced in Structural Engineering and registered in the State where the construction will be performed, that certifies that the Licensed Professional Engineer has evaluated and approved the CONTRACTOR's excavation plan and has prepared complete design calculations and working drawings for the shoring, sheeting and bracing, not specifically shown on the Contract Drawings, which will be used for excavation support. Provide a separate CERTIFICATE for each excavation before starting the excavation. Where commercially manufactured trench boxes are to be used, provide a CERTIFICATE from the CONTRACTOR's Licensed Professional Engineer stating the conditions under which the trench boxes will be used.

1.3 REFERENCES

A. Codes and standards referred to in this Section are:

1. All Federal, State and local laws and regulations applying to the design and construction of shoring, sheeting and bracing.

2. National Bureau of Standards Building Science Series 127 "Recommended Technical Provisions for Construction Practice in Shoring and Sloping Trenches and Excavations."

PART 2 PRODUCTS

2.1 MANUFACTURERS AND MATERIALS

A. Use manufacturers and materials for shoring, sheeting and bracing as recommended by the CONTRACTOR's Licensed Professional Engineer who designed the shoring, sheeting, and bracing. Where wood lagging is to be left in place use oak or treated fir or treated pine. Use only environmentally safe treatment for wood lagging.

PART 3 EXECUTION

3.1 SHORING, SHEETING AND BRACING INSTALLATION

A. General: Provide safe working conditions, prevent shifting of material, prevent damage to structures or other work, and avoid delay to the work, all in accordance with applicable laws and regulations. Properly shore, sheet, and brace all excavations that are not cut back to the proper slope, as determined by the CONTRACTOR's Licensed Professional Engineer.

1. Take sole responsibility for the design and adequacy of shoring, sheeting and bracing not shown on the Contract Drawings.

2. Take sole responsibility for the methods of installation of the shoring, sheeting and bracing.

B. Arrange shoring, sheeting and bracing so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength.

C. If the CONTRACTOR or its Licensed Professional Engineer is of the opinion that at any time the CONTRACTOR's excavation plan, shoring, sheeting or bracing is inadequate or unsuited for the purpose, take immediate and appropriate action. Provide a new CERTIFICATE if the CONTRACTOR's excavation plans, shoring, sheeting or bracing require modifications.

D. Monitoring: Periodically monitor horizontal and vertical deflections of sheeting, shoring and bracing.

E. Accurately locate all underground utilities and take the required measures necessary to protect them from damage. All underground utilities shall be kept in service at all times as specified in Division 1.

F. Remove shoring, sheeting and bracing as the excavation is refilled in a manner to avoid the caving in of the bank or disturbance to adjacent areas or structures or pipe bedding.

1. Carefully fill voids left by the withdrawal of the shore, sheeting and bracing. No separate payment will be made for the filling of such voids.

2. If pipe bedding is disturbed, re-compact it to meet specified density requirements.

G. Permission for Removal: Obtain permission from the CONTRACTOR's Licensed Professional Engineer before the removal of any shoring, sheeting or bracing. Retain the responsibility for injury to structures or to other property or persons for failure to leave such shoring, sheeting and bracing in place even though permission for removal has been obtained.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 33 05 50

LAYING AND JOINTING BURIED PIPELINES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Installation of all underground pipelines. Provide pipeline materials, coatings and linings as specified and pipe of the types, sizes and classes shown or specified.

1. Use proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fittings.

2. Use suitable fittings where shown and at connections or where grade or alignment changes require offsets greater than those recommended and approved.

3. Lay all underground pipelines not supported on piles or concrete cradle in select fill bedding material.

4. Close off all lines with bulkheads when pipe laying is not in progress.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 50 - Leakage Tests
2. Section 31 23 16 - Excavation - Earth and Rock
3. Section 31 23 23 - Backfilling
4. Section 33 13 00 - Disinfection

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM C 12 - Practice for Installing Vitrified Clay Pipe Lines

2. ASTM D 2774 - Practice for Underground Installation of Thermoplastic Pressure Piping

3. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

4. ASTM C 361 - Specification for Reinforced Concrete Low-Head Pressure Pipe

5. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile

6. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, C25, 125, 250, 800

7. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges

8. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

9. ASTM A 139 - Duplicate Entry, Specification Section 33 05 23

10. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Threaded Flanges

11. AWWA C206 - Field Welding of Steel Water Pipe

12. ASTM E 165 - Practice for Liquid Penetrant Examination

13. ASTM E 709 - Practice for Magnetic Particle Examination

1.3 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows:

B. Transportation and Delivery: Take every precaution to prevent injury to the pipe during transportation and delivery to the site.

C. Loading and Unloading: Take extreme care in loading and unloading the pipe and fittings.

1. Work slowly with skids or suitable power equipment, and keep pipe under perfect control at all times.

2. Under no condition is the pipe to be dropped, bumped, dragged, pushed, or moved in any way that will cause damage to the pipe or coating.

D. Sling: When handling the pipe with a crane, use a suitable sling around the pipe.

1. Under no condition pass the sling through the pipe.

2. Use a nylon canvas type sling or other material designed to prevent damage to the pipe and coating.

3. When handling reinforced concrete pipe or uncoated steel or ductile iron pipe, steel cables, chain or like slings are acceptable.

E. Damaged Piping: If in the process of transportation, handling, or laying, any pipe or fitting is damaged, replace or repair such pipe or pipes.

F. Blocking and Stakes: Provide suitable blocking and stakes installed to prevent pipe from rolling.

1. Obtain approval for the type of blocking and stakes, and the method of installation.

G. Storage for Gaskets: Store gaskets for pipe joints in a cool place and protect gaskets from light, sunlight, heat, oil, or grease until installed.

1. Do not use any gaskets showing signs of checking, weathering or other deterioration.

2. Do not use gasket material stored in excess of six months without approval.

1.4 FIELD CONDITIONS

A. Repair of Sanitary Sewers and Services: Rebed, in compacted select fill material, sanitary sewers which cross over the new pipe or which cross under the new pipe with less than 12 inches clear vertical separation. Compact the bedding to densities required for new pipeline construction and extend bedding below the sewer to undisturbed earth. Reconstruct sewers damaged by pipeline construction.

1. Furnish and install all materials and do all work necessary for the reconstruction or repairs of sanitary sewers and services.

2. Provide pipe for reconstruction of sanitary sewers and services meeting the appropriate specification requirements.

3. Provide pipe of the same size as the existing sewer or when the same size is not available, use the next larger size of pipe. Obtain approval of joints made between new pipe and existing pipe.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Dry Trench Bottoms: Lay pipe only in dry trenches having a stable bottom.

1. Where groundwater is encountered, make every effort to obtain a dry trench bottom.

2. If a dry trench bottom has not been obtained due to improper or insufficient use of all known methods of trench dewatering, (then) (the order to) excavate below grade and place sufficient select fill material, crushed stone, or Class D concrete over the trench bottom (may be given).

3. If all efforts fail to obtain a stable dry trench bottom and it is determined that the trench bottom is unsuitable for pipe foundation, obtain an order, in writing, for the kind of stabilization to be constructed.

4. Perform trench excavation and backfill in accordance with Sections 31 23 16 and 31 23 23.

3.2 INSTALLATION

A. General: Install all piping in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

1. Arrange miscellaneous pipelines, which are shown in diagram form on the Plans, clear of other pipelines and equipment.

B. Code Requirements: Provide pipeline installations complying with AWWA C600 for iron pipe, AWWA Manual M11 for steel pipe, AWWA Manual M9 for prestressed concrete cylinder pipe, ASTM C 12 for clay pipe, ASTM D 2774 for thermoplastic pressure piping 6-inch and smaller, and as modified or supplemented by the Specifications.

C. Pipe Laying - General:

1. For pipelines intended for gravity flow, begin pipeline laying at the low end of a run and proceed upgrade.

2. Generally, lay all pipe with bells pointing ahead.

3. Carefully place each pipe and check for alignment and grade.

4. Make adjustments to bring pipe to line and grade by scraping away or filling in select fill material under the body of the pipe.

5. Wedging or blocking up the pipe barrel is not permitted.

6. Bring the faces of the spigot ends and the bells of pipes into fair contact and firmly and completely shove the pipe home.

7. As the work progresses, clean the interior of pipelines of all dirt and superfluous materials of every description.

8. Keep all lines absolutely clean during construction.

9. Lay pipelines accurately to line and grade.

D. Pipe Laying - Trenches:

1. Lay all pipelines in trench excavations on select fill bedding, Class D concrete cradle or other foundations as shown, specified or ordered in writing.

2. Properly secure the pipe against movement and make the pipe joints in the excavation as required.

3. Carefully grade and compact pipe bedding.

4. Bell Holes:

a. Cut out bell holes for each joint as required to permit the joint to be properly made and allow the barrel of the pipe to have full bearing throughout its length.

b. Thoroughly tamp bell holes full of select fill material following the making of each joint.

E. Other Foundations: Install pipelines laid on other types of foundations as specified for such other foundations or as ordered in writing.

F. Ductile Iron Pipe Mechanical Joints:

1. Assembly: In making up mechanical joints, center the spigot in the bell.

a. Thoroughly brush the surfaces with which the rubber gasket comes in contact with a wire brush just prior to assembly of the joint.

b. Brush lubricant over the gasket just prior to installation.

c. Place the gasket and gland in position, bolts inserted, and the nuts tightened fingertight.

d. Tighten the nuts with a torque wrench so that the gland is brought up toward the pipe evenly.

e. Prime all bolts by dipping with a bituminous coating, except the threads. Coat threads immediately prior to installation of nuts.

2. Torques: Apply bolt torques complying with AWWA C600.

3. Remaking of Joints: If effective sealing is not obtained at the maximum torque listed above, disassemble and reassemble the joint after thorough cleaning.

G. Ductile Iron Pipe Rubber Gasket Joints:

1. Assembly: In making up the rubber gasket joint, brush the gasket seat in the socket thoroughly with a wire brush and wipe the gasket with a cloth.

a. Place the gasket in the socket with the large round end entering first so that the groove fits over the bead in the seat.

b. Apply a thin film of lubricant to the inside surface of the gasket that will come in contact with the entering pipe.

c. Brush the plain end of the pipe to be entered thoroughly with a wire brush and place it in alignment with the bell of the pipe to which it is to be joined.

d. Exert sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket to make the joint.

2. Positioning: Before proceeding with backfilling, feel completely around the joint using a feeler gauge to confirm that the gasket is in its proper position.

a. If the gasket can be felt out of position, withdraw the pipe and examine the gasket for cuts or breaks.

b. If the gasket has been damaged, replace it with a new one before re-installing the pipe.

3. Optional Mechanical Joints: Use mechanical joint fittings that meet the requirements of Section 33 05 55 with the rubber gasket joint pipe when specified or when rubber gasket fittings are not available.

4. Positioning: Prior to backfilling, feel completely around the joint using a feeler gauge to determine whether the gasket is in its proper position.

a. If the gasket can be felt out of position, withdraw the pipe and examine the gasket for cuts or breaks.

b. If the gasket has been damaged, replace it with a new one before re-installing the pipe.

H. Steel Pipe Field Welded Lap Joints: For steel pipe 30 inches in diameter and larger, single weld field welded lap joints on the inside of the joint, except that, where restrained joints are shown, double weld the joints. For steel pipe less than 30 inches in diameter, single weld the field welded lap joints on the outside of the joint. Perform 1/4-inch throat fillet welds with a minimum of two passes. Provide adequate space for welding and inspection of the joints. Perform all welding in accordance with the requirements of AWWA C206.

1. Do all welding with skilled welders experienced in the welding methods to be used and with materials to be welded. Qualify the welding operator under the provisions of AWWA C206 not more than one year prior to commencing work on the pipeline. Use machines and electrodes during qualification tests similar to those used in the work.

2. During welding of the joints, protect the pipe coating to avoid damage to the coating by hot weld spatters. Do not make welding grounds on the coated part of the pipe.

3. Clean all dirt, slag and flux after each pass of deposited weld metal prior to making the next pass.

4. As soon as practicable after welding the joint, test the weld around the entire circumference of the joint by the liquid penetrant test method in accordance with ASTM E 165 or the magnetic particle examination method in accordance with ASTM E 709. Repair any defect disclosed by the test and retest the joint at no additional cost.

I. Steel Pipe Joint Coating: Wrap the exterior of all joints for buried steel pipe with a tape coating in accordance with AWWA C209. Provide tape a minimum of 6 inches wide. Apply tape by technicians certified by the manufacturer. Clean, prime and wrap each joint with two wraps of tape, 30 mils minimum thickness.

J. Ductile Iron Pipe and Steel Pipe Joint Lining: For cement mortar lined ductile iron pipe greater than 30 inches in diameter, fill all interior joint recesses with mortar and make recesses smooth and flush with adjacent pipe interior walls in accordance with AWWA C205, Appendix A.2. For cement mortar lined steel pipe 8 inches in diameter and larger, except sleeve type coupling joints, fill all interior joint recesses with mortar and make recesses smooth and flush with adjacent pipe interior walls in accordance with AWWA C205, Appendix A.2. Use Type II portland cement in mortar for interior joint finishing of wastewater pipelines.

K. Cast Iron Soil Pipe Joints:

1. Joints: Provide joints of lead and oakum or rubber gasket compression type.

   a. Thoroughly caulk leaded joints with picked oakum and molten lead.

   b. Use twelve ounces of soft pig or bar lead in each joint for each 1-inch of pipe diameter.

   c. Pour all lead in at one time.

   d. Finish the face of lead joints with the face of the hub and leave without putty, paint or cement.

   e. Extend gasket on rubber gasket joints the full depth of the bell and overlap the face of the bell.

2. Connection: Provide leakproof and gastight joints.

L. Temporary Bulkheads: Provide temporary bulkheads at the ends of sections where adjoining pipelines have not been completed, and in connections built into pipelines where adjoining pipelines or structures have not been completed and are not ready to be connected.

1. Remove bulkheads encountered in connecting sewers or structures included in this Contract, or in pipelines or structures previously built, when they are no longer needed or when ordered.

M. Sleeve Type Couplings: For sleeve type couplings, equally tighten diametrically opposite bolts on the connection so that the gaskets will be brought up evenly all around the pipe.

1. Torque Wrenches: Do the final tightening with torque wrenches set for the torque recommended by the coupling manufacturer.

N. Concrete Cradle

1. General: When a concrete cradle is shown, specified, or ordered in writing, lay the pipe to grade by supporting each section on concrete blocks located near each end.

   a. Shape the tops of the blocks to fit the outside diameter of the pipe.

   b. Set the blocks approximately 3/8 inch low.

c. Place the pipe on the blocks on a layer of stiff mortar of sufficient thickness to bring the pipes to exact grade.

d. Timber blocking, of a type approved, may be employed in place of concrete blocks.

2. Cradle: Place Class D concrete cradle, on one side only, until it has risen above the invert on the other side, after which deposit the remainder of the concrete on both sides to the pipe spring line.

a. Prevent movement of the pipe during concrete placement.

O. Concrete Encasement: When concrete encasement is to be provided, as shown, specified, or ordered in writing, lay and block the pipeline and place concrete as specified for concrete cradle.

1. Continue the placing of concrete to provide complete encasement to the dimensions shown, specified, or ordered.

P. Jointing Concrete Pipe:

1. Preparation of Joint Surfaces: Before joining concrete pipe using flexible rubber gaskets, wipe clean the joint surfaces of both the bell and spigot ends.

a. Repair any lumps, projections, burrs, or chips which would interfere with the proper compression of the gasket.

b. Insert the spigot end into the bell with the gasket in place and with all surfaces lubricated as recommended.

c. Apply pressure to seat the pipe properly in the bell.

2. Curve Offset: Construct curves for reinforced concrete pipelines with standard pipe where the opening of the joint on the outside of the curve is less than 1/2 inch.

3. Curve Fittings: Where greater opening of the joint would be required, construct curves using beveled or radius pipe with standard joints, short lengths of pipe, or plain end radius pipe with cast concrete collar joints, or continuous concrete encasement; or by monolithic construction.

Q. Jointing Clay Pipe: Joint clay pipe with flexible plastic joints in accordance with the manufacturer's instructions and as specified.

1. Wipe the joint surface clean and coat with lubricant on both the bell and spigot ends.

2. Insert the spigot end in the bell and apply sufficient force to seat the pipe properly.

R. Valve Box Setting: Install valve boxes vertical and concentric with the valve stem.

1. Satisfactorily reset any valve box which is moved from its original position, preventing the operation of the extension valve stem.

2. Replace any extension valve stem which has been damaged so that it can be operated.

S. Erection:

1. Anchorage: Place anchorage of pipelines and appurtenances as shown or as ordered.

a. Accomplish anchorage by placing concrete to the dimensions shown between undisturbed earth and the fitting to be anchored.

2. Valve Setting: Erect valves carefully in their proper positions, free from all distortion and strain, with flanged, mechanical or push-on joints, and pack and leave in satisfactory operating condition.

3. Short Tunnel Construction: Joint pipes to be placed in short tunnels prior to being placed into position.

a. Place the pipe into position in a manner which keeps joints tight.

3.3 FIELD QUALITY CONTROL

A. Testing: Test pipelines in accordance with Section 01 45 50.

1. Test valves in place, as far as practicable, and correct any defects in valves or connections.

B. Inspection: Clean, inspect, and examine each piece of pipe and each fitting and special for defects before it is installed.

1. Cut away any lumps or projections on the face of the spigot end or the shoulder.

2. Do not use any cracked, broken, or defective pieces in the work.

3. If any defective piece should be discovered after having been installed, remove and replace this piece with a sound piece in a satisfactory manner at no increase in Contract Amount.

3.4 CLEANING

A. General: Thoroughly clean all pipe before it is laid and keep it clean until it is accepted in the completed work.

B. Removal of Materials: Exercise special care to avoid leaving bits of wood, dirt, and other foreign particles in the pipe. If any particles are discovered before the final acceptance of the work, remove and clean the pipe.

3.5 DISINFECTION

A. General: Disinfect all pipelines that are to carry potable water in accordance with Section 33 13 00.

3.6 SCHEDULE

A. Definitions: Abbreviations used in the schedule are:

1. Pipe Materials:

a.	Al	Aluminum
b.	Br	Brass
c.	C	Concrete
d.	CI	Cast-iron
e.	CISP	Cast-iron soil pipe
f.	Cl	Clay
g.	CPVC	Chlorinated Polyvinyl Chloride
h.	CU	Copper
i.	DI	Ductile Iron
j.	PCCP	Prestressed Concrete Cylinder Pipe
k.	PE	Polyethylene
l.	PVC	Polyvinyl Chloride
m.	RCP	Reinforced Concrete Pipe
n.	RCPP	Reinforced Concrete Pressure Pipe
o.	SS	Stainless Steel
p.	St	Steel

2. Joints:

a.	B&S	Bell and Spigot
b.	F	Flanged
c.	G	Grooved End
d.	H	Harnessed
e.	HSC	Hub and Spigot - Compression Gasket
f.	HSL	Hub and Spigot - Lead and Oakum
g.	MJ	Mechanical Joint
h.	PO	Push-on Joint

i.	RRG	Restrained Retainer Gland
j.	RS	Rubber and Steel
k.	Sd	Soldered
l.	Sl	Sleeve Type Coupling
m.	SW	Solvent Welded
n.	W	Welded

3. Coatings and Linings:

a.	BC	Bituminous - Cold Application
b.	CE	Concrete Encased
c.	CL	Cement-Mortar Lined
d.	E	Epoxy
e.	G	Galvanized
f.	GL	Glass Lined
g.	I	Insulated
h.	KL	Polyvinylidene Fluoride (PVDF or KYNAR®)
i.	P	Painted
j.	PEW	Polyethylene Wrapped
k.	PPL	Polypropylene Lined
l.	RC	Rubber Coated
m.	RL	Rubber Lined
n.	SL	Polyvinylidene Chloride (PVDC or SARAN ®)
o.	TC	Tape Coated
p.	W	Wrapped

B. Schedule: Provide products as listed in the following schedule:

END OF SECTION

BURIED PIPING SCHEDULE

Service	Size (Inches)	Pipe Material	Protective Coatings		Joints	Test Pressure (psig)[1]	Pipe Class or Thickness	Remarks
			Int.	Ext.				
71st Street Force Main	24	DI	CL	PEW	RRG	100	150	
Cherry Creek Force Main Drain Line	12	DI	CL	PEW	RRG	100	150	
Primary Sludge Pump Station Drain Line	8	DI	CL	PEW	RRG	100	150	

Notes:

(1) Measure the test pressures shown in the schedule at the centerline of the pipeline's low point. Adjust test pressures measured at other locations accordingly.

(NO TEXT FOR THIS PAGE)

SECTION 33 05 55

BURIED DUCTILE-IRON PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing buried ductile-iron pipe, fittings and appurtenances, except soil pipe.

1. Provide ductile-iron pipe and fittings complete with all necessary jointing facilities and materials, specials, adapters and other appurtenances required for installation in and completion of the pipelines to be constructed.

2. Provide flanged, plain end or rubber gaskets (push-on or mechanical joint) of the types, sizes and classes shown or specified.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 50 - Leakage Test
2. Section 09 96 00 - High Performance Coatings
3. Section 33 05 50 - Laying and Jointing Buried Pipelines
4. Section 33 13 00 - Disinfection

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AWWA C104/ A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 3 In. Through 48 In., for Water and Other Liquids

4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

5. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Threaded Flanges

6. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids

7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings, 3 In. Through 12 In., for Water and Other Liquids

8. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings

9. AWWAC606 - Grooved and Shouldered Type Joints

10. ASTM A 307 - Carbon Steel Externally Threaded Standard Fasteners

1.3 SYSTEM DESCRIPTION

A. Design Standards: Provide ductile-iron pipe meeting the requirements of AWWA C151/A21.51.

1. Provide pipe of the various sizes and classes as specified in the schedule or shown, except provide minimum Thickness Class 53 for pipe with threaded flanges. Locate restrained joints and various beddings as shown.

2. Construct concrete encasements where shown.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Submit the following shop drawings:

1. Pipe joints, fittings, sleeves and cleanouts. Where special designs or fittings are required, show the Work in large detail and completely describe and dimension all items.

2. Fully dimensioned drawings of piping layouts, including fittings, couplings, sleeves, cleanouts, valves, supports and anchors. Label pipe size, materials, type, and class on drawings and include the limits of each reach of restrained joints. Provide cross sections showing elevations of cleanouts, pipes, fittings, sleeves, and valves.

3. Alignment survey and laying schedule as specified in Division 1. Cross reference the laying schedule to identification marks on pipeline pieces.

4. Catalog data for pipe, joints, fittings, sleeves, harnessing and cleanouts.

C. Quality Control: Submit certificate of compliance for pipe, fittings, gaskets, lining, polyethylene encasement, coatings, specials, sleeves and cleanouts in accordance with this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all pipe, fittings and appurtenances as specified in Division 1 and Section 33 05 50.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Manufacturers of equivalent products may be submitted.

1. Ductile-iron pipe and fittings.

   a. American Cast Iron Pipe Company
   b. McWane Incorporated
   c. United States Pipe and Foundry

2. Ductile-iron retainer glands.

   a. 3-inch through 24-inch diameter
      (1) Nappco, Inc. Series 1246
      (2) Ebba Iron, Inc. Series 100

   b. larger than 24-inch diameter
      (1) Ebba Iron, Inc. Megalug

3. Restrained push-on joints.

   a. U.S. Pipe and Foundry TR Flex
   b. McWane Inc. Super-Lock
   c. American Cast Iron Pipe Company Lok-Ring or Flex-Ring

4. Gaskets.

   a. John Crane, Inc.
   b. Garlock Packing Company
   c. U.S. Rubber Company
   d. American Cast Iron Pipe Company
   e. United States Pipe and Foundry

f. McWane Inc.

5. Coatings and Linings.

a. Kop-Coat
b. Tnemec
c. American Cast Iron Pipe Company
d. United States Pipe and Foundry

2.2 MATERIALS

A. Fittings: Provide all fittings meeting the requirements of AWWA C110/A21.10, unless shown or specified otherwise. Fittings 14 inches and larger require a pressure rating of 150 psi, or as specified, whichever is greater.

1. Flanged: Where long radius flanged fittings and other flanged fittings not covered in AWWA C110/A21.10 are shown or specified, provide items meeting the requirements of AWWA C110/A21.10 and having laying lengths conforming to ASME B16.1 for 125-pound American Standard fittings.

2. Compact Mechanical Joint and Rubber Gasket Joint: Where compact mechanical joint or rubber gasket joint fittings are shown or specified, provide items meeting the requirements of AWWA C153/A21.53.

B. Flanged Joints

1. Threaded Flanges: Provide threaded, ductile-iron long hub flanges meeting the requirements of AWWA C115/A21.15.

a. Screw flanges on the threaded end of the pipe in the shop.

b. Reface the face of the flange and the end of the pipe together.

c. Design flanges to prevent corrosion of the threads from the outside and to prevent leakage through the pipe threads.

2. Facing and Drilling: Provide flanges plain faced and drilled to the requirements of AWWA C115/A21.15, unless special drilling is called for or required. Face flange accurately at right angles to the pipe axis. Drill flanges smooth and true, and cover machined faces with zinc dust and tallow or equivalent material.

3. Taps: Tap flanges where tap or stud bolts are required.

4. Fasteners: Provide bolts, stud bolts, and nuts meeting the requirements of ASTM A 307, Grade B.

5. Gaskets: Provide full-face gaskets for flanged joints on 12-inch diameter and smaller pipe and gaskets of the ring type for flanged joints on larger pipe. Provide flange gaskets meeting the requirements of AWWA C115/A21.15, except make gaskets for gas lines with neoprene and aramid.

C. Rubber Gasket Joints: Provide mechanical joints and push-on type joints meeting the requirements of AWWA C111/A21.11.

D. Harnessing: For ductile-iron pipe and fittings with mechanical joints that require harnessing, provide ductile-iron mechanical joint retainer glands.

1. Coatings: Coat the assembly with two heavy coats of asphalt varnish conforming to AWWA C151/A21.51 after installation.

2. Joint Assemblies: Design the joint assemblies to resist pullout of the joints at the test pressures specified.

E. Sleeves: Provide mechanical joint solid sleeves meeting the requirements of AWWA C110/A21.10 where shown, specified or required for connection to existing facilities.

F. Cleanouts

1. Provide cleanouts where shown or specified.

2. Size: Provide not less than 6 inch diameter cleanout openings for pipe 8 inches in diameter or larger. Provide cleanout openings for pipe 6 inches in diameter or smaller of the same diameter as the pipe.

3. Cleanout Covers: Provide cleanout covers which are blind flanges meeting the requirements of AWWA C110/A21.10, except where conformation is required with the inside curvature of the pipeline, in which case the covers are flanged plugs of proper shape with American Standard flange drilling.

a. Fasten covers by means of steel studs and bronze nuts. Drill and tapcovers for a 1-1/2-inch diameter pipe connection.

4. Plugs: Equip the flange of conformed plugs with a dowel or other suitable means for proper setting.

G. Wall Castings, Connecting Pieces, and Special Fittings

1. General: Provide wall castings and connecting pieces, such as bell and bell, bell and spigot, bell and flange, flange and flange, flange and spigot, and flange and flare, meeting the requirements of AWWA C110/A21.10.

2. Design: Provide special fittings, where required, of an approved design that have the same diameters and thicknesses as standard fittings, unless otherwise required, but their laying lengths and other functional dimensions are determined by their positions in the pipeline and by the particular piping materials to which they connect.

3. Intermediate Collar: Where watertightness is essential and at other locations where indicated, provide wall castings with an integrally cast intermediate collar located at the center of the wall.

H. Temporary Bulkheads: Provide temporary bulkheads at the ends of sections where adjoining pipelines have not been completed and are not ready to connect.

1. Remove all temporary bulkheads when they are no longer needed.

I. Linings and Coatings

1. Cement Lining: Provide ductile-iron pipe and fittings having a cement-mortar lining not less than standard thickness meeting the requirements of AWWA C104/A21.4, unless shown or specified otherwise.

2. Asphaltic Coating: Shop coat pipe which is to be buried with the standard asphaltic outside coating specified in AWWA C151/A21.51.

3. Encased Pipe: Do not coat or paint the outside of fittings and pipe which are to be encased in concrete.

4. Labels: Paint the size, class designation, manufacture date, and control number cross referenced to the laying schedule conspicuously in white on the outside of each pipe, fitting, and special casting after the shop coat has hardened.

5. Flange Joints: Immediately after facing and drilling, coat the back of the flanges and bolt holes with asphaltic coating meeting the requirements of AWWA C151/A21.51, Section 51-8.1.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install all buried ductile iron pipe and fittings in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 01 and Section 33 05 50.

3.2 LEAKAGE TESTING

A. Cleaning: Flush clean and test all pipes after installation.

B. Testing: Test pipes for leaks and repair or tighten as required.

C. Procedures: Conduct tests in accordance with Section 01 45 50.

3.3 DISINFECTION

A. General: Disinfect all pipelines that are to carry potable water before they are placed into service as specified in Section 33 13 00.

3.4 SCHEDULES

A. Refer to the Schedules contained in Section 33 05 50 Laying and Jointing Buried Pipelines for information on the piping that is to be constructed using the pipe materials and methods specified herein.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 40 05 10

ERECTING AND JOINTING INTERIOR AND EXPOSED EXTERIOR PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Furnishing of supports and hangers and installation of all interior and exposed exterior piping and supports.

1. Furnish, support, hang and install piping of the materials, coatings and linings shown or specified at locations as specified or where shown.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 50 - Leakage Tests
2. Section 09 96 00 - High Performance Coatings

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASME B1.20.1 - Pipe Threads, General Purpose, Inch
2. ASME B31.1 - Power Piping with Addenda
3. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances

1.3 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1 (and as follows:)

1. Take extreme care in loading and unloading the pipe and fittings. Do the work slowly using skids or suitable power equipment, and keep the pipe under control at all times.
2. Handling Procedures: Under no condition is the pipe to be dropped, bumped, dragged, pushed or moved in any way which will cause damage to the pipe, lining or coating.

3. Use of Slings: When handling the pipe with a crane, use a suitable pipe hook or sling around the pipe. Under no condition is the sling to be allowed to pass through the pipe unless adequate measures are taken to prevent damage to the pipe ends, lining and coating.

4. Damage: If any piping or fittings are damaged in the process of delivery, storing, handling, or laying, replace or repair such piping or fittings as approved.

PART 2 EXECUTION

2.1 PREPARATION

A. Painting: Paint all pipelines as specified, in accordance with Section 09 96 00.

2.2 INSTALLATION

A. General: Install all piping in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

1. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

2. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications, with 1-inch clearance outside the insulation.

3. Place pipe runs to minimize obstruction to other work.

4. Install piping to allow for expansion and contraction without stressing pipe, joints or connected equipment.

5. Slope piping as shown and arrange systems to drain at low points.

6. Do not penetrate building structural members unless shown.

7. Locate groups of piping parallel to each other and at common elevations whenever practical, spaced to permit applying insulation and servicing of valves.

8. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity.

9. Arrange miscellaneous pipelines, which are shown in diagram form on the Plans, clear of other pipelines and equipment.

10. Fit and install pipelines in a neat and workmanlike manner in accordance with approved shop drawings.

11. Provide an adequate number of unions in main pipe and branch pipe runs to facilitate dismantling or removal of pipeline sections without disturbing adjacent branch or connecting lines.

12. Install suitable sleeves at all points where pipes pass through walls or floors of structures and where wall castings are not provided.

13. Include proper pipe protection saddles on pipes which are covered with insulation.

B. Flanged Joints: Make flanged joints with bolts or bolt studs with a nut on each end.

1. Field Flanges: Shop screw threaded flanges to pipe unless threading in the field is permitted with prior approval.

2. Flange to Pipe Assembly: Assemble pipe to be fitted with threaded flanges as follows:

a. Accurately thread pipe and flanges to the appropriate gauge, screw flanges on by heavy machinery until the end of the pipe projects beyond the face of the flange and a tight metal-to-metal joint is produced without evidence of heat in the threaded portion.

b. Cut the projecting end of the pipe off flush with the face of the flange.

c. Make a light refacing cut across both the end of the pipe and the face of the flange at right angles to the center line of the pipe and then ream the pipe.

d. Flanged to Flange Assembly: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by bolt manufacturer.

C. Mechanical Joints: In making up mechanical joints, center the spigot in the bell.

1. Thoroughly brush the surfaces with which the rubber gasket comes in contact, with a wire brush just prior to assembly of the joint.

2. Brush pipe manufacturers recommended lubricant over the gasket just prior to installation.

3. Place the gasket and gland in position, insert bolts, and finger tighten nuts.

4. Tighten the nuts with a torque wrench to bring the gland up toward the pipe evenly.

5. Torques: Apply bolt torques complying with AWWA C600.

6. Effective Sealing: If effective sealing is not obtained at the maximum torque listed, disassemble and reassemble the joint after thorough cleaning.

D. Sleeve Type Couplings: For sleeve type couplings, equally tighten diametrically opposite bolts on the coupling to bring the gaskets up evenly all around the pipe.

1. Torque Wrenches: Do final tightening with torque wrenches set for the torque recommended by the coupling manufacturer.

E. Welding: Comply welding of pipe joints with the requirements of ASME B31.1 unless otherwise specified. Do all off site welding of steel pipe conforming to the appropriate requirements.

1. Procedures: Confirm that pipe and fittings with wall thickness of 3/16-inch and larger have ends beveled for welding, and that the parts to be welded are securely held in place and are in proper alignment during welding.

a. Separate the abutting pipe ends before welding to permit complete fusion to the inside wall of the pipe without overlapping.

b. Provide welding continuous around the joint and completed without interruption.

c. Provide welds of the single vee butt type, of sound weld metal thoroughly fused into the ends of the pipe and into the bottom of the vee.

d. Provide welds free from cold shuts, pinholes, oxide inclusions or other defects.

F. Anchors and Stands: Furnish and install anchors and stands when specified, shown, or required for holding the pipelines and equipment in position or alignment.

1. Small Piping Supports: Where adjustable supporting devices are not required, support pipelines 3 inches in diameter and smaller on cast-iron, malleable iron, or steel hooks, hook plates, rings or ring plates.

G. Pipe Straps: Furnish and install pipe straps where shown or specified for securing pipelines in place. All pipe straps shall be Type 304 Stainless Steel ¼-inch flat bar with ½-inch anchors.

2.3 FIELD QUALITY CONTROL

A. Tests: After installation of the interior and exposed exterior piping and supports, control equipment and all appurtenances, subject the units to a field running test, as specified in Division 1, under actual operating conditions. Where field welding of pipe joints shown, specified, permitted, or required meet the requirements of ASME B31.1 -Power Piping, Chapter VI Section 136.4.2 Visual Examination

1. Perform testing of pipelines in accordance with the requirements of Section 01 45 50.

2.4 CLEANING

A. General: Clean the interior of pipelines of all dirt and superfluous material of every description in an approved manner.

2.5 SCHEDULE

A. Definitions: Abbreviations used in the schedule are as follows:

1. Pipe Materials:

a.	Al	Aluminum
b.	Br	Brass
c.	C	Concrete
d.	CI	Cast-iron
e.	CISP	Cast-iron soil pipe
f.	Cl	Clay
g.	CPVC	Chlorinated Polyvinyl Chloride
h.	CU	Copper
i.	DI	Ductile Iron
j.	PCCP	Prestressed Concrete Cylinder Pipe
k.	PE	Polyethylene
l.	PVC	Polyvinyl Chloride
m.	RCP	Reinforced Concrete Pipe
n.	RCPP	Reinforced Concrete Pressure Pipe
o.	SS	Stainless Steel
p.	St	Steel

2. Joints:

a.	B	Bituminous
b.	B&S	Bell and Spigot
c.	F	Flanged
d.	G	Grooved End
e.	H	Harnessed
f.	HC	Hubless Coupling
g.	HSC	Hub and Spigot - Compression Gasket
h.	HSL	Hub and Spigot - Lead and Oakum
i.	MJ	Mechanical Joint
j.	PO	Push-on Joint
k.	RRG	Restrained Retainer Gland
l.	RS	Rubber and Steel
m.	Sd	Soldered
n.	SF	Socket Fusion
o.	Sl	Sleeve Type Coupling
p.	SW	Solvent Welded
q.	W	Welded

3. Coatings and Linings:

a.	BC	Bituminous - Cold Application
b.	CE	Concrete Encased
c.	CL	Cement-Mortar Lined
d.	E	Epoxy
e.	G	Galvanized
f.	GL	Glass Lined
g.	I	Insulated
h.	KL	Polyvinylidene Fluoride (PVDF or KYNAR®) Lined
i.	P	Painted
j.	PCL	Polyvinylidene Chloride (PVDC) Lined
k.	PEW	Polyethylene Wrapped
l.	PPL	Polypropylene Lined
m.	RC	Rubber Coated
n.	RL	Rubber Lined
o.	W	Wrapped

B. Schedule: Provide products as listed in the following schedule.

END OF SECTION

(NO TEXT FOR THIS PAGE)

INTERIOR AND EXPOSED EXTERIOR PIPING SCHEDULE

Service	Size (Inches)	Pipe Material	Protective Coatings		Joints	Test Pressure (psig)[2]	Pressure Class or Thickness	Remarks
			Int.	Ext.[1]				
Cherry Creek Lift Station								
Pump Suction Piping	24	DI	CL	BC	F	100	See Section 40 05 16	
Odor Control Piping	14	FRP	--	--	F	5	See Section 23 31 00	
Modified Valve Vault No. 6								
Sanitary Force Main	36	DI	CL	BC	F	100	See Section 40 05 16	
New Valve Vault No. 8								
Sanitary Force Main	24	DI	CL	BC	F	100	See Section 40 05 16	
New 12-inch Drain Valve Manhole								
Sanitary Force Main	12	DI	CL	BC	F	100	See Section 40 05 16	

Notes:
(1) Do not insulate sections of pipe that pass through or are within structures containing water.
(2) Measure the test pressures shown in the schedule at the centerline of the pipeline's low point. Adjust test pressures measured at other locations accordingly.
(3) Malleable iron screwed fittings.
(4) Test by filling with water to top of system or with 5 psi compressed air.

SECTION 40 05 16

DUCTILE-IRON PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing ductile-iron pipe, fittings and appurtenances, except soil pipe.

1. Provide ductile-iron pipe and fittings complete with all necessary jointing facilities and materials, specials, adapters and other appurtenances required for installation in and completion of the pipelines to be constructed.

2. Provide flanged, plain end, rubber gasket, (push-on or mechanical joint), or grooved-type pipe joints of the types, sizes and classes shown or specified.

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 45 50 - Leakage Test
2. Section 09 96 00 - High Performance Coatings
3. Section 40 05 10 - Erecting and Jointing Interior Piping

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water AWWA C104/A21.4

2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids AWWA C105/A21.5

3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 3 inches through 48 inches, for Water and Other Liquids AWWA C110/A21.10

4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings AWWA C111/A21.11

5. AWWA C115/A21.15 - Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges AWWA C115/A21.15

6. AWWA C151/A 21.51 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids AWWA C151/A21.51

7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings, 3 inches through 12 inches, for Water and Other Liquids AWWA C153/A21.53

8. AWWA C606 - Grooved and Shouldered Type Joints AWWA C606

9. ASTM A 307 - Specification for Carbon Steel bolts and Studs

1.3 SYSTEM DESCRIPTION

A. Design Standards: Provide ductile-iron pipe meeting the requirements of AWWA C 151/A21.51.

1. Place pipe in structures using a minimum wall thickness of Thickness Class 52 for sizes up to and including 12-inch diameter and Thickness Class 51 for larger sizes, except provide Thickness Class 53 for pipe with threaded flanges or grooved-type joints.

2. Construct concrete encasement where shown.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Submit the following shop drawings:

1. Pipe joints and fittings, sleeves, cleanouts and couplings. Where special designs or fittings are required, show the Work in large detail and completely describe and dimension all items.

2. Fully dimensioned layout of pipes, fittings, couplings, sleeves, cleanouts, expansion joints, harnessing, valves, supports, anchors and equipment. Label pipe size, materials, type, and class on drawings and include schedule.

3. Cross sections showing elevations of cleanouts, pipes, fittings, couplings, sleeves, valves, supports, anchors and equipment.

4. Catalog data for pipe, fittings, couplings, sleeves, harnessing and cleanouts.

C. Quality Controls: Submit certificates of compliance for pipe, fittings, gaskets, lining, polyethylene encasement, coatings, specials, couplings, sleeves and cleanouts in accordance with this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all pipe, fittings and couplings as specified in Division 1 and Section 40 05 10.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Manufacturers of equivalent product may be submitted.

1. Ductile-iron pipe and fittings.

   a. American Cast Iron Pipe Company
   b. McWane Incorporated
   c. United States Pipe and Foundry

2. Ductile-iron retainer glands.

   a. 3-inch through 24-inch diameter
      (1) Nappco, Inc. Series 1246
      (2) Ebba Iron, Inc., Series 100
   b. larger than 24-inch diameter
      (1) Ebba Iron, Inc., Megalug

3. Sleeve-type couplings.

   a. 12-inches in diameter and smaller
      (1) Dresser Industries, Style 153
      (2) Smith-Blair, Type 441 Omni Coupling System

   b. larger than 12-inches in diameter
      (1) Dresser Industries, Style 38
      (2) Smith-Blair, Type 411

   c. Gaskets.
      (1) Dresser Plain Grade 27
      (2) Smith-Blair 003

4. Restrained push-on joints.

a. U.S. Pipe, TR Flex
b. McWane Incorporated, Super-Lock
c. American Cast Iron Pipe Company, Lok-Ring or Flex-Ring

5. Gaskets.

a. John Crane, Inc.
b. Garlock Packing Company
c. U.S. Rubber Company
d. American Cast Iron Pipe Company
e. United States Pipe and Foundry
f. McWane Incorporated

6. Coatings and Linings

a. Kop-coat
b. Tnemec
c. American Cast Iron Pipe Company
d. United States Pipe and Foundry

2.2 MATERIALS

A. Fittings:

1. General: Provide all fittings meeting the requirements of ANSI A21.10, unless shown or specified otherwise. Fittings 14 inches and larger require a pressure rating of 150 psi, or as specified, whichever is greater.

2. Flanged: Where long radius flanged fittings and other flanged fittings not covered in ANSI A21.10 are shown or indicated, provide items meeting the requirements of ANSI A21.10 and having laying lengths conforming to ANSI B16.1 for 125 pound American Standard fittings.

3. Nonflange: Where compact mechanical joint or rubber gasket joint fittings are shown or indicated, provide items meeting the requirements of AWWA C153/A21.53.

4.

B. Flanged Joints

1. Threaded Flanges: Provide threaded, ductile-iron, long hub flanges meeting the requirements of AWWA C115/A21.15.

a. Screw flanges pipe on the threaded end of the pipe in the shop.

b. Reface the face of the flange and the end of the pipe together.

c. Design the flanges to prevent corrosion of the threads from the outside and to prevent leakage through the pipe threads.

2. Facing and Drilling: Provide flanges faced and drilled to the requirements of AWWA C115/A21.15,unless special drilling is called for or required. Face flange accurately at right angles to the pipe axis. Drill flanges smooth and true, and cover machined faces with zinc dust and tallow or equivalent material.

3. Taps: Tap flanges where tap or stud bolts are required.

4. Fasteners: Provide bolts, stud bolts, and nuts meeting the requirements of ASTM A 307, Grade B.

5. Gaskets: Provide full-face gaskets for flanged joints on 12-inch diameter and smaller pipe and gaskets of the ring type for flanged joints on larger pipe. Provide flange gaskets meeting the requirements of AWWA C115/A21.15 except make gaskets for gas lines with neoprene and aramid.

C. Harnessing

1. General: For ductile-iron pipe and fittings with mechanical joints that require harnessing, provide ductile-iron mechanical joint retainer glands.

2. Joint Assemblies: Design the joint assemblies to resist pullout of the joints at the test pressures specified.

D. Wall Pipes and Sleeves

1. Wall Pipes

a. Where wall pipes are shown or specified, provide ductile iron wall pipes that meet the requirements of AWWA C110/A21.10 with end connections that are 1) of the types shown and 2) flush with the surfaces of the walls or floors. Unless otherwise shown or specified, provide wall pipes with intermediate collars located at the centers of the walls or floors.

2. Sleeves

a. Where pipes pass through exterior walls or floors or wetted interior walls or floors of structures and where wall pipes are not to be provided, provide ductile-iron sleeves meeting the requirements of AWWA C110/A21.10, with ends that are flush with the wall or floor surfaces and with intermediate collars located at the centers of the walls or floors.

b. Where pipes pass through non-wetted interior walls or floors and where wall pipes are not to be provided, provide ductile-iron sleeves meeting the requirements of AWWA C110/A21.10; steel pipe sleeves meeting the requirements of Section 40 05 17 or as shown or specified otherwise. Provide sleeves with ends that are flush with the wall or floor surfaces. Where shown or specified, provide intermediate collars located at the centers of the walls or floors.

c. Provide sleeves having large enough diameters to accommodate the passage of pipe joints, if required.

d. Where shown or specified, provide modular, mechanical sleeve seals, meeting the requirements in Section 40 05 18, in the annular spaces between pipes and sleeves. In all other locations, caulk the annular spaces between pipes and sleeves with caulk meeting the requirements in Section 07 90 00.

E. Sleeve-Type Couplings

1. General: Manufacture middle rings to the following sizes.

a. At least 1/4 inch thick and 5 inches wide for 8-inch diameter and smaller pipe.

b. 3/8 inch thick and 7 inches wide for 10- through 30-inch diameter pipe.

c. 1/2 inch thick and 10 inches wide for 36-inch diameter and larger pipe.

2. Design: Manufacture middle rings without a pipe stop. Provide follower rings of proper thickness. Provide molded rubber gaskets.

F. Cleanouts

1. General: Provide cleanouts where shown or specified.

2. Size: Provide not less than 6 inch diameter cleanout openings for pipe 8 inches in diameter or larger. Provide cleanout openings for pipe 6 inches in diameter or smaller of the same diameter as the pipe.

3. Cleanout Covers: Provide cleanout covers which are blind flanges meeting the requirements of AWWA C110/A21.10, except where conformation is required with the inside curvature of the pipeline, in which case the covers are flanged plugs of proper shape with American Standard flange drilling.

a. Fasten covers by means of steel studs and bronze nuts. Drill and tap covers for a 1-1/2-inch diameter pipe connection.

4. Plugs: Equip the flange of conformed plugs with a dowel or other suitable means to provide proper setting.

G. Connecting Pieces, and Special Fittings

1. Connecting Pieces: Provide connecting pieces, such as bell and bell, bell and spigot, bell and flange, flange and flange, flange and spigot, and flange and flare, meeting the requirements of AWWA C110/A21.10.

2. Special Fittings: Provide special fittings, where required, of an approved design that have the same diameters and thicknesses as standard fittings, unless otherwise required, but their laying lengths and other functional dimensions are determined by their positions in the pipeline and by the particular piping materials to which they connect.

H. Temporary Bulkheads: Provide temporary bulkheads at the ends of pipeline sections where adjoining pipelines have not been completed and are not ready to connect.

1. Removal: Remove all temporary bulkheads when they are no longer needed.

I. Coatings and Linings

1. Cement Lining: Provide all ductile-iron pipe and fittings having a cement-mortar lining not less than standard thickness meeting the requirements of ANSI A21.4, unless shown or specified otherwise.

2. Exterior Primer: Shop coat ductile-iron pipe and fittings on the outside with one coat of Kop-Coat 340 Gold Primer, 2.0 mils minimum dry thickness, for use in exposed locations, such as inside buildings, where finish painting or insulating is required.

3. Asphaltic Coating: Coat pipe for use not exposed to view with the standard asphaltic outside coating specified in AWWA C151/A21.51.

4. Encased Pipe: Do not coat or paint the outside of fittings and pipe which are to be encased in concrete where watertightness is to be obtained.

5. Labels: Paint the weight and class designation conspicuously in white on the outside of each pipe, fitting, and special casting after the shop coat has hardened.

6. Grooved-type Couplings: Shop coat couplings with Kop-Coat 340 Gold Primer, 2.0 mils minimum dry thickness.

7. Flange Joints: Immediately after facing and drilling, coat the back of the flanges and bolt holes with asphaltic coating meeting the requirements of AWWA C151/A21.51, Section 51-8.1.

8. Sleeve-type Couplings:

   a. Shop coat couplings with Dresser Industries Red D or Smith-Blair Standard Blue shop coat.

   b. Provide an additional shop coat of Kop-Coat Hi-Guard epoxy or Tnemec Pota-pox on the interior of the middle ring.

   c. Finish coat exterior of sleeve-type coupling after installation with the same coating specified in Section 09 96 00 for the pipeline of which it is a part.

   d. Ensure shop coats and finish coats are compatible.

J. Drip Pans: Provide drip pans constructed of 16-gauge Type 304 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install all ductile-iron pipe and fittings in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1 and Section 40 05 10.

B. Insulation: Where shown or specified provide insulation, as specified in Section 40 42 00, for pipes and fittings that are exposed to atmosphere after installation.

C. Drip Pans: Provide drip pans under all ductile-iron pipelines installed over electrical equipment and motors and properly connect to the drainage system with 3/4-inch red brass pipe. Make leak tight connection between the drip pan and the drain pipe. Pitch pans uniformly toward the drain pipe not less than 1/8-inch per lineal foot.

3.2 LEAKAGE TESTING

A. Cleaning: Flush clean and test all pipes after installation.

B. Testing: Test pipes for leaks and repair or tighten as required.

C. Procedures: Conduct tests in accordance with Section 01 45 50.

3.3 SCHEDULES

A. Refer to the Schedule contained in Section 40 05 10 Erecting and Jointing Interior Pipe for information on the piping that is to be constructed using the pipe materials and methods specified herein.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 40 05 20

VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for furnishing the New Pump Discharge Control Valves at the Cherry Creek Lift Station and Isolation Valves located within modified Valve Vault No. 6 and new Valve Vault No. 8, as shown on the Contract Drawings. Provide valve operators as specified complete, including a suitable enclosure, with all appurtenances necessary for the operator to perform its intended function. Such appurtenances include, but are not limited to, anchor bolts and other mounting hardware, control switches, limit switches, pressure switches, torque switches, gauges, control valves, electrical supply connections, internal electric wiring and controls, terminal blocks, regulating controls, push button controls, miscellaneous controls, extension stems, local and remote indicators.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 26 05 19 – Wires and Cables – 600 Volts and Below
2. Section 40 90 50 – Process Control System Description

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1.	ASME B16.1	- Cast Iron Pipe Flanges and Flanged Fittings
2.	ASTM A 27/A27M	- Specification for Steel Castings, Carbon, for General Application
3.	ASTM A 29/A29M	- Specification for Steel Bars, Carbon and Alloy, Hot Wrought and Cold-Finished, General Requirements
4.	ASTM A 48	- Specifications for Gray Cast Iron Castings
5.	ASTM A 126	- Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
6.	ASTM A 536	- Specification for Ductile Iron Castings

7. ASTM B 30 - Specification for Copper Base Alloys in Ingot Form

8. ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings

9. ASTM B 148 - Specification for Aluminum-Bronze Castings

10. ASTM B 584 - Specification for Copper Alloy Sand Castings for General Applications

11. AWWA C500 - Metal Seated Gate Valves for Water and Sewerage Systems

12. AWWA C507 - Ball Valves, 6-inch through 60-inch

13. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service

14. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Shop Drawings: Submit the following:

1. Complete detailed drawings of all valves

2. Working drawings, including arrangement and erection drawings of the operators and control equipment; schematic control diagrams, electrical connection diagrams, and complete description of the control system; and operating characteristics

C. Quality Control Submittals: Submit the following:

1. Manufacturer's certified performance and material records.

2. Complete calculations for each size of motor operator indicating the force required to operate the valve, the operator force provided, full load and locked rotor current, and horsepower.

D. Operation and Maintenance: Submit operation and maintenance manuals for the valve and operators to include the following:

1. One copy of equipment start-up reports for each item of equipment.

2. One copy of the manufacturer's operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts.

3. List of electrical relay settings and control and alarm contact settings.

4. Electrical interconnection wiring diagram for equipment furnished including all control systems.

5. All information provided in the manual shall be modified so that it ONLY includes information pertaining to the approved equipment and shall accurately depict the equipment provided. All "optional" and non-pertinent materials and information shall be excluded from the manual or noted as such.

6. Furnish all O&M Manual in accordance with Specification Section 01 78 23.

1.4 QUALITY ASSURANCE

A. Furnish all valves of the same type from the same manufacturer. Provide parts that are interchangeable for all valves of the same type and size.

1.5 DELIVERY, STORAGE AND HANDLING

A. Tests: Furnish a letter confirming that all valves have been satisfactorily tested as specified, prior to shipment.

B. Storage and Erection: Pack and store all valves in satisfactory operating condition. Carefully erect all valves in their respective positions, free from all distortion and strain.

1.6 SPARE PARTS

A. For electric motor operators:

1. One motor
2. One torque switch of each size
3. One limit switch assembly
4. Six push buttons
5. Six color caps of each color
6. Twenty indicating lamps

7. One solid state reversing starter matching unit
8. One overload relay of each size

PART 2 PRODUCT

2.1 MANUFACTURERS

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Gate Valves:

   a. Pratt
   b. DeZurik

2. Metal Seated Ball Valve:

   a. Pratt
   b. DeZurik

3. Eccentric Plug Valves:

   a. Pratt
   b. DeZurik

4. Electric Motor Operator - Modulating:

   a. Limitorque Corporation

2.2 MATERIALS

A. General:

1. Fabricate valves of materials resistant to corrosion for the required service.

2. Fabricate valves that are to be installed in metal pipelines and that are 20 inches in diameter and larger of the materials specified herein.

3. Fabricate operators of materials resistant to corrosion for the required services. Provide operator materials as specified.

4. Operator housings and pedestal handwheels:

a.	Cast iron	ASTM A 126, Class B ASTM A 48, Class 30 or 35
b.	Ductile iron	ASTM A 395

	c. Cast steel	ASTM A 536, Grade 65-45-12 ASTM A 27/A27M
5.	Operator worms, steel	ASTM A 29/A29M Grade Designation 8620
6.	Operator gears, steel (spur & helical)	ASTM A 572/A572M
7.	Worm gears, bronze	ASTM B 148, Alloy C95400 or C95500 ASTM B 584, Alloy C86300

B. Valve Joints

1. Provide flanges that are faced accurately at right angles to the axis of the casting. Face and drill flanges and shop coat with a rust-preventive compound before shipment.

2. Provide flanges whose dimensions and drillings meet the requirements of ASME B16.1, 125 pounds as a minimum. Provide flanges whose pressure ratings equal or exceed the specified test pressure of the pipeline. Furnish special drillings where required. For valves having flanges that do not conform with the thickness requirements of ASME B16.1, test each valve in accordance with the hydrostatic shell test pressure requirements of ASME B16.1.

2.3 GATE VALVES

A. Materials: Unless otherwise shown or specified, furnish and install gate valves meeting the following requirements:

Nominal Valve Size, Inches	Standard	Type
3 and smaller	MSS SP-80	Solid wedge
4 thru 12 for HVAC Service	MSS SP-70	Solid Wedge
4 thru 12, except for HVAC Service	AWWA C509	Resilient seat
16 and larger, except for HVAC Service	AWWA C500	Double disc

B. Rising Stems: Manufacture all gate valves with rising stems, unless otherwise shown or specified. Design all gate valves to open when the nut or handwheel is turned counterclockwise.

C. Nonrising Stem: For buried service, furnish nonrising stem gate valves. Equip nonrising stem valves, except for buried or submerged service, with externally visible indication of the disc position at all points of travel.

D. Stem Seals: Use the following types of stem seals:

Valve Type	Stem Seal
Nonrising stem	O-ring
Rising stem (Outside stem and yoke)	Stuffing box
Geared	
Nonrising stem	O-ring or stuffing box
Rising stem (Outside stem and yoke)	Stuffing box

E. Packing: Provide nonasbestos braided, twisted or formed ring type packing suitable for the pressure-temperature ratings of the valve.

F. Bonnet: Provide 3-inch and smaller gate valves with threaded bonnets. Provide 4-inch and larger gate valves with outside screw and yoke bonnets.

G. Accessories: Provide zinc plated bonnet bolts, studs and nuts. except for submerged service. Provide stainless bonnet bolts, studs and nuts for submerged service. Make wedging devices bronze to iron or bronze to bronze. Provide glands which are bronze or bronze bushed and bronze gland bolts and nuts.

2.4 METAL SEATED BALL VALVE

A. Provide a metal seated ball valve for the New Pump Discharge Control Valve at the Cherry Creek Lift Station.

B. ASME B16.1 Class 150-pound flanged ends, metal seated, Ductile Iron Body, ductile Iron Rotor with 316 stainless Steel edge, 304 Stainless Steel Shaft and Pins, PTFE Seat, Teflon Lined Fiberglass bearings, 8 Mils Amercoat 370 Epoxy Interior, 8 Mils Amercoat 370 Epoxy Exterior.

C. Provide each valve, actuator and positioner assembled, adjusted, and tested as a unit by the valve manufacturer or an authorized automation facility. Conduct performance testing on each valve and tie test results to the valve serial number.

D. Valve manufacturer is to warrant the valve to be free of defects in material and workmanship for a period of three years from date of installation.

E. The Valve shall be bubble tight at rated pressure with flow in either direction.

2.5 ECCENTRIC PLUG VALVES

A. General: Provide quarter turn valves having an eccentric action that causes the plug to rise off the seat contact during the opening movement rather than sliding from its seat.

B. Plugs: Provide plug valves with Neoprene or Buna-N faced plugs.

C. Materials: Construct plug valves of cast iron or semi-steel at least equal to ASTM A 126, Class B. For valve sizes 3-inch and larger, construct the body seats with a welded-in overlay, of not less than 90 percent pure nickel, on all surfaces contacting the plug face. For valve sizes under 3-inch provide uncoated or epoxy coated body seats. Make the overlay a minimum of 1/16-inch thick for valve sizes 20-inch and smaller and a minimum of 1/8-inch thick for valve sizes 24-inch and larger. Provide zinc plated bonnet bolts, studs and nuts.

D. Seat Adjustment: Make the water-tightness or gas-tightness of the valve seating adjustable. Provide a seating adjustment device that is external to the valve and that can be used without the need to remove the valve from the piping and with the valve under pressure.

E. Lubrication: Furnish plug valves with oil impregnated, permanently lubricated, Type 316 stainless steel bearings in the upper and lower journals.

F. Stem Seal: Provide a stem seal consisting of multiple, self-adjusting and replaceable chevron type packing rings and a packing gland or provide two replaceable, self-adjusting, U-cup seals. Make the stem seal adjustable and replaceable without removing the valve from the piping and without the need to disassemble the valve and operator. For buried or submerged service, provide a sealed enclosure to keep the stem seal clean.

G. Valve Port: Unless otherwise specified, construct the valve with a minimum port area of 80 percent of the full area of the pipe in which the valve is installed.

H. Multiport: Provide 3 and 4-way valve configuration when shown or specified.

I. Position Indicator: Equip plug valves, except for buried or submerged service, with external visible indication of the plug position.

J. Operators: Unless otherwise shown or specified, equip 6-inch and smaller valves with wrench or lever operators and 8-inch and larger valves with gear operators. Equip all valves in low pressure gas service with gear operators. Furnish one wrench for each size valve in each individual room or space in which valves are located. House gear operators for submerged or buried service in a watertight enclosure. For buried or submerged service, equip valve operators with stainless steel external bolting.

2.6 FLOOR STANDS

A. General: Provide stands for 24-inch and larger valves of single crank, 2-speed operated as specified.

B. Materials: Use materials in floor and bench stands meeting the applicable requirements of the "General" specifications subsection. Provide frames of cast

iron or fabricated steel of heavy and substantial design with smooth exterior and neat appearance. Make adequate provision for lubrication and protect all operating parts.

C. Nameplate and OPEN Indication Marking: Equip each stand with a nameplate stating the valve controlled by the stand and also stamp the operator with an arrow and the word OPEN to indicate the direction of rotation.

D. Rising Stems: Fit rising stem floor and bench stands with ball or roller bearings designed to take the thrust. Equip rising stem stands with a transparent plastic cover to protect the stem. Provide the cover with labels and other attachments that will facilitate its use as an indicator of valve position.

E. Operating and Lift Nuts: Provide operating nuts or lift nuts of bronze meeting the requirements of ASTM B 62, finished all over, suitably splined to connect with the handwheel or gear and with threads which will engage smoothly with those of the lifting shaft.

F. Handwheel-Operated Stands: Provide handwheel-operated stands with handwheels that open the valve when the wheel is turned counterclockwise. Locate the center of the handwheel approximately 36 inches above the operating floor. Provide a handwheel of sufficient diameter so that the stand will operate the valve with a maximum pull on the handwheel of 40 pounds.

2.7 ELECTRIC MOTOR OPERATORS

A. General: Provide electric motor operators of the close-coupled, electric motor-driven, worm gear type, complete with motor, gearing, limit switches and auxiliary contacts, torque switches, position indicator, handwheel, integral controller, and all required appurtenances. Design the operators to rotate valve discs through 90 degrees from the fully open to the fully closed position and back, as in butterfly, ball or plug valves. Provide operators that complete each operation in the time specified. Provide operators that hold the discs in any position from fully open to fully closed without vibration.

B. Operator Mounting: Design the operator to be mounted in the position shown or specified.

C. Standard: Except as otherwise specified, provide operators meeting AWWA C540.

D. Open and Close Time Periods: Provide valve operators that fully open the valve from the closed position in approximately 38 seconds and fully close it in approximately 38 seconds when the differential pressure and flow are at the values specified for the valve and the voltage at the terminals is within 15 percent of the nominal voltage. Design the operator to operate the valve through three consecutive opening and closing cycles or for a period of 15 minutes, whichever is

longer, during every 60-minute period, at specified ambient temperature conditions under full differential pressure.

E. Temperature Range: Design the operator for indoor operation and for an ambient temperature range of -20 to 140 degrees F in full sunlight.

F. Torque: Design the operator to exert an unseating torque of at least 50 percent in excess of the required disc seating torque at the specified voltage, neglecting hammer-blow effect.

G. Power Gearing: Provide power gearing consisting of helical or spur gears and worming gearing. Fabricate helical and spur gears of accurately machined hardened alloy steel. Provide a hardened alloy steel worm with threads ground and polished after heat treating. Provide a nickel or manganese bronze worm gear. Use antifriction bearings throughout. Grease pack or oil bath lubricate the operator. Provide lubricants suitable for the ambient temperatures specified.

H. Lost-Motion Device: Design operators for gate valves to include a lost-motion device that will permit the motor to attain full speed, and then impart a hammer blow to the stem nut to start movement of the disc in both the opening and closing directions. Do not include this feature if the valve is for modulating service.

I. Handwheel - Manual Operation: Provide a handwheel for manual operation with a maximum rim pull of 40 pounds. Design the handwheel so that it does not rotate during electrical operation and the motor does not rotate during manual handwheel operation. Provide an operator that is arranged so that motor or motor gearing failure does not prevent manual operation. Arrange the operator to automatically change from manual operation to electrical operation when its motor is energized and to continue electric operation until the operator is reset to manual operation. Provide a means for locking the drive in either manual or motor operation. Provide removable handwheels. Provide an adaptor key or drive nut to permit operation by a portable operator.

J. Declutching Mechanism: Provide a declutching mechanism to disengage the motor mechanically but not electrically from motor to handwheel operation. If the clutch is of the external lever type, arrange it such that the lever does not move when the motor is energized.

K. Position Indication: Provide an operator-mounted disc position indicator of the mechanical or indicating light type. For OPEN-CLOSED service, indicate the fully open, fully closed and intermediate disc position either mechanically or by lights. For modulating or throttling service, provide continuous disc position indication between the fully open and fully closed positions. Provide electrical contacts as required for remote indication of disc position.

L. Electric Motor Design: Provide manufacturer selected, integral operator motor of the high torque, ball or roller bearing, squirrel-cage type designed for continuous

valve duty. Provide motor rated for 5 minute duty cycle or ten complete opening and closing valve strokes, whichever is longer during a 60 minute period under full differential pressure at 40 degrees C ambient. Design the motor for use on a nominal 480 volts, 3-phase, 60-hertz electrical service. Provide motor windings and leads with Class F or better insulation with built-in thermal overload protection. Provide motor meeting torque requirements of the valve.

M. Housing: Provide housings for controls, gears, and motors with integrally cast flanges. Fully machine and template drill the flanges and their mating surfaces. Provide joints which are metal-to-metal or gasket or O-ring sealed as required.

N. Control and Motor Enclosures: Provide NEMA 4 control and motor enclosures, except as otherwise specified. Provide the controller with mechanical interlocks and mount as an integral part of the operator.

O. Electrical Compartment Heater: Provide electrical compartment heaters, unless other means can be proven effective for moisture elimination.

P. Electrical Requirements: Provide electrical controls for the operator as shown or specified. Design operators for 480-volt, 3-phase, 60-hertz service. Design all control circuits for 120- volt, single-phase, 60-hertz ac. Provide an integral 480/120-volt control transformer with fused secondary.

Q. Reversing Controller, Overload Protection and Internal Wiring: Provide a NEMA rated reversing controller, or an approved special duty rated reversing controller, complete with mechanical interlocks and controls as an integral part of the operator. Provide adequate overload protection in the controller or embedded in the motor windings. Install an overload device in each phase. If overload devices are installed in the motor windings, provide devices of the manual reset type with remote-indication with the contacts in the control circuit. Arrange the internal wiring in the operator so that the opening and closing coils cannot be energized simultaneously at any time, regardless of external wiring conditions.

R. Push Buttons and Selector Switches: Provide remote operator inside the Bird Creek Pump Station in an accessible location, mount OPEN- STOP-CLOSE push buttons or a selector switch as shown on the operator housing. Also mount red and green position indicator lights and, where shown or required, an amber ready light or MANUAL-AUTO mode selector on the operator housing. Connect all internal control and indication wiring to a terminal block within the valve operator enclosure and provide a separate control station for remote mounting. Provide the remote control station with the same NEMA rating as the operator.

S. Limit and Torque Switches: Provide the operator with limit and torque switches, either direct or gear driven. Provide adjustable limit and torque switches with auxiliary contacts that are operative in either direction of travel. Provide limit switches that are "in step" with torque switches at all times, whether in motor or manual operation. Equip the operator with limit switches to stop movement in

each direction and torque switches for protection against mechanical overload and to stop movement in either direction if an obstruction is encountered. Provide the number, function and arrangement of limit switches as shown, specified or required.

T. Additional Accessories: Provide additional limit switches, indicating lights, position transmitters and remote position indicators, remote operating controls and other accessories and controls as shown, specified or required.

2.8 ELECTRIC MOTOR OPERATORS - MODULATING

A. General: Provide modulating motor operators that meet the requirements for in paragraph 2.5, Electric Motor Operators, except as specified herein. In addition, provide an electronic control module and a solid state reversing starter.

B. Control Module: Provide a solid-state type control module with a comparator circuit which senses the error between the input command signal and the position feedback signal. Mount the control module within the operator switch compartment.

1. Accept a 4-20 mAdc input command signal. Provide zero and span adjustments to align minimum and maximum valve position with zero and 100 percent values of the input command signal. Provide deadband adjustment from 0.16 to 1.0 percent to eliminate excessive motor movement due to minor variation in the process variable signal.

2. Activate the solid state reversing starter to drive the actuator in the proper direction necessary to reduce the error to zero. Provide proportional band adjustment from 5-40 percent. When the error is outside the proportional band, run the actuator motor continuously toward set point. When the error is within the proportional band, pulse the actuator motor toward set point to prevent overshoot.

3. Provide actuator to open the valve when command input signal increases.

4. On loss of command input signal, have valve fail in last position. On loss of feedback signal, have valve fail in last position.

C. Selector Switch and Push Buttons: Where the operator is 7 feet or less from the floor and in an accessible location, integrally mount a 3-position AUTO-OFF-MANUAL selector switch plus two push buttons marked OPEN and CLOSE on the operator housing. Provide local control station remote from valve in an accessible location, connect all internal control and indication wiring to a terminal block and provide a separate control station for remote mounting.

D. Auto and Manual Operations: Provide operators that, when in the AUTO position, will respond to the automatic signal as described above. Provide operators that,

when in the MANUAL position, will be operable by either push buttons or handwheel.

E. Motor Design: Design the motor specifically for valve operator service and to be continuous rated for continuous modulating duty. Provide motor insulation of at least Class H.

2.9 EXTENSION STEMS, VALVE BOXES AND FLOOR BOXES

A. Equip valve in vault with operating nuts and extended shafts to grade, unless otherwise shown or specified. Provide two tee wrenches for each size and type of operating nut.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install valves in accordance with the manufacturer's recommendations and approved shop drawings and as specified in the City of Tulsa Standard Specifications.

B. Floor Stands: Accurately center floor and bench stands over the valve. Solidly bolt stands to the floor or support structure, with through-bolts wherever possible. Place approximately 3/4 inch of nonshrink cement grout beneath stands mounted on concrete or similar construction to assure uniform support. For stands installed within the area of a removable type floor, platform, or grating, securely mount them on their own support structure independent of the removable element, unless otherwise shown or specified.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Furnish the services of a qualified representative of each of the various manufacturers to provide inspect the completed installation, direct the Contractor to make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment and place the equipment in trouble-free operation, as specified in the City of Tulsa Standard Specifications.

B. Tests: After installation of the valves, control equipment and all appurtenances, subject the units through field calibration testing. Operate each valve under each Control Philosophy as provide in Specification Section 40 90 50.

END OF SECTION

VALVE SCHEDULE

Facility/Service	Valve Type	Size Inches	Joint Type	Operator Type	Remarks
Cherry Creek Lift Station					
Mechanical Room	Metal Seated Ball Valve	20	F	E	
SSWWTP					
Modified Valve Vault No.6	Eccentric Plug	36	F	H	Stem Extension, Floor Stand with Handwheel Operator
New Valve Vault No.8	Knife Gate Valve	24	F	H	Handwheel Operator
New Valve Vault No.8	Knife Gate Valve	24	F	H	Handwheel Operator
New Drain Valve Manhole	Eccentric Plug Valve	12	F	H	Stem Extension with Valve Box
New Drain Valve Manhole	Knife Gate Valve	12	F	H	Handwheel Operator

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SECTION 40 05 22

PIPELINE STOPPING AND WET TAPPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

B. Related Work Specified In Other Sections Includes, But is Not Limited to, the Following:

1. Specification Section 01 33 00 – Submittals
2. Specification Section 01 45 50 - Leakage Test
3. Specification Section 40 05 16 – Ductile Iron Pipe
4. Specification Section 40 05 20 – Valves

1.2 PAYMENT

A. There shall be no separate payment for the work of this Section. All costs shall be included in the lump sump price bid for Additive Alternate Contract Item 2 as specified in Specification Section 01 20 50 – Contract Items.

1.3 QUALIFIED SERVICE PROVIDERS

A. TDW Services Inc.
B. Furmanite America Inc.
C. Or Approved equal

1.4 DESIGN REQUIREMENTS

A. Design Data:

Description	Raw Sewage Force Main
Pipe Size	12" Nominal Size
Material type/thickness	Ductile Iron / 0.28 inches
Pipe Liner	
Interior	Asphalt Coated Cement Lined
Exterior	Tape Coated
Pressure	
Maximum Operating Pressure	40 psi
Minimum Operating Pressure	13 psi
Flow	
Flow Rate in Blow-Off Line	0 MGD

B. Services:

1. The Contractor shall engage the services of one of the listed qualified service providers to perform the 12-inch Force Main Drain wet tapping and temporary plug line stopping required for holding back flow from the 36-inch Cherry Creek Force Main for constructing the new 12-inch Drain Valve Manhole as shown on the Contract Drawings.

2. The Service Provider shall provide all tapping and line stopping equipment, pipe fittings and valves required for the wet tapping and the temporary line stopping work, excluding all piping, couplings, and valves located within the new 12-inch Drain Valve Manhole, which can be provided by either the Contractor or Services Provider for the wet tapping and temporary stopping line work, as specified herein and as shown on the Contract Drawings.

3. Services include installation, operation and removal of the line stopping and wet tapping equipment.

C. Contractor Requirements:

1. The Contractor shall be required to furnish all labor, materials and equipment required for the Service Provider to successfully perform the work described herein.

2. The Contractor's responsibility includes, but is not limited to, unloading, staging, and loading (after the job is complete) the service provider's equipment, pipe fittings, couplings and valves at the construction site, excavation, installation and removal of temporary and permanent supports, backfill, shoring, scaffolding, concrete, pipe closure plates and end restraints, and pipe finishes.

3. The Contractor's responsibilities also include, but are not limited to, as a minimum providing the labor and equipment support as described in the Service Providers quotation for the installation of furnished fittings, valves and equipment as required for the wet tapping and line stopping work.

1.5 SUBMITTALS

A. In accordance with the requirements and procedures of Section 01 33 00 – Submittals, the Contractor shall submit Working Drawings that include techniques and details for the pipeline stopping and wet tapping fittings, valves and installation equipment. Working Drawings shall clearly indicate materials and equipment to be furnished by the Service Provider and materials and equipment that have to be furnished by the Contractor for the installation and removal of pipeline stopping and wet tapping fittings and valves as required for the completion of the work.

B. Working Drawings shall include a schedule showing the phasing and duration of work which includes, but is not limited to, the pipeline stopping and wet tapping, installation, removal of the existing 12-inch plug valve, construction of the new 12-inch Drain Valve Manhole including all piping, couplings and valves, and removal of the pipeline stopping and wet tapping equipment.

PART 2 PRODUCTS

2.01 WET TAPPING AND PIPELINE STOPPING EQUIPMENT

A. All pipeline stopping folding plug valves and wet tapping fittings and equipment shall be as engineered, manufactured and furnished by the Service Provider and shall meet the requirements for its' intended service. The intended service is defined as, to isolate flow from the existing 36-inch Cherry Creek Force Main for replacement of an existing 12-inch Drain Valve and installation of new 12-inch Drain Valve Manhole including all piping, couplings and valves as shown on the Contract Drawings.

B. All tapping fittings shall be a full encirclement split Tee-Fitting manufactured and furnished by the Service Provider. The tapping fitting must be provided with a means to flush out the scrap material which will be produced from cutting into the existing12-inch Drain Line.

C. All line stop fittings shall include a means for removing the line stop isolation valve under pressure after the temporary plug has been removed. This system is typically known as a closure plug and shall be included in the design.

PART 3 EXECUTION

3.01 12-INCH RAW SEWAGE FORCE MAIN WET TAPPING

A. The Contractor and Service Provider shall tap the existing 12-inch Drain Line for inserting a temporary plug to isolate the 36-inch Cherry Creek Force Main. The cutting bit will have suitable means for removing the cut section of pipe, referred to as the coupon, with the tapping apparatus. The isolation valve shall be closed before the tapping apparatus is removed. Any raw sewage which leaks out during this process will be the Contractor's responsibility to properly dispose of.

-END OF SECTION-

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SECTION 40 05 30

SLIDE AND SLUICE GATES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for furnishing and installing all slide gates, sluice gates and operators.

1. Where gate operators are installed in NEC Class I, Group D, Division 1 or 2 hazardous locations (as specified), provide operator-related electrical equipment and appurtenances that are UL, Inc. approved for use in such areas.

2. Provide gate operators complete, including a suitable enclosure, with all appurtenances necessary for the operator to perform its intended function. Such appurtenances include, but are not limited to, anchor bolts and other mounting hardware, control switches, limit switches, pressure switches, torque switches, gauges, control valves, electrical supply connections, internal electric wiring and controls, terminal blocks, air supply piping, solenoid valves, miscellaneous valves, regulating controls, push button controls, miscellaneous controls, local and remote indicators, operating nuts, purge water service with all associated piping, indicating lights, and other such items.

3. For each gate provide the type of operator specified for the gate in the Gate Schedule.

B. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 09 96 00 - High Performance Coatings
2. Section 26 05 19 - Wires and Cables - 600 Volts and Below

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASME B1.20.1 - Screw Threads - Pipe Threads, General Purpose (Inch)

2. ASTM A 27/A27M - Specification for Steel Castings, Carbon, for General Application

3.	ASTM A 29/A29M	-	General Requirements for Specification for Steel Bars, Carbon and Alloy, Hot Wrought and Cold Finished,
4.	ASTM A 48	-	Specification for Grey Iron Castings
5.	ASTM A 126	-	Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings
6.	ASTM A 276	-	Specification for Stainless and Heat Resisting Steel Bars and Shapes
7.	ASTM A 395	-	Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
8.	ASTM A 572/A572M	-	Specification for High Strength Low Alloy Columbium Vanadium Structural Steel
9.	ASTM A 536	-	Specification for Ductile Iron Castings
10.	ASTM A 582	-	Free Machining Stainless and Heat Resisting Steel Bars, Hot Rolled or Cold Finished User
11.	ASTM B 21	-	Specification for Naval Brass Rod, Bar, and Shapes
12.	ASTM B 62	-	Specification for Composition Bronze or Ounce Metal Castings
13.	ASTM B 98	-	Specification for Copper Silicon Alloy Rod, Bar, and Shapes
14.	ASTM B 148	-	Specification for Aluminum Bronze Sand Castings
15.	ASTM B 584	-	Specification for Copper Alloy Sand Castings for General Applications
16.	ASTM D 256	-	Standard Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials
17.	ASTM D 570	-	Test Method for Water Absorption of Plastics
18.	ASTM D 638	-	Test Method for Tensile Properties of Plastics

19. ASTM D 696 - Test Method for Coefficient of Linear Thermal Expansion of Plastics

20. ASTM D 790 - Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

21. ASTM D 2583 - Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

22. AWWA C560 - Cast-Iron Slide Gates

23. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates

24. Fed. Spec. TT-V-51 - Varnish, Asphalt

25. SAE J356 - Welded Flash Controlled Low Carbon Steel Tubing Normalized for Bending Double Flaring and Beading

26. SAE J524 - Seamless Low Carbon Steel Tubing Annealed for Bending and Flaring

27. SAE J525 - Welded and Cold Drawn Low Carbon Steel Tubing Annealed for Bending and Flaring

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide all sluice gates from one manufacturer.

2. Provide sluice gates that meet the requirements of AWWA C560, except as otherwise specified.

3. Design sluice gates for seating or unseating pressures as specified, measured to the center of the gate.

1.4 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Shop Drawings: Submit shop drawings, including arrangement and erection drawings of the gates, operators and control equipment; structural design data, if requested; schematic control diagrams, electrical connection diagrams, and complete description of the control system; and operating characteristics.

C. Quality Control:

1. Submit manufacturer's certified performance and material specifications, as specified.

2. Submit manufacturer's certified physical test reports of the fiberglass gates, if specified.

3. Submit an affidavit of compliance with all applicable provisions of AWWA C560 and additions as specified.

4. If requested, submit complete calculations for each size of motor operator indicating the force required to operate the gate, the operator force provided, full load and locked rotor current, and horsepower.

D. Operation and Maintenance Manuals: Submit operation and maintenance manuals for the slide and sluice gates and gate operators.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Division 1.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

1. Sluice Gates

a. Rodney Hunt Company
b. Waterman Industries

2.2 MATERIALS

A. General: Fabricate the various equipment components of materials that meet the following requirements.

B. Sluice Gates:

Iron Castings	ASTM A 126 Class B
Seating Facings:	
Bronze	ASTM B 21 Alloys 464 or 482
Stainless Steel	ASTM A 276 Types 302, 303, 304
Thrust Nut and Wedges	ASTM B 584 Alloy 865
Assembly Bolts, Studs, Nuts and Anchor Bolts:	
Bronze	ASTM B 98
Stainless Steel	ASTM A 276 Types 302, 303, 304
Stems:	
Bronze	ASTM B 21 Alloy 464 or ASTM B 98
Stainless Steel	ASTM A 276 Types 302, 303, 304 ASTM A 582 Type 303

C. Sluice Gate Operators

1.	Operator housings and pedestal handwheels:	
	a. Cast Iron	ASTM A 126, Class B ASTM A 48, Class 30 or 35
	b. Ductile iron	ASTM A 395 ASTM A 536, Grade 65-45-12
	c. Cast steel	ASTM A 27/A29M
2.	Operator worms, steel	ASTM A 29/A29M Grade Designation 8620
3.	Operator gears, steel (spur & helical)	ASTM A 572/A572M
4.	Worm gears, bronze	ASTM B 148, Alloy C95400 or C95500 ASTM B 584, Alloy C86300

2.3 SLUICE GATES

A. Frames: Provide frames of the standard flange type with the rear face machined and drilled to attach to the flange of a wall thimble or pipe. Equip square frames with bolting equivalent to round frames based on the total opening area. In no case exceed 12-inch bolt spacing.

B. Seat Facings: Provide seat facings driven into dovetail grooves machined in the face of the disc and frame.

C. Wedges: Provide gates with adjustable wedging devices as required to prevent excessive leakage. Mount the wedge adjustment on the slide.

D. Wall Thimbles: Furnish wall thimbles from the gate manufacturer except when gates are to be attached to wall castings which are a part of a pipeline. Provide

wall thimbles with the shape of a letter F and of cast iron. Extend the body of each thimble into the concrete or masonry as shown or specified, and in no case less than 6 inches. Provide ribs where necessary on the periphery of the thimble casting joining the flange, body, and collar and extending into the concrete to provide additional strength. Provide a rubber gasket or mastic between the gate frame and the thimble.

E. Stems: Fabricate all sluice gates with rising stems except as otherwise specified. Where nonrising stems are permitted, provide the bottom of the stem above the waterway. Provide thread contact surfaces with a minimum 63 micro-inch finish.

F. Flush Bottom Closure: Provide gates with a flush bottom closure as shown or specified with compressible resilient seal at the bottom of the flush bottom closure gate opening. Securely fasten this seal either to the bottom of the disc or to the invert of the opening. In either case, provide the invert of the opening flush with the floor of the channel as shown, with no projection. When the gate is fully closed make a leakproof seal by firm contact between the resilient seal and gate. Machine all parts which come into contact with the resilient seal fully and rounded sufficiently to prevent any cutting of the seal.

2.4 SLUICE GATE FLOOR AND BENCH STANDS

A. General: Provide sluice gate floor and bench stands of the wheel or crank type. Provide crank operators of the single-speed type, unless the two-speed type is specified.

B. Materials: Provide stand frames of cast iron or fabricated steel of heavy and substantial design with smooth exterior and neat appearance. Make adequate provision for lubrication and protect all operating parts.

C. Nameplate and OPEN Indication Marking: Equip each stand with a nameplate stating the gate controlled by the stand and also stamp the operator with an arrow and the word OPEN to indicate the direction of rotation.

D. Rising Stems: Fit rising stem floor and bench stands with ball or roller bearings designed to take the thrust. Equip rising stem stands with a transparent plastic cover to protect the stem. Provide the cover with labels and other attachments that will facilitate its use as an indicator of valve position.

E. Nonrising Stems: Fit nonrising stem floor and bench stands with thrust ball or roller bearings. Provide an indicator to show the position of the gate.

F. Operating and Lift Nuts: Provide operating nuts or lift nuts of bronze meeting the requirements of ASTM B 62, finished all over, suitably splined to connect with the handwheel or gear and with threads which will engage smoothly with those of the lifting shaft.

G. Crank-Operated Stands: Provide crank-operated stands with a crank that will open the gate when the crank is turned counterclockwise. Locate the center of the crank approximately 36 inches above the operating floor. Provide gears which are bevel or worm, of hardened steel or manganese bronze, with machine cut teeth and enclosed in a cast-iron body. Equip the crank with a brass or bronze sleeve-type handgrip rotating freely on the handle. Utilize a gear ratio that will enable the stand to operate the gate with a maximum force of 40 pounds on the crank at single or low speed.

H. Handwheel-Operated Stands: Provide handwheel-operated stands with handwheels that open the gate when the wheel is turned counterclockwise. Locate the center of the handwheel approximately 36 inches above the operating floor. Provide a handwheel of sufficient diameter so that the stand will operate the gate with a maximum pull on the handwheel of 40 pounds.

2.5 PORTABLE OPERATOR

A. Provide a portable operator of the electric drill type with a reversing switch and safety hold-down ON-OFF switch incorporated in the handle. Provide a heavy-duty electric drill that drives through an overload release clutch of the positive, spring loaded, hand type which instantly releases at a preset torque. Provide adaptors to fit the pinion shafts on the floor stands and other operators. Furnish a heavy-duty cord at least 50 feet long with an explosion-proof plug. Provide a plug that is compatible with the convenience outlets specified under Section 26 27 26. Mount the unit on a tripod which has an adjustable height. Provide a unit that operates using 120-volt, 60-hertz current.

2.6 SOURCE QUALITY CONTROL

A. Hydraulic Power Unit Shop Test: Prior to shipping the fluid power unit, conduct a shop test that demonstrates that the unit fulfills the operating requirements of the Specifications.

PART 3 PART EXECUTION

3.1 INSTALLATION

A. General: Install slide and sluice gates in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Division 1.

B. Floor and Bench Stands: Accurately center floor and bench stands over the gate. Solidly bolt stands to the floor or support structure, with through-bolts wherever possible. Place approximately 3/4 inch of nonshrink cement grout beneath stands

mounted on concrete or similar construction to assure uniform support. For stands installed within the area of a removable type floor, platform, or grating, securely mount them on their own support structure independent of the removable element, unless otherwise shown or specified.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Furnish the services of a qualified representative of each of the various manufacturers to provide instruction on the proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment and place the equipment in trouble-free operation, as specified in Division 1.

B. Tests:

1. After installation of the gates, control equipment and all appurtenances, subject the units to a field running test, as specified in Division 1, under actual operating conditions.

2. Test sluice gates for leakage, strength, and opening and closing against the maximum heads practicable to obtain under operating conditions. Stop any leaks around the thimbles, frames or gates. Provide gates for which leakage around discs does not exceed the amounts allowed by AWWA C560.

3.3 CLEANING AND PAINTING

A. Paint slide and sluice gate in accordance with the requirements in Section 09 96 00. Do not paint bright or rubbing surfaces, but protect and leave bright.

3.4 SCHEDULE

A. Abbreviations used in the schedule are as follows:

Types

TSG	Timber Slide Gate
ASG-L	Aluminum Slide Gate - Large
ASG-S	Aluminum Slide Gate - Small
FSG	Fiberglass Slide Gate
SG	Sluice Gate

Direction of Head

S	Seating
U	Unseating

Operators

AC Air-Oil Cylinder
BS Bench Stand (Manual)
E Electric Motor (Nonmodulating)
FS Floor Stand (Manual)
HC Hydraulic Cylinder (High Pressure)
ME Modulating Electric Motor
PC Pneumatic Cylinder
WC Water Cylinder (Low Pressure Hydraulic Cylinder)

END OF SECTION

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GATE SCHEDULE

Service	Type	Size WxH or Dia (Inches)	Design Pressure			Operator	Remarks
			Head (feet)	Direction	Cntrln Elev		
Cherry Creek Lift Station Wet Well	SG	Determined in the Field	25	Both	592 + / -	FS	Contractor to field verify the size, bolt pattern, and centerline of the existing cross over gate.

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SECTION 40 80 50

PROCESS CONTROL SYSTEM COMMISSIONING

PART 1 GENERAL

1.1 SUMMARY

A. Provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install all equipment and coordinate all activities necessary to perform check-out and start-up of the equipment installed as part of the Tiawah Tunnel And Bird Creek Pump Station Improvements project.

B. Contractor: retain the services of a System Integrator, with substantial documented experience, to supervise and perform check-out and start-up of all Process Control System components. Provide the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the equipment.

C. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 40 05 20 – Ball Valve
2. Section 40 90 50 - Process Control System Descriptions
3. Section 40 91 00 - Process Control System Instrument

1.2 SUBMITTALS

A. General: Furnish all submittals as specified herein.

B. Action Submittals

1. Prior to beginning commissioning activities, submit the following for Owner approval, meeting the sequence and schedule established by the Contractor for facilities impacted by the Contract, as well as overall commission. Submit to meet requirements for commissioning:

a. Test Plan

b. Test Forms

c. Test Schedule

d. Testing Tools

e. Test results

f. Test Logs

g. Loop Check List

h. Point to Point Wiring Diagrams

i. Preliminary Testing Results

j. Approved O&M Manual List

k. Certification that the Test Engineer has reviewed all data and the system and certifies that it is ready for operation

l. Submit certification that all appropriate Operator Component training has been completed.

2. Forms

a. Submit sample test forms and test logs for review.

C. Closeout Submittals: Furnish submittals as required below.

1. Project Record Documents: Provide the following:

a. Program documentation: Provide paper copies of all software development and configuration including listing of all register tables.

b. Include functional narrative description of the developed ladder logic to describe each control system. Ladder logic is to be annotated to include functional alphanumeric description of logic elements to assist Owner in understanding the ladder logic for troubleshooting and future modification.

c. Program copies: Provide two digital copies in CD-ROM format and USB storage drive format of fully configured systems.

d. Operator interface program copies: Provide hard copy printouts and digital copies in CD-ROM format and USB storage drive format of new or modified OIT screens and database listings.

2. Programming Software:

a. Provide a licensed copy of the latest version of PLC, OIT, and instrumentation programming software for the project related programming platforms.

b. Provide system capable of adapting to program changes without impacting the hardware, with programs protected from accidental changes by use of passwords and/or key lock switches or Cryptographic Controller Engineering Key Lock.

c. Provide capability for logic programming and I/O configuration printout.

d. Programming software to be turned over to the Owner at the completion of the project.

e. Provide with the programming software any external security product used. Turn over licensing to the Owner as part of the project.

3. System Validation:

a. Provide updated Transfer Valve Operating Parameters table after testing, calibration, and validation is completed. The table shall be signed by authorized representatives of Contractor, System Integrator, and Engineer.

4. Operation and Maintenance Data: Provide operation and maintenance manuals. Include the following information:

a. Recommended spare parts list.

b. Manufacturer approved repair and service centers list.

c. Replacements part sources.

d. Recommended maintenance procedures and frequencies.

1.3 SYSTEM CHECKOUT AND START-UP

A. System Integrator: perform the following, as witnessed by the Owner, as applicable:

1. Check and approve the installation of all Process Control System components and all cable and wiring connections between the various system components.

2. Conduct a complete system testing, calibration, and validation of the Transfer Valve Operating Parameters specified in the Control Philosophy section of Section 40 90 50 - Process Control System Description.

3. Conduct a complete system checkout and adjustment, including checking each components functions, and testing of final process control system instrument, device, computer, and network functions. Promptly correct all problems encountered to prevent any delays in start-up of the equipment.

B. System Integrator: furnish all test equipment necessary to perform the testing during system checkout and start-up.

C. System Integrator: assume responsibility of the operation of the process control system. Make any required changes, adjustments, or replacements necessary to the system to perform the intended functions.

D. System Integrator: furnish Engineer an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of Contractor, System Integrator, and equipment Supplier.

1.4 INTEGRATED SYSTEM FIELD TEST

A. System Integrator: perform a complete system test, as witnessed by the Owner, as applicable, to verify that all instrumentation and controls equipment, network hardware, and software is operating properly as a fully integrated system, and that the intended network functions are fully implemented and operational. Complete this integrated test after all process areas are demonstrated as operational and tested individually, and after individual facilities are tested and proven operational.

B. System Integrator: correct any defects or problems found during the test and then retest to demonstrate proper operation.

C. Refer to Part 2 of this specification for detailed Integrated System Field Test (SAT & Start-up) requirements.

1.5 7-DAY TEST

A. The 7-Day Test is a period of time during which the equipment shall be utilized by the Owner in day-to-day operations. The purpose of the 7-Day test is to test the equipment and control system stability and completeness over time. The intent of the test is for the system to operate without modification or repairs.

B. Contractor: start the 7-Day Test upon written approval from the Owner / Engineer.

C. 7-Day Test shall continue until a time frame has been achieved wherein the system (both hardware and software) availability meets or exceeds 99.7 percent for 7 consecutive days and no system failures have occurred which result in starting the 7-Day Test over. During the 7-Day Test the system shall be available to facility operating personnel for use in normal operation of the facility.

D. For the purpose of the 7-Day Test, the system shall be defined as all new control system work installed under this Contract, as well as any modifications made to the existing control system.

E. The 7-Day Test shall be terminated if one or more of the following occur. Following correction of the problem, a new 7 consecutive day 7-Day Test shall begin.

1. Failure to repair a hardware or software problem, causing one or more processes halt execution, within 24 consecutive hours from the time of notification failure(s).

2. Recurrent hardware or software problems: If the same type of problem occurs three times or more.

3. Programming or configuration changes shall reset the 7-Day clock.

4. Valve or instrument failure.

F. The following conditions shall constitute a system failure in determining the system availability based on the equation specified in Paragraph 1.5.G, below:

1. Loss of communications between devices on the process control system network.

2. Failure of one or more network devices

3. Failures of any device impacting two or more process control system components simultaneously.

4. Failure of Power Supply: Where redundant power supplies are provided, failure of one power supply will not constitute a system failure provided the backup power supply operates properly and maintains power supply. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.

5. The system shall be considered down if the system cannot generate the periodic reports, alarm log, or event log. The report and logs need not appear on the printer originally selected for the report.

6. Downtime caused by primary utility power failure will not count as downtime.

7. Loss of any microprocessor shall be considered downtime.

8. Loss of any inputs or outputs per processor shall be considered downtime.

9. The accuracy and precision of all of the analog inputs and outputs must be within the limits specified, or the system shall be considered down.

10. The time between notifying the Contractor of a system failure and the time it has been corrected and back on line shall be considered downtime.

11. Shutdown of the critical systems from a software fault shall be considered downtime.

G. The system availability shall be calculated based on the following equation:

$$A = \frac{TTO}{TTO + TTR} \times 100 \text{ percent}$$

where,

A = system availability in percent
TTO = total time in operation
TTR = total time to repair

H. Time to repair shall be the period between the time that Contractor is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.

1. Actual travel time for service personnel to get to the Site up to four hours per incident from the time Contractor is notified of a system failure.

2. Time for receipt of replacement parts to the Site once identified up to 8 hours per incident. Work done on the system while waiting for delivery of replacement parts does not stop the failure clock.

3. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the 7-Day Test extended for an amount of time equal to the total dead time. Dead time shall be totalized.

I. Contractor: furnish all parts and maintenance materials required to repair the system prior to completion of the 7-Day Test at no additional cost to Owner. Immediately replace parts that are obtained from the Contract spare parts inventory.

1.6 SPARE PARTS

Not Used

PART 2 SITE ACCEPTANCE TESTING

2.1 GENERAL

A. The Site Acceptance Test (SAT) shall be focused on verifying that all instrumentation, equipment, PLC/OIT/HMI, and controller hardware and software is working properly and that all software configurations match the requirements identified in the detailed process narratives. Successful completion of the SAT shall be considered to be a critical project milestone.

B. Contractor: test the software under all possible process conditions in order to demonstrate the robustness of the software. The software test shall be witnessed by Owner / Engineer.

C. The SAT shall consist of testing using the actual field inputs/outputs once all field equipment has been installed and successfully tested.

D. SAT testing shall be carried out for all PLC/OIT/HMI and controller software including packaged and vendor supplied products as a whole system.

2.2 PREREQUISITES

A. Complete equipment start-ups with manufacturer representatives including all mechanical equipment required to fully test the operation of the software. Complete process area start-ups prior to overall SAT.

B. Install, calibrate, and test all required instrumentation prior to starting SAT.

C. Install and test all required network equipment prior to starting the first facility SAT.

D. Submit the SAT & Start-Up Test plan for approval by the Owner / Engineer no later than four (4) weeks in advance of the SAT.

E. Wire, test, and sign off 100% all process area and packaged system panel I/O prior to commencing SAT unless otherwise approved by Owner / Engineer. Submit a request to defer I/O testing until after the SAT for review and approval at the same time when the SAT & Start Up test plan is submitted for review and I/O is not available. Identify the reason for deferring I/O testing in the request along with a proposed date when the I/O shall be tested.

2.3 START-UP TEAM

A. The Start-Up Team shall consist of individuals from the Owner, Engineer, Contractor, System Integrator, and Equipment Manufacturers.

B. The Start-Up Team shall review the testing plan, SAT, & Start-Up Plan and revise,

if necessary, at a pre-SAT & Start-Up meeting to be scheduled no later than six (6) weeks in advance of the proposed SAT period.

C. Furnish details for the SAT & Start-Up Plan to clearly identify the proposed test procedure for the equipment and software.

D. The SAT testing shall be witnessed by the Start-Up Team.

E. Members of the Start-Up Team shall be identified at the pre-SAT & Start-Up meeting. These team members will be involved throughout the process and shall be changed only with the approval of the Engineer.

2.4 PURPOSE AND SCOPE

A. Goal of software testing: to verify that the system released for use by the Facility's Staffs meets the contract requirements, and is error-free, and does not adversely affect other systems. Software installed or modified under the project shall not adversely affect the operation of other systems currently in operation at existing Owner facilities. All functionality that is currently available within the system must remain available at the completion of the testing.

B. Test all software installed as part of the project to confirm that the software developed, tested, and installed under the project conforms to the approved process control narratives.

C. All software shall meet the requirements of the project specifications including all operational control, monitoring, and alarming. Software shall integrate all vendor packaged systems as defined within the contract documents.

D. Testing shall demonstrate that all software developed works throughout Owner SCADA workstations. Conduct all system-wide testing concurrently with the local testing to confirm operation throughout the system.

2.5 DEFINITIONS

A. Software Testing: defined as the execution of a program to find its faults, and not just a process to verify its correctness.

B. Other definitions are:

1. Verification: The process of proving the program's correctness.

2. Validation: An attempt to find errors by executing a program in the controllers, Control nodes, and Monitoring nodes.

3. Debugging: Diagnosing the precise nature of a known error then correcting

it. Debugging is a "fix" activity, not strictly a testing activity.

4. Errors: Human mistakes; errors in design definition or interpretation of the design by the programmer.

5. Defects: Improper program conditions that are generally the result of an error. Not all errors produce defects (as with incorrect program comments, for example).

6. Bugs: A fault that is a program defect found when the program is being tested or is in operational use. Bugs result from defects, but all defects do not necessarily produce bugs.

2.6 OBJECTIVES

A. The following identifies the overall objectives of the PCS Site Acceptance Test:

1. Confirm and document that the PLC I/O matches the panel shop drawings in terms of input/output configuration, tagging, and function.

2. Confirm and document that the individual device logic operates all field equipment correctly and safely, as described in the detailed process control description.

3. Confirm and document that the control logic operates the facility correctly and safely, as described in the detailed process control description.

2.7 APPROACH

A. As part of the testing process regression, incorporate testing into all test plans to demonstrate that any changes made to the software do not impact other areas of the logic. This approach shall ensure that corrections/modifications have not adversely affected the previously tested (and debugged) systems and system components.

B. Testing is to be both progressive and regressive.

1. Progressive testing introduces and tests new functions and uncovers problems in the newly added or modified modules and in their interfaces.

2. Regressive testing concerns the effects of newly introduced changes or system components on all previously integrated (tested) code.

2.8 TEST SUCCESS CRITERIA

A. Test success shall be based on the number of defects and the defect severity encountered during the testing period. The Owner / Engineer, at their discretion, shall determine to restart a new SAT.

2.9 COMPLETION CRITERIA

A. Testing of software is deemed to be complete when all features, functions and information required in contract drawings, and the complete functionality as described in the contract documents has been verified as present and functioning, and documented as accurate within the anticipated operating range for the process being monitored and controlled.

2.10 PARTICIPANT AND RESPONSIBILITIES

A. SAT & Start-Up Test Planner (Contractor / System Integrator / Equipment Manufacturer):

1. Develops the complete SAT & Start-Up test plan

2. Develops the schedule

3. Coordinates all meetings identified in the contract documents to develop and implement the test plan

4. Coordinates the involvement of all team members and equipment manufacturers required to be present during testing

5. Develops/compiles the test data

6. Oversees the test planning and test plan execution of the process control system

7. Obtains approval for test plan and schedule from Engineer.

B. Owner / Engineer:

1. Reviews and approves test plan

2. Documents test results and classifies defect severity

3. Identifies system "design" defects (where the design does not match the specification) and coding defects (where the system does not behave as specified)

4. Reviews test results

5. Assigns fault severity. Logs action required and taken in the Software Action Log

6. Maintains Software Action Log

7. Maintains Deficiency Log related to other trades: electrical, instrumentation, vendor packages, and others

8. Presents Correction Requests to the Owner for prioritization

9. Schedules approved Correction Request work

10. Maintains Correction Request Log

11. Coordinates with City operations staff to avoid conflicts and minimize impact to operations of construction activities

12. Participates and assists in the acceptance testing

13. Responsible for signing-off on the acceptance testing that the system is fully functional as defined within the detailed process control narrative

14. Oversee the integration of the software into the existing SCADA network

C. System Integrator

1. Responsible for defining the procedure required to complete the SAT & Start-Up tests

2. Responsible for directing the SAT and start-up testing and for providing input to the Contractor as to which trades are required to complete the tests identified within the test plan

3. Installs and tests all software for functionality as per the detailed process control description

4. Fixes all defects

5. Documents test results and forwards to Contractor

D. Contractor / System Integrator

1. Responsible for conducting complete system testing, calibration, and validation of the Transfer Valve Operating Parameters specified in the Control Philosophy section of Section 40 90 50 - Process Control System Description.

PART 3 EXECUTION

3.1 GENERAL

A. Part 3 provides an outline of the work to be carried out by the Owner / Engineer / Contractor / System Integrator / Equipment Manufacturer as part of the PCS Site Acceptance Test(s).

3.2 TEST SUB-PHASE

A. The types of software tests are:

1. Individual instruments, equipment, and process units: these sub-phases test/verify that devices and their larger system parts (e.g. process units and duty tables) perform as specified.

2. Intra-system Integration: tests/verifies the interfaces between units and the associated process logic related to multiple units, and facility-wide operating strategies.

3. Function: tests/verifies the functions the program is to perform as set out in the detailed process control narratives.

4. Performance/Operational: tests/verifies the system's performance under a variety of conditions (normal/abnormal) and verifies these results against the detailed process control narratives. Includes testing of the system's configuration, security, backup/recovery, and reliability in the planned network architecture.

5. System Wide Integration: tests/verifies the operation of all control areas from all OITs and HMI operator workstations.

3.3 DEFECT HANDLING

A. During testing, identify the need for corrections to the system. This shall be as a result of a test failure or as a result of an incorrectly implemented requirement (test did not fail, but the requirement is incorrectly implemented).

B. For test failures, record the defect in the SAT test document. Immediately review and resolve all defects during the SAT period.

C. If Correction Requests are required, they will be prepared by the Engineer. Possible implications of not proceeding should also be identified. The Owner will authorize the work to be done under any correction request. Prior to implementing, Contractor shall schedule correction request work based on the project priorities.

3.4 SUCCESSFUL COMPLETION

A. The SAT is deemed successful when the following items have been completed:

1. SAT Test plan has been completed and signed-off

2. All faults identified during the SAT have been corrected and verified for correct operation

3. The completed SAT plan has been reviewed and signed off by the Engineer, Contractor, and System Integrator.

3.5 FACILITY STARTUP PERIOD

A. Following successful completion of the SAT testing, the startup period may commence. Owner, Engineer, Contractor, System Integrator, and Equipment Manufacturers, are to be present during the startup period.

B. Engineer maintains a log of faults/deficiencies encountered during the startup period. The Contractor / System Integrator / Equipment Manufacturer is to immediately correct faults/deficiencies at the request of the Owner, or Engineer. If any fault occurs during the startup period, the test period shall be restarted from Day 1 after completion of the software modifications and testing by the System Integrator.

C. Following completion of the startup period, the fault/deficiency log is submitted to the Engineer for review. Sign-off by Owner, Engineer, Contractor, and System Integrator is required at the completion of the facility startup period.

3.6 TRAINING

A. Provide training on new valve and modified controls in accordance with the requirements contained in Contract Documents and Drawings.

3.7 MANUFACTURER'S FIELD SERVICES AND TRAINING

A. During the 7-Day Test, the Contractor shall include the services and training time of factory trained personal, as required, from each manufacturer listed. This time shall be utilized at the discretion of the Owner. Field services shall be based on an eight (8) hour day, Monday through Friday, during the Facility's normal working hours. All travel and living related costs are the responsibility of the Contractor.

1. Valve manufacturer

2. System Integrator

END OF SECTION

SECTION 40 90 00

PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section 40 90 00 describes the general requirements for furnishing and installing process control system (PCS) including all labor, materials, equipment and incidentals as shown, specified, and required to furnish, install, calibrate and place in operation a complete system as illustrated on drawings, and as specified in the following sections.

B. Provide labor, materials, equipment, and services to store, transport, install, calibrate, and make operational the PCS work for the Cherry Creek Lift Station (CCLS) Pump Restoration improvements. The work includes the design shown on the drawings and specifications including instruments, field devices, networks, programming, integration, testing, and commission for all devices provided including packaged systems and control. Work shall also include wiring, raceway, fittings, and connections to link and integrate the individual components and packaged control systems into the existing SCADA network.

C. Work Areas for This Project Include, But are Not Limited to:

1. Cherry Creek Lift Station
2. Flow Equalization Basins
3. Modifications to existing PLCs and HMIs at the Southside Wastewater Treatment Plant

D. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 01 33 00 - Submittals
2. Section 40 80 50 - Process Control System Commissioning
3. Section 40 90 50 - Process Control System Description
4. Section 40 91 00 - Process Control System Instruments
5. Section 40 95 13 - Process Control System Panel Enclosure and Equipment
6. Section 40 96 15 - Process Control System Input and Output List
7. Section 40 98 00 - Process Control System Training

1.2 SYSTEM SUPPLIERS

A. CONTRACTOR: provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place

in satisfactory operation a complete process control system. Assume responsibility for all elements specified and provided as part of this section and related sections.

B. SYSTEM INTEGRATOR: provide all programming, integration, testing, start-up, and commissioning services related to PLC control system and PCS HMI systems.

1.3 REFERENCES

A. Regulatory Requirements

1. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes, applicable to construction and installation of electrical wiring, devices, material and equipment.

2. NECA Standards: Comply with applicable portions of National Electrical Contractor's Association's "Standard of Installation".

3. UL Labels: Provide control panel components, power supplies, relays, etc., which have been listed and labeled by Underwriter's Laboratories.

B. The purpose of Contract drawings and specifications is to convey information required for complete and functioning systems.

C. SYSTEM INTEGRATOR is responsible for all details necessary to properly install, adjust, configure, and place in operation the intended systems. Instrument List and Input/Output List, if provided, are for convenience; their accuracy is not guaranteed.

D. Section 01 42 20 - References.

E. Codes and Standards referred to in this Section are:

1.	NFPA 70	National Electrical Code
2.	UL	Underwriter's Laboratory
3.	NEMA	National Electrical Manufacturers Association

1.4 QUALITY ASSURANCE

A. Standard Products

1. Use standard hardware and software which is fully developed, tested, and supported as a base for the Work. Provide custom modifications as specified elsewhere. Provide a fully operational, reliable system which meets the functional intent of the Specifications.

B. Software Testing Standards

1. Test programs to ensure that the software to be provided is consistent with the design parameters and that no errors occur when the programs are executed, either at machine level (PLC) or operator level (HMI).

2. Establish testing standards.

C. Revision Level

1. Update hardware and firmware to the manufacturer's latest revision level. Perform updates periodically until final acceptance, as revisions are issued by the manufacturer. Hardware and firmware shall be uniform across enterprise system.

2. Exceptions will be considered on a case-by-case basis. Exceptions shall not be allowed without certification that the original equipment manufacturer will continue to support and warranty the hardware.

3. Ensure retention of compatibility with all systems before performing any hardware, software, or firmware upgrades.

1.5 ABBREVIATIONS

A.	CCLS	Cherry Creek Lift Station
B.	FEB	Flow Equalization Basin
C.	HMI	Human Machine Interface
D.	OIT	Operator Interface Terminal
E.	OWS	Operator Workstation
F.	PC	Personal Computer
G.	PCS	Process Control Systems
H.	PLC	Programmable Logic Controller
I.	RIO	Remote Input/Output
J.	SCADA	Supervisory Control and Data Acquisition
K.	SSWWTP	South Side Wastewater Treatment Plant
L.	TMUA	Tulsa Metropolitan Utility Authority

1.6 DEFINITIONS

A. Process Instrumentation and Control Equipment: Instrumentation and control and monitoring components such as field elements, panels, process control systems, and associated electromechanical, electrical, and electronic accessories.

B. Process Instrumentation and Control System: Materials, equipment, and work required to implement a complete and operating system of instrumentation and control equipment.

C. PLC (Programmable Logic Controller): System includes power supply, central processing unit (CPU), communication controller, interconnect cables, and input and output interface.

D. SCADA (Supervisory Control and Data Acquisition): Computer system that operates as primary operator interface to the entire PLC network, which includes process visualization and control, data collection and storage, alarm management, and process data link to other office productivity software.

E. OIT (Operator Interface Terminal): Graphical local operator interface terminal at a PLC enclosure or control panel.

F. OWS (Operator Workstation): PC based operator system, including hardware, operating system software, and operator interface HMI system software. This is generally referred to as the SCADA or HMI workstation.

1.7 GENERAL DESCRIPTION OF WORK

A. Summary

1. Pressure Transmitters: Provide new pressure transmitters for four (4) raw sewage pumps at the CCLS and connect new pressure instruments to the existing CCLS PLC (PLC-F).

2. PTMS: Provide a new Pressure Transient Monitoring System, (PTMS) to monitor the suction pressure, discharge pressure and pressure downstream of the pump discharge check valve for Raw Sewage Pump #2 (S104-LFT1-RSP02).

3. Vibration Sensors: Provide new vibration sensors for four (4) raw sewage pump shaft outboard motor bearings and connect new vibration sensors to the existing CCLS PLC (PLC-F).

4. Pump Discharge Valve Integration: Connect four (4) new motorized pump discharge valves to the existing CCLS PLC (PLC-F) for each of four (4) raw sewage pumps. Provide System Integration for the new pump discharge valves as required by the Contract Documents.

5. Provide System Integration and modifications to PLC-F and two (2) associated RIO panels (RIO-3, RIO-4) as required by Contract Documents.

B. Provide all materials and work necessary for complete and fully functional systems.

1. Provide instrumentation and controls components as well as complete system integration. Provide all mounting hardware and supports. Work shall

include panel mounting and the completion of all wiring terminations within control panels.

2. Integrate new and existing equipment and instrumentation to existing PLC systems for monitoring and control of equipment as shown in the contract drawings. Control strategies for the PLC systems are provided in Section 40 90 50 - Process Control System Description.

3. Configure all I/O points as shown on Contract Drawings and as required by Section 40 96 15 - Process Control System Input/Output List.

4. Commission PLC system per the requirements of section 40 80 50 - Process Control System Commissioning.

5. Ensure communication with existing SCADA system through existing control network allowing monitoring and control of new equipment.

6. Ensure proper interface between SCADA, PLC, and OIT, OWS, RIO systems and equipment provided in this contract.

7. Provide training for OWNER to perform all functions necessary to operate equipment per Section 40 98 00 - Process Control System Training.

8. Work is generally as shown on the drawings and as specified. Programming of each PLC/OIT/HMI is required including communication and messaging with related equipment (drives, packaged systems, generators, power monitors, etc.). Configuration of network equipment, including implementation of network security consistent with TMUA is required.

9. Coordinate work with all electrical, mechanical, civil, and structural work provided in this Contract.

10. Install, make final connections, adjust, test, start-up systems per manufacturer's instructions and recommendations.

C. Source Code Ownership

1. Any developed ladder logic (along with source code) shall become property of the OWNER. This applies to any logic associated with package control systems as well.

2. Any developed or modified PLC, HMI, OWS, and OIT applications (along w/ source code) shall become property of the OWNER, and shall be consistent with existing for look, feel, navigation, including type of graphics and colors. This applies to any logic associated with package control systems as well.

3. All passwords shall be documented and submitted to OWNER.

1.8 SUBMITTALS

A. General: Furnish all submittals, including the following, as specified in Section 01 33 00 - Submittals.

B. SYSTEM INTEGRATOR: Prior to beginning any work on this Contract, submit a plan for performing programming, site testing, commissioning, and start-up for OWNER approval.

C. Include the following information in the submittal for this section:

1. A system hardware overview that provides an overall description of the PCS equipment being added, including a detailed system configuration diagram.

2. Power and grounding interconnection diagrams. Show the grounding philosophy and implementation. Detail interconnections from the main power source. Show uninterruptible power supplies and power conditioners.

3. Interconnecting wiring and cabling diagrams. Include maximum distance limitation between panels and equipment. Include cable identification.

4. Color schedule with color and samples for panels.

D. Include the following submittal information on each hardware item:

1. General data and description.

2. Engineering specifications and data sheets, annotated as necessary to describe specific hardware.

3. Dimension drawings, including exterior dimensions and clearances required, cable ingress and egress areas, cable routing and terminations.

4. Equipment weights.

5. Power and grounding requirements, wiring diagrams, and electrical schematics.

6. Heat rejections and environmental operating requirements.

7. Spare parts list, special tools and test equipment.

8. Other submittal information as required in individual specification sections.

E. Action Submittals

1. Product Data: Submit manufacturer's official and published product data, specifications, and installation recommendations for each item.

2. Shop Drawings: Submit shop drawings as per Section 01 33 00 - Submittals, and as required below. Include the following information in each submittal:

   a. Instrumentation

      (1) Instrument index, including tag number, description, location, and calibrated range for each instrument.

      (2) Individual instrument specification sheet, including manufacturer's name and complete catalog number.

      (3) Installation and mounting details for each instrument application. Installation and mounting details shall include any required mounting brackets, hardware and instrument enclosures.

      (4) Instrument wiring diagrams.

   b. Control Panels: Submit complete drawings for PLC-F and two (2) associated RIO panels (RIO-3, RIO-4).

      (1) Drawings shall show as-built conditions for the entire PLC system and control panel with revision clouds to indicate what modifications were made for this project.

      (2) Panel construction drawings with dimensions, layout, and bill of materials.

      (3) Panel wiring diagrams

      (4) Loop diagrams

      (5) Input and Output drawings, containing, but not limited to, the following information:

         (a) Line numbers and instrument tag numbers

         (b) Individual component locations

(c) Actual equipment wiring terminal designations, point to point wiring, and cable shield terminations

(d) Wire type, size, and identification number

(e) Signal types (e.g., 120 VAC, 4-20 mA, pulse frequency, etc.)

(f) Contact orientations (e.g., normally open, normally closed, etc.)

(g) Equipment grounding requirements

(h) Signal boosters, interposing relays, optical isolators, and shunt resistors.

3. Communication and digital networks diagrams

a. Network diagrams shall include all digital and serial interfaces and connections to the PCS network and/or to other equipment or devices in the PCS.

b. Network diagrams shall include and identify all digital and serial communications protocol, including but not limited to: Ethernet TCP/IP, Modbus TCP/IP, Modbus RTU Serial, ControlNet, DevieNet, Profibus, Profinet, Foundation Fieldbus, HART , RS-232, RS-485, and DNP.

c. Network diagrams shall include all wireless communication systems including but not limited to: radio communication systems, WiFi, mesh networks and Bluetooth.

d. Identify cable, termination type, termination location, and drop lengths for each segment.

e. Format: Network schematic for each different type of network.

4. Graphics: Completely developed process graphics/screens for the following PCS equipment.
   a. PLC-F Operator Interface Terminal (OIT)
   b. SSWWTP SCADA Workstations / HMI Applications
   c. Submit static copies of each graphic screen including alarm screens. Submittal shall indicate navigation, pop-ups, alarms, and status information.

F. Information Submittals

1. Test Reports: Provide all loop field calibration reports.

2. Factory and Field Testing: Provide the following:

   a. Test Results:

      (1) Pass/fail status of all digital I/O.

      (2) Results of analog I/O testing.

   b. Miscellaneous:

      (1) Detailed step-by-step in-factory and field test procedure at least 6-weeks in advance of scheduled test date. Include sign-off sheets and punch list forms and description of configurations to be tested.

      (2) Complete inventory of equipment to be tested including make, model, and serial number. Label each piece of equipment.

      (3) Preventive maintenance schedule.

      (4) Repair Report Forms.

      (5) Spares and Consumables Report.

3. Provide manufacturer published installation manuals and operations manuals for each instrument, device, or equipment.

G. Closeout Submittals: Furnish submittals as required below.

1. Project Record Documents: In addition to requirements described in Section 01 78 90 - Contract Close Out, provide the following:

   a. Program documentation: Provide paper copies of all software development and configuration including listing of all register tables.

   b. Include functional narrative description of the developed ladder logic to describe each control system. Ladder logic is to be annotated as specified in Section 40 94 43 - Programmable Logic Controller Systems to include functional alphanumeric description of logic elements to assist OWNER in understanding the ladder logic for troubleshooting and future modification.

c. Program copies: Provide two digital copies of fully configured systems. Digital copies shall be included in both CD-ROM format and USB storage drive format.

d. Operator interface program copies: Provide hard copy printouts and digital copies of new or modified OWS screens and database listings. Digital copies shall be included in both CD-ROM format and USB storage drive format.

2. Operation and Maintenance Data: Provide operation and maintenance manuals as specified in Division 1. Include the following information:

a. Recommended spare parts list.
b. Manufacturer approved repair and service centers list.
c. Replacements part sources.
d. Recommended maintenance procedures and frequencies.

3. Warranty: Provide warranty certificate as described in Section 01 78 90 - Contract Close Out.

1.9 RESPONSIBILITY

A. SYSTEM INTEGRATOR:

1. Provide application software programming as specified in Section 40 90 50 - Process Control System Description.

2. Prepare Interconnecting Wiring Diagram Drawings for the Process and Instrumentation Control System. Interconnecting wiring and terminations for the System shall be provided by the electrical CONTRACTOR under Division 26, in accordance with the Interconnecting Wiring Diagram Drawings.

3. Responsible for configuration, coordination, and addressing of Ethernet networks for the devices specified herein and as shown on the Drawings. Where additions to existing plant networks are required, request the range of available addresses from the OWNER and coordinate requirements.

4. For Process Control System control panels, components, and ancillaries specified under this section:

a. Coordinate to ensure that: The proper size, type, and number of PCS related raceways and conductors are provided and installed.

b. Complete panel fabrication drawings.

c. Provide the specified submittals.

d. Provide panels, components, and ancillaries.

e. Provide programming and configuration of PCS components.

f. Provide instructions, details, and advice to and coordinating with the CONTRACTOR to ensure proper installation.

g. Certify correctness of installation.

h. Verify final power and signal connections and labeling (lugging and connecting).

i. Adjust and calibrate components and devices.

j. Perform Start-up

k. Perform Testing

l. Provide the required training.

5. For systems, components, and ancillaries not provided under this Section but that are directly connected to components provided under this Section:

a. Obtain manufacturers' information regarding installation, interface, function, and adjustment.

b. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacture's recommendations.

c. Testing to demonstrate proper interface and operation with PCS.

B. CONTRACTOR: immediately correct incomplete or deficient Work discovered during application software programming, downloading, testing, troubleshooting, and System startup. Use interim modifications or patches as required to maintain 24 hr x 7 day operation.

1.10 APPLICATION SOFTWARE PROGRAMMING

A. SYSTEM INTEGRATOR:

1. Provide application software programming as required in this and related Sections.

2. Download and test application software programming after successful completion of Process Control System Factory Acceptance Testing specified in Section 40 98 50 and Process Control System Commissioning in Section 40 80 50.

B. Training Services specified in Section 40 98 00 - Process Control System Training shall not begin until SYSTEM INTEGRATOR has successfully completed application software programming, downloading, and testing. Refer to construction sequences and constraints that affect completion of application software programming, downloading, and testing.

C. All work performed by the SYSTEM INTEGRATOR shall be performed in accordance with TMUA SCADA standards.

1.11 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver, store, and handle all products and materials as specified in Section 01 60 00 - Material and Equipment.

B. Acceptance at Site: Inspect all materials and equipment against approved shop drawings at time of delivery. Immediately return for replacement or repair any equipment or materials damaged or not meeting requirements of approved shop drawings.

C. Storage and Protection: Label all equipment and materials after they have been inspected. Store all equipment and materials in dry, covered, ventilated location. Protect from harm in accordance with manufacturer's recommendations.

1.12 PROJECT/SITE CONDITIONS

A. Environmental Requirements: Protect all equipment and instruments specified herein from moisture. Site is a wastewater treatment plant with potential for hazardous, corrosive, and chemical rich vapors. Process control equipment may be located outdoors and subject to temperatures from -20F to +120F, with rain and 100% humidity.

1.13 SEQUENCING AND SCHEDULING

A. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawing Reviews by ENGINEER:

a. Prerequisite: RESIDENT PROJECT REPRESENTATIVE's acceptance of Schedule of Values and Progress Schedule.

2. Training

a. Prerequisite: Associated training plan Submittal approved.
b. Prerequisite: Offsite Training plan submittal approved

PART 2 PRODUCTS

2.1 GENERAL

A. Provide hardware consisting of ruggedized components designed specifically for the site conditions. Refer to other sections for appropriate NEMA requirements.

B. Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter's Laboratories (UL), Inc., and so marked or labeled, together with manufacturer's brand or trademark.

C. Provide material and equipment in accordance with applicable codes and standards, except as modified by the specifications.

D. Coordinate instrumentation to assure proper interface and system integration. Provide signal processing equipment, to include, but not be limited to, process sensing and measurement, transducers, signal converters, conditioners, transmitters, receivers, and power supplies. Coordinate the various subcontractors, equipment suppliers, and manufacturers.

2.2 SYSTEM ARCHITECTURE

A. SYSTEM INTEGRATOR: responsible to configure and program the PCS to provide control and monitoring of all instruments, devices, and equipment connected to the PLC system as described in this Contract.

2.3 MONITORING AND CONTROL – GENERAL

A. Functional descriptions of the processes and equipment to be monitored and controlled by (or through) the Process Control System are specified in Section 40 90 50 - Process Control System Description.

2.4 SYSTEM HARDWARE

A. Provide all hardware and ancillary equipment required to provide a fully functional PCS. PCS components, including panel hardware, motor starters, etc. shall be as specified in Division 40 and other Divisions.

2.5 SYSTEM INTEGRATION

A. Provide system integration of the complete PCS. System integration may require the installation of additional pieces of equipment to make the PCS a reliable, safe, maintainable and fully functional system. Such equipment includes, but is not limited to, communication modules, terminations, wires, cables, connectors, power supplies, transceivers, transducers, signal isolators, power surge suppressers, lights, switches, circuit breakers, fuses, power receptacles, fans, and communication devices.

B. Provide all additional pieces of equipment as necessary to provide a fully integrated, fully operative PCS with fully functional signal interfaces to field instrumentation, motor controllers, and other control devices as described elsewhere.

C. System integration requires thorough testing of all system equipment and circuits under all probable system conditions to ensure a robust PCS.

2.6 GRAPHIC DISPLAY REQUIREMENTS

A. The displays shall include at a minimum all the equipment shown in the Process and Instrumentation Diagrams and described in the control description provided in Section 40 90 50 - Process Control System Description. Graphics shall follow requirements of High Performance HMI standards. All equipment shall be labeled as shown on the Contract Drawings or as listed in the I/O list.

B. All HMI & OIT displays shall have the following attributes:

1. Display window sizes:

    a. 1330 wide by 553 high with "Size to Main Window at Runtime" checked

    b. 1900 wide by 790 high

2. Pop-up displays (e.g. Set Point Displays):

    a. No set size, but sized appropriately for content and be smaller than display window sizes as defined above

    b. Use the "On Top" Display Type

3. OIT Display Window sizes:

    a. Size normal display windows to appropriately the full screen or scale properly as to avoid stretching

b. Pop-up displays

(1) Do not have to be set to fill the screen, but should use the "On Top" display type.

(2) Background color shall be Grey

(3) All Buttons will be Style: Recessed

(4) All standard text will have the following attributes:

(a) Arial Bold 10pt font
(b) Center aligned
(c) Either Black or White, dictated by whichever color provides the best contrast for easy readability

(5) All numeric displays and numeric inputs shall have the following

(a) Courier New Bold 10pt font
(b) Right-aligned
(c) Fore Color: White

(6) Any visual graphics (e.g. tanks) will endeavor to reasonably reflect their real-world counterpart in look

(7) All grouping containers will use the panel object tool and have the following attributes:

(a) Inset border style
(b) Border width: 2
(c) Back style: Solid
(d) Pattern Style: None
(e) Back color of Dark Grey

C. Color standards for all HMI & OIT displays (specified in RGB):

1. Numeric displays – centered in a small panel object with an associated background color:

a. Levels: 0, 136, 200
b. Temperatures: 140, 140, 0
c. Pressures: 0, 128, 0
d. Flows: 128, 0, 0

2. Green: 0, 255, 0
3. Red: 255, 0, 0
4. Grey: 128, 128, 128
5. Dark Grey: 63, 63, 63
6. Yellow: 255, 255, 0
7. White: 255, 255, 255
8. Black: 0, 0, 0
9. Other Colors with OWNER approval

D. HMI Tags

1. All HMI tags shall have a prefix designated by OWNER.

2.7 CABLES AND CONNECTORS

A. Provide wiring, connectors, and cables to connect the equipment.

B. Size wiring and cables to equipment such as printers, operator workstations, and similar devices to accommodate relocation within the control rooms and operator workstation areas. Add a minimum of 25 percent of the cable length or 15 feet, whichever is greater, to the laying lengths.

C. Clearly label all cables at both ends according to requirements of electrical identification.

PART 3 EXECUTION

3.1 GENERAL

A. Provide the detailed hardware configuration, integration, construction, testing, startup, installation, and demonstration of all equipment.

B. Install all equipment at the OWNER's facilities in accordance with applicable federal, state, and local codes. Supervise the installation and be responsible for the performance of the completed system.

C. Provide for the protection, insurance, and proper storage of equipment. In the event the equipment is damaged, for whatever reason, repair or replace, as required, the damaged equipment at no cost to the OWNER until Final Acceptance.

D. Provide coordination of the overall PCS for resolution of interface discrepancies between the PCS input/output hardware, panels, equipment, instrumentation, and final control devices. Where interface conflicts exist, provide resolution to the

problems and document them in writing to the RESIDENT PROJECT REPRESENTATIVE. Keep Drawings current with all changes.

E. Provide operations and maintenance manuals, record drawings, documentation, and warranty as described elsewhere in the Specifications.

3.2 EXAMINATION

A. Verify equipment locations and delivery routes prior to installation to ensure the equipment will fit in the available space. Investigate and make any field modifications necessary to allocated space for new equipment.

B. Existing raceways which contain space to run wiring may be used with the approval of the RESIDENT PROJECT REPRESENTATIVE. Do not damage existing equipment or wiring. If equipment or wiring is damaged, repair or replace it at no additional cost to the OWNER. Do not interrupt control or monitoring signals or power. Obtain approval from the OWNER before pulling wires.

3.3 PROTECTION

A. Maintain site security.

1. Check in with facility staff each day while on site.

2. Verify that all enclosures, doors, and gates which were opened during the day are locked when leaving.

3. Do not leave unlocked enclosures unattended for longer than 30 minutes.

3.4 INSTALLATION AND WIRING

A. Install wiring to interface the PCS components to field devices for all points on the I/O list. Wiring shall be in accordance with the recommended methods and practices of the manufacturers of the field devices and the manufacturer of the PCS.

B. Resolve all interface problems. Supply all additional hardware, signal isolators, media converters, signal converters, transceivers, relays, and other required components as necessary to properly interface each field I/O point to the PCS.

C. Provide and keep a neatly marked set of record wiring drawings on the job site showing the installed location and routing of all wiring, including spares, and instrumentation cable runs. These drawings shall also show all terminal connections. These drawings must show as a minimum:

1. All wiring between PCS components and field devices and/or panels, including terminal and wire numbers for all wiring.

2. All PCS communication wiring and interconnection.

3. All interconnections between any PCS components.

4. All power connections to PCS components.

D. Keep drawings current with the work as it progresses, subject to inspection by the RESIDENT PROJECT REPRESENTATIVE at any time.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspection: Provide tests as required in Section 40 80 50 - Process Control System Commissioning.

B. Inspection: Demonstrate that instruments, panels, programming equipment and network equipment:

1. Has not been damaged by transportation or installation,
2. Has been properly installed,
3. Has no mechanical defects,
4. Is in proper alignment,
5. Has been properly connected.

C. Testing Process:

1. Test digital inputs and outputs by actual starting and stopping of equipment when possible, or with jumpers at field equipment terminals.

2. Conduct all tests in presence of plant personnel ENGINEER, and RESIDENT PROJECT REPRESENTATIVE.

D. Manufacturers Field Service: Provide manufacturer field service for calibration, initial setup, programming, and commissioning of each instrument.

END OF SECTION

SECTION 40 90 50

PROCESS CONTROL SYSTEM DESCRIPTION

PART 1 GENERAL

1.1 SUMMARY

A. Section 40 90 50 includes requirements for furnishing and installing instrumentation and control systems including all work and materials necessary to perform control and monitoring functions as illustrated on drawings, and as specified in this document.

B. Related work specified in other sections includes, but is not limited to the following:

1. Section 40 05 20 – Valves
2. Section 40 80 50 – Process Control System Commissioning
3. Section 40 91 00 – Process Control System Instruments

C. Refer to the Contract Drawings for point of connection and equipment locations.

1.2 SYSTEM SUPPLIERS

A. The Contractor shall furnish all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a process control system as specified herein and in Contract Documents and Drawings.

1.3 SYSTEM DESCRIPTION

A. General Description of Work

1. The Instrumentation and Control documents are requirements to assist the Contractor with the detailed design of control system including networks and communication with existing facilities' Process Control System (PCS).

    a. Provide process control applications for the Cherry Creek Lift Station (CCLS) control system as shown on drawings and as specified in this document to provide a completely functioning control system including networking and software development.

    b. Conduct a complete system testing, calibration, and validation of the Pump Control Valves specified herein, and as specified in Section 40 05 20 – Valves.

c. Perform the Site Acceptance Testing for each equipment individually and with other equipment as a system.

B. The Control Descriptions provide the functional requirements of the Control represented in the Contract Documents.

C. The Control Descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions but are rather intended to supplement and complement the Drawings and other Specification Sections. The Control Descriptions will be the base document for the Contractor creation of the Control Strategies. Identification of required elements, documentation, and coordination between loops are to be developed during shop drawings. Finalizing and tuning of strategies, as required by process characteristics, are to be completed during start-up.

D. The project scope includes the following facilities and areas:

1. Cherry Creek Lift Station (CCLS):

a. Addition of new 20-inch Pump Control Valves on each pump discharge line for startup and shutdown of each pump.

b. Addition of new process instrumentation as specified herein, and as specified in the Contract Documents and Drawings.

2. System Integration: The CCLS has an existing PLC (PLC-F) for control and monitoring of the lift station. There is also SCADA HMI Workstation at the SSWWTP that allows for remote control and operation of the CCLS. Provide System Integration as required to modify PLC-F and the SSWWTP HMI application to implement the following functionality.

a. Integration of the new 20-inch Pump Discharge Control Valves and all new process instrumentation into the existing PLC-F as required to accomplish pump and valve controls as specified herein, and as specified in the Contract Documents and Drawings.

b. Integration of new process instrumentation to provide pump station control and monitoring functions as specified herein and as specified in the Contract Documents.

c. Modification of the existing PLC-F Operator Interface Terminal (OIT) to integrate the operation of the new 20-inch Pump Discharge Control Valves and the new process instrumentation, as well as existing instrumentation as required.

d. Modification of existing HMI applications at the SSWWTP to integrate operation of the new 20" Pump Discharge Control Valves and new process instrumentation, as well as the existing instrumentation as needed.

3. System Validation:

a. Testing, calibration, and validation of the Pump Discharge Control Valve Operating Parameters specified in herein, and as specified in Section 40 05 20 – Valves.

1.4 SUBMITTALS

A. Contractor: furnish all submittals as specified herein.

B. Action Submittals

1. Product Data: Submit manufacturer's official and published product data, specifications, and installation recommendations for each item.

2. Shop Drawings: Submit shop drawings as required below. Include the following information in each submittal:

a. I/O List complete with Instrument Ranges, Alarm levels, and setpoints.

b. Each detailed control logic permissive and interlock.

c. Complete control description/strategies further developed from the control descriptions provided in this Specification, with a breakdown on each control mode, based on requirements of Part 3 of this Specification.

(1) Include sufficient detail for a complete understanding of each Operator controllable setpoint, failure mode, and alarm.

(2) Include detailed ranges, setpoints, and operator adjustments for each detailed control strategy.

(3) Provide modified screen layouts for OIT/Human-Machine Interface (HMI) applications including navigation, graphic standards, alarms, popups, and animation. Match existing graphics and color codes.

d. Complete and include in the submittal all graphics and process screens for all PLC control strategies and PCS control strategies.

e. Ladder logic focused diagrams, functional blocks as approved by the Owner, and messages to carry out the program. The messages shall be within the program to explain how the control program will carry out the required functions. The use of "structured text" type programing shall not be an acceptable alternative to ladder logic programing.

f. Configuration and data register assignments.

C. Closeout Submittals

1. Contractor: furnish submittals as required below:

a. Project Record Documents: Provide the following:

(1) Provide record documents and program copies as specified in Section 40 80 50 - Process Control System Commissioning.

b. Programming Software:

(1) Provide licensed copies of PLC and OIT/HMI programming software as specified in Section 40 80 50 - Process Control System Commissioning.

c. System Validation:

(1) Provide updated Pump Control Valve Operating Parameters table as specified in Section 40 80 50 - Process Control System Commissioning.

d. Operation and Maintenance Data: Furnish operation and maintenance manuals as specified in Contract Documents, including the following information:

(1) Recommended spare parts list
(2) Manufacturer approved repair and service centers list
(3) Replacements part sources
(4) Recommended maintenance procedures and frequencies

1.5 QUALITY ASSURANCE

A. Contractor: furnish Quality Assurance as specified in Contract Documents.

B. The purpose of contract drawings and specifications is to convey information required for complete and functioning systems. System Integrator shall be

responsible for all details necessary to properly install, adjust, and place in operation intended systems. Preliminary Input and Output points will be provided to the Contractor on the Contract Drawings for convenience; however, their accuracy will not be guaranteed.

C. Meetings

1. Meetings shall be scheduled as necessary at the Engineer's designated office to jointly review control requirement submittals. This shall also serve to coordinate and resolve any issues or discrepancies regarding the operator interface software programming and implementation, and detailed PLC programming. Plan to attend meetings of one-day duration to jointly review all control requirements with the Owner's representative and Engineer.

2. At a minimum, meetings to review progress of test plan, schedule, training, and software graphics shall include:

   a. Kick-Off Meeting
   b. Controls development at 60% development
   c. Controls development at 100% development

D. When requested by Contractor, Owner, and/or Engineer, System Integrator will attend Monthly Progress Meetings and Weekly Meetings as required and specified.

1.6 APPLICATION SOFTWARE PROGRAMMING

A. System Integrator: provide application software programming as specified herein and in the Contract Documents and Drawings. Modify existing PLC and OIT software, test application software programming to demonstrate operation as part of the Process Control System Commissioning, as specified in Section 40 80 50.

B. Training services, and equipment testing and start-up shall not begin until System Integrator has successfully completed application software programming, downloading, and testing.

1.7 DELIVERY, STORAGE, AND HANDLING

Not Required

1.8 PROJECT/SITE CONDITIONS

A. Equipment is subject to humidity, dust, noise, and elevated and reduced temperatures.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 SITE MONITORING AND CONTROL

A. Monitoring and control functions to be programmed under this Contract are outlined in the narratives described below.

B. All settings shall be adjustable based on log-in credentials.

C. All alarms and trips shall have time delay dampening.

3.2 CHERRY CREEK LIFT STATION – PUMP CONTROL

A. General

1. The Cherry Creek Lift Station (CCLS) allows for the reliable flow diversion of raw wastewater to either the Cherry Creek Flow Equalization Basins (FEBs) or the Southside Wastewater Treatment Plant (SSWWTP). As part of the improvements to the Cherry Creek Lift Station operation, the new pump discharge control valves are being provided to improve pump operation and improve pump reliability.

2. Provide the necessary modifications to the existing CCLS PLC (PLC-F), the CCLS PLC Operator Interface Terminal (OIT), and the SSWWTP HMI Application Graphics to allow for the operation of the CCLS from the PLC-F OIT or the SSWWTP HMI Workstations, as specified herein.

3. The CCLS has four (4) pumps and two (2) magnetic flow meters located downstream of the pumps. New 20-inch metal seated ball type valves will be installed on each individual pump discharge line, as shown on Contract Drawings.

4. The new Pump Discharge Control Valves shall be provided to open and close during the pump startup and shutdown sequences to provide appropriate back pressure and pump protection. The PLC shall issue Pump Start and Pump Stop commands to the pump VFDs, which shall contain a hardwired relay-based control circuit that shall open and close the Pump Discharge Control Valves based on a timed sequence. The Pump Discharge Control Valves shall not be directly controlled by discrete output signals from PLC-F. The hardwired relay-based control circuit in the Pump VFDs

shall provide the relays that directly open and close the Pump Discharge Control Valves.

5. New pressure indicating transmitters shall be provided for each pump to provide pressure measurement at the pump suction and pump discharge. The pressure transmitters shall be connected to the existing CCLS PLC (PLC-F) to provide pressure monitoring of the pump suction and discharge. The suction pressure and discharge pressure shall be displayed on the CCLS PLC OIT and the SSWWTP HMI Workstations.

6. Differential pressure across each pump shall be calculated by subtracting the difference between the pump discharge pressure and pump suction pressure. Pump differential pressure shall be displayed on the CCLS PLC-F OIT and on the SSWWTP HMI Workstations.

7. New vibration sensors shall be provided at the pump shaft outboard bearing (connecting the pump shaft to the motor). The vibration sensors shall be connected to PLC-F to provide high vibration alarm signals. The new vibration signals shall be displayed on the PLC-F OIT and the SSWWTP HMI Workstations.

B. Equipment Tag Numbers Included: See Contract Drawing N03 for P&ID with affected equipment.

C. Pump Control Modes

1. LOCAL
   a. The pump is operated using the control devices at the VFD.
   b. The HOA (HAND-OFF-AUTO) selector switch at the VFD must be in the HAND position.
   c. When the HOA selector switch at the VFD is in the HAND position, all commands from PLC-F and SCADA are disabled.

2. REMOTE MANUAL
   a. REMOTE MANUAL mode shall be selectable from either the PLC-F OIT or the SSWWTP HMI Workstation.
   b. In REMOTE MANUAL mode, the pump is controlled manually via the PLC-F OIT or the SSWWTP HMI Workstation. Operators shall be able to start, stop and control pump speed in REMOTE MANUAL mode. In REMOTE MANUAL, pump discharge valves shall still be controlled through the control circuit in the VFD.
   c. The HOA selector switches at the associated VFD must be in the AUTO position to allow REMOTE MANUAL mode to be selected.

3. REMOTE AUTO
   a. REMOTE AUTO mode shall be selectable from either the PLC-F OIT or the SSWWTP HMI Workstation.
   b. In REMOTE AUTO mode, the pump operation is automatically controlled by PLC-F as required by the CCLS Auto Pump Control Strategy provided in this Specification.
   c. The HOA selector switches at the associated VFDs must be in the AUTO position to allow REMOTE AUTO mode to be selected.

D. Control Locations:

1. Discharge Valve Local Control Station (LCS): Actuator manufacturer supplied LCS integral to the actuator located in accessible location near the Pump Discharge Control Valves. The LCS shall provide local control capabilities independent of PLC-F or SCADA. The LCS shall provide the control transfer capability using a LOCAL-OFF-REMOTE switch to transfer remote control to the PLC-F or SCADA.

2. Pump VFDs: Each VFD is in a separate cabinet located with the CCLS Electrical Room. The Pump VFD enclosures shall provide local control capabilities (start, stop and speed control) independent of PLC-F or SCADA. The VFD enclosures shall provide the control transfer capability using a HAND-OFF-AUTO (HOA) switch to transfer remote control to PLC-F or SCADA.

3. PLC-F OIT

4. SSWWTP SCADA HMI Workstation

E. Discharge Valve Local Control Stations (LCS)

1. There shall be an LOR (LOCAL/OFF/REMOTE) selector switch at each LCS that shall function as follows:
   a. LOCAL: Valve is controlled from the LCS
   b. OFF: Valve does not operate under any condition
   c. REMOTE: Valve is controlled from control circuit in the associated VFD

2. Provide additional control devices at the valve LCS as follows:
   a. OPEN/CLOSE selector switch at each LCS
   b. VALVE POSITION INDICATOR at each LCS
   c. OPEN/CLOSED/FAULT status indicating lights at each LCS

F. Pump VFD Functions

1. The Pump VFD shall contain the hardwired relay-based control circuit that opens and closes the new Pump Discharge Control Valves based on a timed sequence of operation. See Contract Drawings for the VFD control circuits.

   a. Pump Start: Upon pump start command signal, the pump discharge control valve shall follow its startup sequence and open to 5 degrees first prior to the Pump starting. Once the Pump starts the Pump Control Valve will open from 5 to 90 degrees open within 45 seconds.

   b. Pump Stop: Upon pump shutdown command signal, the pump discharge control valve shall follow its shutdown sequence where the valve closes with the pump from 90 to 0 degrees in 45 seconds.

2. The discrete output signals from the CCLS PLC (PLC-F) shall not directly interface to the Pump Discharge Control Valve actuators to open and close the valves, but rather provide open command requests and close command requests to the VFD. The VFD shall contain a hardwired relay-based control circuit with timers and relays that are wired directly to the Pump Discharge Control Valve actuators for opening and closing the valves.

3. There shall be an HOA (HAND/OFF/AUTO) selector switch at each VFD that shall function as follows:
   a. HAND: Pump is controlled from the VFD enclosure
   b. OFF: Pump does not operate under any condition
   c. AUTO: Pump receives control commands from PLC-F

4. Provide additional control devices at the Pump VFDs as follows:
   a. VFD Keypad
   b. Indicating Lights
      (1) Running
      (2) Fault
      (3) Motor Vibration Alarm
      (4) Pump Vibration Alarm
      (5) Pump at Speed
   c. Pushbuttons
      (1) Reset
   d. Control Switches
      (1) HAND/OFF/AUTO
   e. Motor Runtime Indicator / ETM Indicator

G. Pump Sequencing

1. Operators shall have the ability to configure pumps in Lead, Lag 1, Lag 2 and Standby pump configuration.

2. Operators shall be able to assign any of the four (4) raw sewage pumps as the Lead, Lag 1, Lag 2 or Standby pump.

3. In Normal Mode, the Lead pump shall be started first at the High (H) level setpoint. The Lag 1 pump shall be started at the High-High (H2) level setpoint. The Lag 2 pump shall be started at the High-3 (H3) Level setpoint. The Standby pump shall be started if any of the other three pumps fail during operation, fail to start after a start command is issued by PLC-F, or the Wet Well Level Reaches the High-4 (H4) Level Setpoint.

4. In Low Flow Mode, only the Lead Pump shall be operated only at the minimum speed and shall be cycled on and off based upon level in the wet well. The Lead Pump shall start when the level in the wet well rises above the High-4 (H4) Level Setpoint.

5. Please see the CCLS Pump Control Strategy contain subsequently in this specification for additional automated pump control requirements.

H. CCLS Pump Auto Control Strategy when Pumping to the SSWWTP

1. Low Flow Mode

   a. Flows
      (1) Minimum Flow: 3.2 MGD
      (2) Average Flow: 4.75 MGD
      (3) Maximum Flow: 7.0 MGD

   b. Number of Cycles: Average of three (3) cycles per night in Low Flow Mode operation based on operating wet well level from 12-20 feet and 2020 nighttime flow data.

   c. Number of Pumps in Operation: One (1) Lead Pump is required for Low Flow Mode operation. The Lead Pump is cycled on and off based on level setpoints in the wet well. The Lead Pump shall only be operated at the **Low Flow Mode Pump Speed** setpoint.

d. Setpoints: Low Flow Mode shall have the following adjustable setpoints.

Setpoint	Default Value
Less than the Low Flow Setpoint (See Operating Mode Criteria section later in this Specification)	< 2.5 feet / minute
Low Flow Mode Pump Speed Setpoint	43 Hz

Low Flow Mode Pump Operation Setpoints		
Pump	**Pump Start Setpoint**	**Pump Stop Setpoint**
Lead	WWL > 20 feet (H4 level)	WWL < 12 feet (L4 level)
Lag 1	Starts upon Lead pump failure or a failure to start for Lead pump	
Lag 2	Starts upon Lag 1 pump failure or a failure to start for Lag 1 pump	
Standby	Starts upon Lag 2 pump failure or a failure to start for Lag 2 pump	

e. Lead Pump Startup
   (1) WWL > 20 feet (H4 Level)
   (2) Lead Pump Startup: Bring pump on from 0 to 43 Hz in 43 seconds and control speed of pump at a constant speed equal to the Low Flow Mode Pump Speed Setpoint (default 43 Hz, adjustable).
   (3) Lead Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump start command signal, the pump discharge control valve shall follow its startup sequence and open to 5 degrees first prior to the Pump starting. Once the Pump starts the Pump Control Valve will open from 5 to 90 degrees open within 43 seconds.

f. Lead Pump Shutdown
   (1) WWL < 12 feet (L4 Level)
   (2) Lead Pump Shutdown: Shutdown pump by reducing speed from 43 Hz to 0 Hz in 43 seconds.
   (3) Lead Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 43 seconds.

2. Normal Mode
   a. Flows
      (1) Dry Weather Flow: 8.1 MGD
      (2) Peak Wet Weather: 41 MGD
      (3) Future Peak: 45 MGD

   b. Number of Pumps in Operation: Four (4) pumps are required for Normal Mode operation. In Normal Mode, the pumps are operated in a Lead, Lag 1, Lag 2 and Standby configuration. Provide an adjustable **Lag Pump Time Delay** setpoint that provides a delay between the starting of subsequent pumps (pumps shall not be started too close together). The time delay shall be initiated when all operating pumps reach their maximum speed. Each pump is started based on a level setpoint in the wetwell as shown in the table below. All level setpoints shall be adjustable from the PLC-F OIT.

Setpoint	**Default Value**
Greater than the Low Flow Setpoint (See Operating Mode Criteria section later in this Specification)	> 2.5 feet / minute
Lag Pump Time Delay	60 seconds

Pump	**Pump Start Setpoint**	**Pump Stop Setpoint**
Lead	WWL > 12.5 feet (H Level)	WWL < 10 feet (L Level)
Lag 1	WWL > 17 feet (H1 Level)	WWL < 12 feet (L2 Level)
Lag 2	WWL > 18 feet (H2 Level)	WWL < 15 feet (L3 Level)
Standby	WWL > 20 feet (H3 Level) or failure to start Lead, Lag 1 or Lag 2 pumps.	WWL < 18 feet (L4 Level)

   c. Lead Pump Startup
      (1) WWL > 12.5 feet (H Level)
      (2) Lead Pump Startup: Bring pump on from 0 to 43 hz in 43 seconds. Control pump speed to maintain a WWL of 14 feet.
      (3) Lead Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump start command signal, the pump discharge control valve shall follow its startup sequence and open to 5 degrees first prior to the Pump starting. Once the Pump starts the Pump Control Valve will open from 5 to 90 degrees open within 45 seconds.

(4) Lead Pump Speed Control: Pump speed shall be adjusted between 43 to 52 Hz to maintain WWL at 14 feet.

d. Lag 1 Pump Startup
   (1) WWL > 17 feet (**H1 Level**)
   (2) Lag Pump Time Delay must have elapsed
   (3) Lag 1 Pump Startup: Ramp Lead Pump down to 45 Hz. Bring Lag 1 Pump on from 0 to 45 Hz in 45 seconds. Control Lead and Lag 1 Pump speed together from 45 to 58 Hz to maintain a WWL of 14 feet.
   (4) Lag 1 Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon start command signal, the pump discharge control valve shall be opened in 45 seconds.

e. Lag 1 Pump Shutdown
   (1) WWL < 12 feet (**L1 Level**)
   (2) Lag 1 Pump Shutdown: Shut down Lag Pump when WWL drops below the **L1 Level** setpoint. (At this time, both Lead and Lag 1 pumps should be operating at 45 Hz.)
   (3) Lag 1 Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

f. Lag 2 Pump Startup
   (1) WWL > 18 feet (**H2 Level**)
   (2) Lag Pump Time Delay must have elapsed
   (3) Lag 2 Pump Startup: Ramp Lead Pump and Lag 1 Pump down to 48 Hz. Bring Lag 2 Pump on from 0 to 48 Hz in 48 seconds. Control Lead, Lag 1 and Lag 2 Pump speed together from 48 to 58 Hz to maintain a WWL of 14 feet.
   (4) Lag 2 Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon start command signal, the pump discharge control valve shall be opened in 45 seconds.

g. Lag 2 Pump Shutdown
   (1) WWL < 15 feet (**L2 Level**)
   (2) Lag 2 Pump Shutdown: Shut down Lag 2 Pump when WWL drops below the **L2 Level** Setpoint. (At this time, both Lead, Lag 1 and Lag 2 pumps should be operating at 48 Hz.)

(3) Lag 2 Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

h. Standby Pump Startup
   (1) WWL > 20 feet (**H4 Level**)
   (2) Standby Pump Time Delay must have elapsed
   (3) Standby Pump Startup: Ramp Lead Pump, Lag 1 Pump, and Lag 2 Pump down to 53 Hz. Bring Standby Pump on from 0 to 53 Hz in 53 seconds. Control Lead, Lag 1 and Lag 2 Pump speed together from 53 to 58 Hz to maintain a WWL below 20 feet.
   (4) Standby Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon start command signal, the pump discharge control valve shall be opened in 45 seconds.

i. Standby Pump Shutdown
   (1) WWL < 18 feet (**H2 Level**)
   (2) Standby Pump Shutdown: Shut down Standby Pump when WWL drops below the **H2 Level** Setpoint. (At this time, both Lead, Lag 1, Lag 2, and Standby pumps should be operating at 53 Hz.)
   (3) Standby Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

j. Lead Pump Shutdown
   (1) WWL < 10 feet (**L Level**)
   (2) Lead Pump Shutdown: Shut down Lag Pump when WWL drops below **L Level** Setpoint. (At this time, the Lead pump should be operating at 43 Hz.)
   (3) Lead Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

k. Wet Well Level Control
   (1) Provide an adjustable level control setpoint.

(2) In Normal Mode, PLC-F shall control the speed of all operating pumps together to maintain WWL at the level control setpoint.

3. Operating Mode Criteria

a. The CCLS PLC (PLC-F) shall monitor WWL and calculate rate of change in the WWL over an adjustable **WWL Rate of Change Interval**. The **WWL Rate of Change Interval** shall be an adjustable parameter from 0 to 60 seconds.

b. The CCLS PLC (PLC-F) shall calculate the **WWL Rate of Change** and determine whether to operate the CCLS in either of two operating modes:

(1) Normal Mode: Initiated if EITHER of the following conditions are present.

(a) The WWL is increasing at a rate of change that is greater than the **Low Flow Setpoint** (default 2.5 feet / minute)

(b) The WWL is greater than the **H2 Level** setpoint (default 18 feet) and the **WWL Rate of Change** indicates that the WWL is increasing.

(2) Low Flow Mode: Initiated when BOTH of the following two conditions are present.

(a) No pumps are operating

(b) The WWL is increasing at a rate of change that is less than **Low Flow Setpoint**, initially set at 2.5 feet per minute (adjustable).

c. Transitioning from Low Flow Mode to Normal Mode

(1) If the WWL is greater than the **H2 Level** setpoint (see Normal Mode section of this specification) AND the **WWL Rate of Change** is increasing, the CCLS shall be transitioned from Low Flow Mode to Normal Mode. The Lag 1 Pump shall be started and the Lead and Lag 1 pump speed shall be controlled as described in Normal Mode operation.

(2) Since the WWL will be above the **H2 Level** setpoint, an adjustable **Lag Pump Time Delay** (default 30 seconds) shall be provided to prevent both Lag 1 and Lag 2 pumps from starting simultaneously after the transition from Low Flow Mode to Normal Mode. The time delay shall be initiated after both the Lead Pump and Lag 1 Pump reach maximum speed. PLC-3 shall wait for the **Lag Pump Time Delay** to expire before starting the Lag 2 Pump.

I. CCLS Pump Auto Control Strategy when Pumping to the FEBs

1. Low Flow Mode

a. Flows
   (1) Minimum Flow: 3.2 MGD
   (2) Average Flow: 4.75 MGD
   (3) Maximum Flow: 7.0 MGD

b. Number of Cycles: Average of three (3) cycles per night in Low Flow Mode operation based on operating wet well level from 12-20 feet and 2020 nighttime flow data.

c. Number of Pumps in Operation: One (1) Lead Pump is required for Low Flow Mode operation. The Lead Pump is cycled on and off based on level setpoints in the wet well. The Lead Pump shall only be operated at the **Low Flow Mode Pump Speed** setpoint.

d. Setpoints: Low Flow Mode shall have the following adjustable setpoints.

Setpoint	**Default Value**
Less than the Low Flow Setpoint (See Operating Mode Criteria section later in this Specification)	< 2.5 feet / minute
Low Flow Mode Pump Speed Setpoint	43 Hz

Low Flow Mode Pump Operation Setpoints		
Pump	**Pump Start Setpoint**	**Pump Stop Setpoint**
Lead	WWL > 20 feet (H4 level)	WWL < 12 feet (L4 level)
Lag 1	Starts upon Lead pump failure or a failure to start for Lead pump	
Lag 2	Starts upon Lag 1 pump failure or a failure to start for Lag 1 pump	
Standby	Starts upon Lag 2 pump failure or a failure to start for Lag 2 pump	

e. Lead Pump Startup
   (1) WWL > 20 feet (H4 Level)
   (2) Lead Pump Startup: Bring pump on from 0 to 43 Hz in 43 seconds and control speed of pump at a constant speed equal to the Low Flow Mode Pump Speed Setpoint (default 43 Hz, adjustable).
   (3) Lead Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-

based control logic that is implemented in the control circuit located in the VFD. Upon pump start command signal, the pump discharge control valve shall follow its startup sequence and open to 5 degrees first prior to the Pump starting. Once the Pump starts the Pump Control Valve will open from 5 to 90 degrees open within 43 seconds.

f. Lead Pump Shutdown
   (1) WWL < 12 feet (L4 Level)
   (2) Lead Pump Shutdown: Shutdown pump by reducing speed from 43 Hz to 0 Hz in 43 seconds.
   (3) Lead Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 43 seconds.

2. Normal Mode
   a. Flows
      (1) Dry Weather Flow: 8.1 MGD
      (2) Peak Wet Weather: 41 MGD
      (3) Future Peak: 45 MGD

   b. Number of Pumps in Operation: Four (4) pumps are required for Normal Mode operation. In Normal Mode, the pumps are operated in a Lead, Lag 1, Lag 2 and Standby configuration. Provide an adjustable **Lag Pump Time Delay** setpoint that provides a delay between the starting of subsequent pumps (pumps shall not be started too close together). The time delay shall be initiated when all operating pumps reach their maximum speed. Each pump is started based on a level setpoint in the wetwell as shown in the table below. All level setpoints shall be adjustable from the PLC-F OIT.

Setpoint	**Default Value**
Greater than the Low Flow Setpoint (See Operating Mode Criteria section later in this Specification)	> 2.5 feet / minute
Lag Pump Time Delay	60 seconds

Pump	**Pump Start Setpoint**	**Pump Stop Setpoint**
Lead	WWL > 12.5 feet (H Level)	WWL < 10 feet (L Level)
Lag 1	WWL > 17 feet (H1 Level)	WWL < 12 feet (L2 Level)
Lag 2	WWL > 18 feet (H2 Level)	WWL < 15 feet (L3 Level)

Standby	WWL > 20 feet (H3 Level) or failure to start Lead, Lag 1 or Lag 2 pumps.	WWL < 18 feet (L4 Level)

c. Lead Pump Startup
   (1) WWL > 12.5 feet (H Level)
   (2) Lead Pump Startup: Bring pump on from 0 to 43 hz in 43 seconds. Control pump speed to maintain a WWL of 14 feet.
   (3) Lead Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump start command signal, the pump discharge control valve shall follow its startup sequence and open to 5 degrees first prior to the Pump starting. Once the Pump starts the Pump Control Valve will open from 5 to 90 degrees open within 45 seconds.
   (4) Lead Pump Speed Control: Pump speed shall be adjusted between 43 to 46 Hz to maintain WWL at 14 feet.

d. Lag 1 Pump Startup
   (1) WWL > 17 feet (**H1 Level**)
   (2) Lag Pump Time Delay must have elapsed
   (3) Lag 1 Pump Startup: Ramp Lead Pump down to 43 Hz. Bring Lag 1 Pump on from 0 to 43 Hz in 43 seconds. Control Lead and Lag 1 Pump speed together from 43 to 50 Hz to maintain a WWL of 14 feet.
   (4) Lag 1 Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon start command signal, the pump discharge control valve shall be opened in 45 seconds.

e. Lag 1 Pump Shutdown
   (1) WWL < 12 feet (**L1 Level**)
   (2) Lag 1 Pump Shutdown: Shut down Lag Pump when WWL drops below the **L1 Level** setpoint. (At this time, both Lead and Lag 1 pumps should be operating at 43 Hz.)
   (3) Lag 1 Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

f. Lag 2 Pump Startup
   (1) WWL > 18 feet (**H2 Level**)
   (2) Lag Pump Time Delay must have elapsed

(3) Lag 2 Pump Startup: Ramp Lead Pump and Lag 1 Pump down to 43 Hz. Bring Lag 2 Pump on from 0 to 43 Hz in 43 seconds. Control Lead, Lag 1 and Lag 2 Pump speed together from 43 to 58 Hz to maintain a WWL of 14 feet.

(4) Lag 2 Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon start command signal, the pump discharge control valve shall be opened in 45 seconds.

g. Lag 2 Pump Shutdown

(1) WWL < 15 feet (**L2 Level**)

(2) Lag 2 Pump Shutdown: Shut down Lag 2 Pump when WWL drops below the **L2 Level** Setpoint. (At this time, both Lead, Lag 1 and Lag 2 pumps should be operating at 43 Hz.)

(3) Lag 2 Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

h. Standby Pump Startup

(1) WWL > 20 feet (**H4 Level**)

(2) Standby Pump Time Delay must have elapsed

(3) Standby Pump Startup: Ramp Lead Pump, Lag 1 Pump, and Lag 2 Pump down to 43 Hz. Bring Standby Pump on from 0 to 43 Hz in 43 seconds. Control Lead, Lag 1 and Lag 2 Pump speed together from 43 to 58 Hz to maintain a WWL below 20 feet.

(4) Standby Pump Discharge Control Valve Opening Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon start command signal, the pump discharge control valve shall be opened in 45 seconds.

i. Standby Pump Shutdown

(1) WWL < 18 feet (**H2 Level**)

(2) Standby Pump Shutdown: Shut down Standby Pump when WWL drops below the **H2 Level** Setpoint. (At this time, both Lead, Lag 1, Lag 2, and Standby pumps should be operating at 43 Hz.)

(3) Standby Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

j. Lead Pump Shutdown
   (1) WWL < 10 feet (**L Level**)
   (2) Lead Pump Shutdown: Shut down Lag Pump when WWL drops below **L Level** Setpoint. (At this time, the Lead pump should be operating at 43 Hz.)
   (3) Lead Pump Discharge Control Valve Closing Sequence: The Pump Discharge Control Valves receive commands from relay-based control logic that is implemented in the control circuit located in the VFD. Upon pump shutdown, close the control valve in 45 seconds.

k. Wet Well Level Control
   (1) Provide an adjustable level control setpoint.
   (2) In Normal Mode, PLC-F shall control the speed of all operating pumps together to maintain WWL at the level control setpoint.

3. Operating Mode Criteria

   a. The CCLS PLC (PLC-F) shall monitor WWL and calculate rate of change in the WWL over an adjustable **WWL Rate of Change Interval**. The **WWL Rate of Change Interval** shall be an adjustable parameter from 0 to 60 seconds.

   b. The CCLS PLC (PLC-F) shall calculate the **WWL Rate of Change** and determine whether to operate the CCLS in either of two operating modes:
      (1) Normal Mode: Initiated if EITHER of the following conditions are present.
         (a) The WWL is increasing at a rate of change that is greater than the **Low Flow Setpoint** (default 2.5 feet / minute)
         (b) The WWL is greater than the **H2 Level** setpoint (default 18 feet) and the **WWL Rate of Change** indicates that the WWL is increasing.

      (2) Low Flow Mode: Initiated when BOTH of the following two conditions are present.
         (a) No pumps are operating
         (b) The WWL is increasing at a rate of change that is less than **Low Flow Setpoint**, initially set at 2.5 feet per minute (adjustable).

   c. Transitioning from Low Flow Mode to Normal Mode

      (1) If the WWL is greater than the **H2 Level** setpoint (see Normal Mode section of this specification) AND the **WWL Rate of**

Change is increasing, the CCLS shall be transitioned from Low Flow Mode to Normal Mode. The Lag 1 Pump shall be started and the Lead and Lag 1 pump speed shall be controlled as described in Normal Mode operation.

(2) Since the WWL will be above the **H2 Level** setpoint, an adjustable **Lag Pump Time Delay** (default 30 seconds) shall be provided to prevent both Lag 1 and Lag 2 pumps from starting simultaneously after the transition from Low Flow Mode to Normal Mode. The time delay shall be initiated after both the Lead Pump and Lag 1 Pump reach maximum speed. PLC-3 shall wait for the **Lag Pump Time Delay** to expire before starting the Lag 2 Pump.

J. PLC-F OIT Functions

1. Provide three (3) OIT screens at the PLC-F OIT.
   a. CCLS LL Pump Config
   b. CCLS Main Screen
   c. Pump Control Popup

2. CCLS Pump Config Screen

   (1) Provide the ability to adjust all high and low level setpoints, pump configuration settings, and wet well level control setpoint as described in this specification.

   (2) Provide the ability to configure the four (4) pumps in the Lead, Lag 1, Lag 2 and Standby sequence. Operators shall have the ability to set any of the four pumps to any of the sequences.

   (3) Provide the ability to adjust minimum and maximum pump speed settings (in Hz):

      (1) One pump Running Max Speed
      (2) One pump Running Min Speed
      (3) Two Pumps Running Max Speed
      (4) Two Pumps Running Min Speed
      (5) Three Pumps Running Max Speed
      (6) Three Pumps Running Min Speed

b. Provide the ability to adjust all Operating Mode Setpoints for the CCLS.

Setpoint	Default Value	Allowable Range
WWL Rate of Change Interval	30 seconds	0 to 60 seconds
Low Flow Setpoint	WWL Rate of Change < 2.5 feet / minute	0 to 20 feet / minute
Low Flow Mode Pump Speed	43 Hz	0 to 60 Hz
Lag Pump Time Delay	60 seconds	0 to 600 seconds
One Pump Running Max Hz	46 Hz	0 to 60 Hz
One Pump Running Min Hz	43 Hz	0 to 60 Hz
Two Pump Running Max Hz	50 Hz	0 to 60 Hz
Two Pump Running Min Hz	43 Hz	0 to 60 Hz
Three Pump Running Max Hz	58 Hz	0 to 60 Hz
Three Pump Running Min Hz	43 Hz	0 to 60 Hz
Three Pump Running Max Hz	58 Hz	0 to 60 Hz
Three Pump Running Min Hz	43 Hz	0 to 60 Hz

c. Low Flow Mode Setpoints (L4, H4)

Pump	Pump Start Setpoint	Pump Stop Setpoint
Lead	WWL > 20 feet (H4 level)	WWL < 12 feet (L4 level)

d. Normal Flow Mode Setpoints (L, L2, L3, H, H2, H3)

Pump	Pump Start Setpoint	Pump Stop Setpoint
Lead	WWL > 12.5 feet (H Level)	WWL < 10 feet (L Level)
Lag 1	WWL > 17 feet (H1 Level)	WWL < 12 feet (L2 Level)
Lag 2	WWL > 18 feet (H2 Level)	WWL < 15 feet (L3 Level)

3. CCLS Main Screen

a. Display P&ID for the CCLS with all controlled or monitored equipment. P&ID displayed shall match P&ID provided in the Contract Drawings.

b. Background shall be gray.

c. Pump Parameters

(1) Running (Red) / Stopped (Green) Status
(2) Local / Remote Status
(3) VFD Speed
(4) Amps
(5) Pump Runtime

d. Pump Discharge Valve Parameters
(1) Opened / Closed Indication
(a) Fully Opened = Red
(b) Fully Closed = Green
(c) Intermediate Travel = Half of the valve symbol to displayed in red, the other half to be displayed in green
(2) Local / Remote Status
(3) Fault Alarm

4. Pump Control Popup
(1) Provide a Pump Control Popup Screen that is displayed when selecting a pump from the CCLS Main Screen.

(2) The Pump Control Popup shall display all operating parameters, statuses and alarms for the selected pump.

(3) Provide REMOTE AUTO / REMOTE MANUAL mode selections at the existing OITs on the PLC-F panel.

b. The four (4) pumps at the CCLS shall be controlled by existing PLC located within CCLS (PLC-F), in either LOCAL, REMOTE MANUAL, or REMOTE AUTO.

K. SCADA HMI Control Functions
1. Same as specified for the PLC-F OIT.

L. Pressure Transient Monitoring System (PTMS)
1. Provide a PTMS as specified in Specification 40 91 00 and as shown on Contract Drawings.

2. The PTMS shall provide an alarm signal (as a discrete input) to PLC-F when a pressure transient event has occurred. Alarms shall be generated at the PLC-F OIT and at the SSWWTP SCADA HMI Workstation.

3.3 CALIBRATION

1. Settings and calculations described above shall be calibrated as part of section 40 80 50 - Process Control System Commissioning. Contractor shall make adjustments to programmed elements to demonstrate successful calibration as directed by the Engineer.

2. Settings, ranges, and alarms shall be adjustable based on login permission.

END OF SECTION

SECTION 40 91 00

PROCESS CONTROL SYSTEM INSTRUMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section 40 91 00 specifies the requirements for furnishing, installing, and placing into operation field-mounted instrumentation.

B. It is the Contractor's responsibility to provide a complete functional system. Provide all instrument devices that are necessary for a complete system. This includes, but is not necessarily limited to, terminal blocks, fuses, signal conditioners, power supplies, transient and surge protection, special wires/cables and connectors, and any other electronics that may be necessary to properly interface with the instrumentation provided.

C. It is the Contractor's responsibility to verify the type, state, and condition of all existing signals required to interface to the Process Control System (PCS). Information concerning these signals given in these Contract Documents is provided for the Contractor's reference and is deemed reliable but is not guaranteed to be accurate or true. Acceptance by the Contractor without field verification of the information contained herein regarding existing instrumentation and associated signals is done at the Contractor's risk.

D. Related Work Specified in Other Sections Includes, But is Not Limited to, the Following:

1. Section 40 80 50 - Process Control System Commissioning
2. Section 40 90 50 - Process Control System Description

1.2 SUBMITTALS

A. General: Provide all submittals as specified herein.

B. Action Submittals

1. Provide Shop Drawings as required below. Organize the submittal in a logical manner and have a schematic diagram for each system.

a. Provide complete and detailed system schematic drawings showing all components with the electrical point to point connections of each system (wiring and piping diagrams). Include a description of the operation of the system and equipment.

b. Provide instrumentation equipment specifications: Include manufacturer's catalog information showing product data, outlines, dimensional drawings, and instructions for installation, storage, handling, and protection. Duplicate equipment may be covered by one set of literature.

2. Include the following for each model instrument provided under Division 40:
   a. Manufacturer's design and performance specification data and descriptive literature (catalog cutsheets)
   b. Equipment dimensioning and installation requirements and recommendations.
   c. Electrical signal and power connection diagrams.
   d. Required accessories lists.

3. For each instrument specified in the sections which follow, include the following information in the submittal for that section:
   a. Tag number and description.
   b. Complete model number.
   c. Data sheets and catalog literature edited to indicate specific items provided.
   d. Mounting details for all typical installation requirements and special details for non-typical applications.
   e. Methods and materials required for installation. Include power and signal connection details.
   f. List of spare parts provided.
   g. Other specific submittal information as specified in the particular instrument specification.

C. Closeout Submittals

1. Include the following for each model instrument provided under Division 40:
   a. Operations and maintenance manuals for each type of instrument after product approval.
   b. Calibration certifications from the manufacturer for each calibrated instrument.
   c. Provide written loop-calibration report as specified in Part 3 of this document.
   d. List of recommended spare parts

2. Instruction Manuals
   a. Operation and maintenance information: provide complete descriptive literature/shop drawings for each piece of equipment, including a list and description of all parts of each piece of equipment and instructions for calibration, testing, and maintenance requirements.

   b. Project Record Documents: provide revisions from the Approved shop drawings and previous submittals. This includes as built records such as instrument ranges and actual component/instrumentation locations, including sources of control power.

   c. Provide revised or updated Instrument Data Sheets, P&IDs (I&C series drawings), and process flow diagrams showing location of instrumentation and equipment including calibration data.

3. Maintenance Material Submittals:
   a. Provide list of recommended spare parts
   b. Provide list of special tools necessary for normal operation, maintenance, and calibration.

1.3 QUALITY ASSURANCE

A. Provide instrumentation of rugged construction designed for the site conditions. Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter's Laboratories (UL), Inc., and so marked or labeled, together with manufacturer's brand or trademark.

B. Use single source manufacturer for each instrument type. Use the same manufacturer for different instrument types whenever possible.

C. Coordinate instrumentation to assure proper interface and system integration. Provide signal processing equipment, to include, but not be limited to, process sensing and measurement, transducers, signal converters, conditioners, transmitters, receivers, and power supplies. Coordinate the various subcontractors, equipment suppliers, and manufacturers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Each manufacturer or supplier to provide and securely attach the tag number and instructions for proper field handling and installation to each instrument prior to packaging.

B. Each manufacturer or supplier package instrumentation to provide protection against shipping damage, dust, moisture, and atmospheric contaminants. Include a shipping label which contains the following information:

1. Tag number and description
2. Instructions for unloading, transporting, storing, and handling at the site

C. Contractor to provide for unloading, transporting, storing, and handling instrumentation at the site. Inspect instrumentation for damage in shipment and return damaged instrumentation to the manufacturer.

D. Do not store instrumentation out-of-doors. Provide dry, permanent storage facilities.

1.5 WARRANTY

A. Warranty the instrumentation, materials, workmanship, and installation to be free from defects for a period of one year from the date of Final Acceptance of the Work. Extend standard manufacturer's warranties as necessary to ensure coverage. Document warranty coverage immediately prior to Final Acceptance.

B. Furnish and install replacement parts during the warranty period for any defective component at no additional cost. Replace spare parts consumed during the warranty period with new equipment at no additional cost, immediately after use, to restore the spare parts inventory. A complete contingent of unused spare parts should exist one year after Final Acceptance.

1.6 MAINTENANCE

A. Provide spare parts as specified in the individual instrument sections.

B. Provide special tools necessary for normal operation, maintenance, and calibration.

C. Package spare parts in a manner suitable for long term storage and adequately protected against corrosion, humidity, and temperature.

PART 2 PRODUCTS

2.1 GENERAL INSTRUMENTATION REQUIREMENTS

A. Provide instruments which operate on 115 VAC, single phase, 60 Hertz electrical service, unless otherwise specified, and which return automatically and immediately to accurate measurement upon restoration of power after a power failure, except where specifically noted.

B. Provide open and short circuit protection except for two-wire transmitters.

C. Provide two-wire transmitter power supplies in local panels or enclosures with receiver/indicator/transmitter as required. Loop power supplies are to be installed in the PLC cabinets complete with a separate fuse and blown fuse indicator for each analog circuit.

D. Provide fuses or switches for equipment as recommended by the instrument manufacturer.

E. Provide instrument transmitters which produce isolated 4-20 mA DC analog signals. Follow ISA-S50.1. Process transmitters shall be smart electronic type devices capable of driving a load of at least 1000 ohms with non-interacting zero and span adjustments and remote recalibration features.

F. Each transmitter shall be supplied with an integral junction box with terminal strip, integral test jacks, and conduit connection, and shall be complete with all mounting accessories.

G. Provide signal isolators as necessary to resolve interface problems between field instruments, final control elements, panel instruments, and PCS components. Signal isolation may require the inclusion of one or more isolated signal converters for analog circuits and one or more interposing relays for discrete circuits.

H. Where interposing relays are required to provide proper contact rating from devices interfacing to the PLCs, install the relays in the PLC cabinets.

I. For each field mounted instrument (transmitter, analyzer, gauge, etc.) requiring 120 VAC, provide an individual non-fused disconnect switch with auxiliary contact (switch position indication) to allow for remote monitoring and indication functionality. Provide Pass & Seymour PS30SSAX, Square D Class 2510-Type KW1, or NEMA rated disconnect as required, or equal. Provide disconnect switch cover, Crouse Hinds Model DS185 or equal.

J. Provide instruments with printed circuit boards suitably coated to prevent damage by dust, moisture, fungus, and airborne contaminants. All spare boards shall be conformal coated.

K. Provide instruments complete with mounting hardware, floor stands, wall brackets, or instrument racks. Provide all stainless steel mounting hardware for surface, panel or handrail mounting as required by location. Mounting hardware shall meet the requirements of the area.

L. Provide instrument enclosures NEMA rated for the environment. In areas subject to flooding, provide submergence rated enclosures.

M. Provide sun shields for all outdoor enclosures and indicators.

N. Provide tool kits and test equipment, as recommended by the manufacturer, necessary for assembling, calibrating, and maintaining equipment.

O. Provide each instrument with engraved phenolic nametag, white with black letter, 1/2-inch tall minimum showing device ID.

2.2 LEVEL SWITCH – FLOAT TYPE

A. Type: Potential-free switching reed contact, magnetic float trigger, displacement type liquid level sensor.

B. Construction Features

1. Provide mercury free float switches.

2. Float Body: Hollow hermetically sealed, 316 stainless steel cylinder or sphere containing permanent built triggering magnet.

3. Switch: Potential-free reed contact built into the guide tube, rated 1 amp resistive at 120 VAC.

4. Electrical cable:
   a. Heavy duty, three conductor, flexible, and submersible cable, sheathed in PVC and connected to float and switch with watertight seal.
   b. Length provided to be sufficient to extend to junction box.

5. Ambient Temperature Limits: -22 degF to 176 deg

6. Medium Temperature Limits: -22 degF to 176 deg

7. Safety Classification: As required by process area.

C. Manufacturers:

1. Flygt, Model ENM-10
2. Rotofloat
3. Or approved equal

2.3 PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS

A. Differential capacitance cell type. Two-wire, 4-20 mA DC output signal. Loop powered from 24V DC nominal. Output load impedance of at least 550 ohms.
B. Microprocessor based "smart" electronics. HART protocol compatible.
C. Accuracy: +\- 0.10 percent of calibrated span.

D. Span and zero continuously adjustable, either locally or via hand-held digital interface.
E. NEMA 4 housing. Suitable for operation over ambient temperature range of -22 degF to 176 degF.
F. Ceramic or stainless steel wetted parts. Stainless steel bleed and drain fittings. All metal external parts.
G. Integral 4-digit LCD output indicator graduated 0-100 percent. Provide integral mounting bracket suitable for wall, pipestand, or unistrut mounting.
H. NPT process connections.
I. Manufacturers:

1. Siemens SITRANS P series (no substitution)

2.4 DIAPHRAGM SEALS

A. General: Furnish diaphragm seals for pressure gauges, switches and transmitters at locations shown and as specified.

B. Required Features

1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
2. Instrument Connection: ½" NPT.
3. Process Connection: 1" NPT.
4. Working Pressure Rating: Equal to or greater than the attached gauge or switch operating pressure specified.
5. Bolting Materials: Type 316SS for non-wetted exposed parts (typ.)
6. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
7. Flushing connection: ½" NPT.

C. Construction Features

1. Top Housing: Type 316 stainless steel.
2. Diaphragms: 316SS
3. O-Ring: Buna-N
4. Gasket: PTFE
5. Process Side Housing Material: 316 SS for metallic piping; CPVC to match non-metallic piping.
6. Sensing Liquid: Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, provide Halocarbon 63 or Flurolube 63 for the filling liquid.

7. Working Pressure Rating: Equal to or greater than the attached instrument, and the operating pressure specified in the Exposed Piping Installation, section 15109, whichever is greater.

D. Assembly and Calibration

1. Provide complete diaphragm seal assembly, including gauge, switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch setpoints specified prior to shipment.

2. Coordinate location and orientation of the gauges, switches and seal assemblies with the actual piping and equipment installations so that gauges and indicators can be easily read and accessed for maintenance by OWNER personnel.

3. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping and equipment installation, relocate, re-orient, re-assemble, and re-calibrate as directed by the ENGINEER at no cost to the OWNER.

E. Product and Manufacturer

1. Type 741, as manufactured by Ashcroft.
2. As Option with Instrument.

2.5 SIGNAL LINE TRANSIENT PROTECTION

A. All signal lines for solid state electronic equipment shall be equipped with line voltage surge suppressors to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby equipment.

B. This shall include, but is not be limited to digital inputs, analog inputs, analog outputs, flow transmitters, and level transmitters. The signal line transient protection shall be provided on any signal lines which are outside of the building structure housing the PLC control panel.

C. The signal line transient protection shall include gas discharge tubes, varistors, and suppressor diodes.

D. The unit shall be Phoenix Contact terminal block type consisting of protective plug and base element, with integrated multi-stage status indicator, Model PT-IQ-1X2+F, or approved equal.

E. Terminal block shall be DIN rail type, mounted in the vertical position.

F. Provide lightning protection termination for all digital and analog signals, plus a minimum of 10 percent spares per panels.

G. Field instruments, for 24V DC analog signals

1. Manufacturers: Phoenix Contact PIPETRAB series.

2. Conduit Mounted: Protection circuit mounted ¾ inch (19 mm) stainless steel pipe nipple.

3. Provide surge protection for analog and digital I/O designed to withstand a 10kA test current of a (8/20) microseconds waveform according to IEC 1024 Application Guide A and ANSI/IEEE C62.41 Category C Area.

4. Surge protection shall consist of a multistage hybrid circuit utilizing only diodes and gas discharge tubes but no Metal Oxide Varistors (MOVs).

5. Resistance: Less than 10 ohms of series resistance.

6. Surge protection shall have a response time less than 1 microsecond.

7. Maximum Continuous Operating Voltage: Not to exceed 28V DC.

8. Cutoff Frequency: Less than 400 kHz (for a 600 ohm system) to allow HART protocol and other superimposed smart digital signals to function.

9. Operating Temperature Range: -40 degC to 65 degC, minimum.

2.6 PRESSURE TRANSIENT MONITORING SYSTEM (PTMS)

A. General

1. Provide a Pressure Transient Monitoring System (PTMS) to measure pressure at the suction, discharge, and downstream of the pump discharge check valve of pump S104-LFT1-RSP02 as required by the Contract Drawings.

2. The PTMS shall consist of:
   a. Type 316SS diaphragm seals
   b. Pressure transducers
   c. Capillary tubing
   d. Transmitter that records the measured pressure
   e. Laptop with QView and Spike software

3. The PTMS shall have the ability for a setpoint to be configured in the transmitter such that pressure transients above the setpoint trigger the "Transient Mode" of the PTMS. When "Transient Mode" is triggered, the PTMS begins to record measured pressure at 20 millisecond intervals until the transient event has ended.

4. PTMS shall have the capability for cellular connectivity to be added.

B. Communication:

1. Integral WiFi and Ethernet LAN
2. Cellular (optional)

C. Transducer:

1. Process connection shall be made using a diaphragm seal with 316SS construction. Contractor shall be responsible for coordinating and selection appropriate process connection sizes based on Contract Documents and actual field conditions.

2. Transducer shall be connected to the diaphragm seal either directly or through the use of capillary tubing.

3. Transducers shall be provided with transducer cable of adequate length to connect to the transmitter.

4. Transducers shall have the ability to be connected up to a distance of 150 feet from the transmitter.

5. Transducers shall provide a 0-5V signal to the transmitter proportional to the measured pressure.

6. Electrical Classification: Class I, Division 2, Group D

D. Transmitter:

1. Power Supply: The PTMS shall be powered by 120 VAC. Power shall be connected to the transmitter, which shall provide the appropriate power to all connected transducers as required

2. Signal Input: PTMS shall accept a minimum of eight (8) transducer input signals at 0-5 V input.

3. Signal Output: 2 output contacts to signal a pressure transient event has occurred

4. Sampling Frequency
    a. Sample Rate: 1,000 Hz
    b. Recording Rate: 1 Hz to 100 Hz

5. Data Storage Capacity: PTMS shall have the capacity to store 30 minutes of pressure transient monitoring data sampled at 20 milliseconds.

6. Electrical Classification: Class I, Division 2, Group D

E. Laptop

1. Model: HP Probook 11 G2 Touchscreen
2. Operating System: Windows 10 Pro
3. Processor: 1 GHz
4. RAM: 8 GB
5. Hard Drive: 128 GB SSD

F. Software

1. QView Plus:
    a. Instantly detects and records transient pressures up to 100 times per second
    b. Sets the limits of the system's normal operating pressure
    c. Alerts when any pressure transient is detected.

2. QUE Remote Asset Monitor: User configurable dashboard for all manufacturer products

3. Spike
    a. Provides graphical analysis of recorded data
    b. Reads the data files that are created by the processor and stores it in a database
    c. Database format shall be Microsoft Access database

4. Convert Spike Data: Converts the data downloaded from your unit into a comma separated value file which can be opened with Excel

5. WiFi to SurgeWave: Configures laptop IP settings and connects to the SurgeWave network automatically

6. WiFi to Your Network: Returns the laptop IP settings back to auto which allows for connection back to the preferred network

G. Products

1. Blacoh SurgeWave Guardian Transient Monitoring System

2.7 VIBRATION TRANSMITTER

A. Provide an intrinsically safe, 2-wire, 24 VDC loop powered vibration transmitter.

B. Sensing element: Ceramic

C. Mounting threads: ¼" NPT

D. Performance
1. Measurement Range: 0.0 to 1.0 inch/sec
2. Frequency Range: 3 to 1,000 Hz
3. Signal Output: 4-20 mA
4. Resolution: 0.005 inch/sec peak

E. Environmental Operating Conditions
1. Temperature Range: -40 to 176°F

F. Electrical
1. Housing Material: Stainless Steel
2. Conduit connection position: Top
3. Conduit connection: 1" NPT
4. Classifications: Class I, Div. 2 approval

G. Products
1. PCB Piezotronics / IMI Sensors EX640B71

PART 3 EXECUTION

3.1 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of transmitters and switches with piping and equipment installers.

3.2 EXAMINATION

A. Examine the Drawings and the site for placement of instrumentation. Investigate the space in the buildings through which the equipment must pass to reach its final location. Make provisions to move the instrumentation into place.

B. The instrument installation details show general intent. They are not to scale. Secure and utilize instrument mounting details from the manufacturer or supplier for installation purposes.

3.3 INSTALLATION

A. Provide labor, materials, tools, equipment, supplies, and services, and auxiliary devices including, but not limited to, brackets and mounting hardware to install the instrumentation. Install all devices as. specified and shown on the Contract Drawings in accordance with manufacturer's requirements. The Contractor shall be responsible for any problems resulting from any deviation from manufacturer installation instructions.

B. Install all transmitters vertically, with the integral indicators facing front or sides. Install on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from floor elevation. For pipe mounted instruments, provide sufficient clearance to permit 360° access to the units.

C. Install the instrumentation and auxiliary devices to be accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install instrumentation to be accessible from floor level or grade.

D. Attach a durable stainless steel tag using stainless steel wire or stainless steel drive screws to each primary element, transmitter, and field mounted readout device. Permanently engrave the tag with the instrument tag number and description as given in the Instrument List for each instrument. Include manufacturer's name and model number if not discernible on the instrument. Provide tags which are a minimum of 1"x 3" size, 1/16" thick, with characters 1/4" high (minimum).

E. Seal all conduit and wiring entries into all instruments installed below ground or in vaults with non-setting transparent potting material. Seals shall be water tight, suitable for accidental submergence in 30 feet of water.

F. Follow additional installation requirements as specified in the individual instrument sections and as recommended by the manufacturer.

3.4 FIELD QUALITY CONTROL

A. Provide instrument manufacturer services for installation assistance, field calibration, startup, and training as specified in the individual instrument sections.

B. Remove shipping stickers, paint splatters, dirt, grease, and other contaminants to restore the instrumentation to a clean and like new condition prior to Final Acceptance.

3.5 MANUFACTURER'S SERVICES

A. An authorized manufacturer's representative shall inspect the installation of all work provided under this Section and shall provide a certificate of proper installation.

B. The Contractor shall provide the services of an experience, authorized manufacturer's representative (Salesperson does not qualify) for the equipment specified herein who shall be present at the jobsite and/or classroom designated by the City for the minimum man-days listed for the services shown below, time travel excluded:

1. One (1) man-day for inspection, start-up, functional testing, and certificate of proper installation.
2. One (1) man-day for Training and Commissioning.

3.6 DEMONSTRATION

A. Prepare an instrumentation installation and calibration certification sheet for each primary element sensor and electronic indicator/analyzer/transmitter for each instrument uniquely specified. Use these sheets for documenting installation and testing. Copies of completed instrument certification sheets need to be provided to the Owner's Maintenance Group.

B. Calibrate each instrument, including its complete instrument loop. Indication at remote receiving instruments, including any SCADA system operator interface screens, shall be equal to readings at local transmitter indicators.

C. Provide written loop-calibration report for each instrument loop, which shall include, but not limited to the following:

1. Project Name
2. Tag Number and Service Description
3. Manufacturer
4. Model and Serial Number
5. Date, time, and names and signatures of factory trained personnel performing calibration
6. Weather conditions at the time the final calibration was performed
7. Comparison of readings at the local transmitters with readings at the remote receiving instruments.
8. Verification of operation of all contact outputs, including those at the receiving instruments.
9. Description of method of calibration.
10. Calibration data to include:

a. Table showing calculated and measured values at 0%, 25%, 50%, 75%, and 100%.
b. Input, output, and error at 0, 25, 50, 75, and 100 percent of span for analog instruments.
c. Switch setting, contact action, and deadband, if applicable, for discrete elements.

11. Space for comments.
12. Certification by installer and acknowledgment by Contractor and date.
13. Names and signatures of Owner representative witnessing calibration process.

3.7 INSTRUMENT LIST

A. The Instrument List included herein indicates all minimum required instruments for the project, and shall not be considered a complete list, and shall be used as reference material.

B. The Instrument List does not include all details that must be coordinated during project implementation. However, columns have been provided in the attached Instrument List to facilitate inclusion of this information as the project installation progresses.

C. See Appendix A that has been provided following this specification for Instrument List.

SECTION 40 91 00 APPENDIX A

INSTRUMENT LIST

INST TAG	SERVICE DESCRIPTION	P&ID	TYPE	SCALE	RANGE	AREA CLASS	VENDOR	MODEL NO.	SPEC
PIT-001A	Raw Sewage Pump #1 Suction Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 15 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4
PIT-001B	Raw Sewage Pump #1 Discharge Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 50 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4
VE-001E, VT-001E	Raw Sewage Pump #1 Motor Outboard Bearing Vibration A	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00 Item 2.7
VE-001F, VT-001F	Raw Sewage Pump #1 Motor Outboard Bearing Vibration B	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00 Item 2.7
PIT-002A	Raw Sewage Pump #2 Suction Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 15 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4
PIT-002B	Raw Sewage Pump #2 Discharge Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 50 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4

SECTION 40 91 00 APPENDIX A

INSTRUMENT LIST

INST TAG	SERVICE DESCRIPTION	P&ID	TYPE	SCALE	RANGE	AREA CLASS	VENDOR	MODEL NO.	SPEC
VE-002E, VT-002E	Raw Sewage Pump #2 Motor Outboard Bearing Vibration A	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00
VE-002F, VT-002F	Raw Sewage Pump #2 Motor Outboard Bearing Vibration B	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00
PR-002	Raw Sewage Pump #2 Pressure Transient Monitoring System (PTMS)	N03	Pressure Transient Monitoring System	NA	0 – 150 psi	Cl. 1, Div. 2, Group D	Blacoh	By Vendor	40 91 00 Item 2.6
PIT-003A	Raw Sewage Pump #3 Suction Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 15 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4
PIT-003B	Raw Sewage Pump #3 Discharge Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 50 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4
VE-003E, VT-003E	Raw Sewage Pump #3 Motor Outboard Bearing Vibration A	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00

SECTION 40 91 00 APPENDIX A

INSTRUMENT LIST

INST TAG	SERVICE DESCRIPTION	P&ID	TYPE	SCALE	RANGE	AREA CLASS	VENDOR	MODEL NO.	SPEC
VE-003F, VT-003F	Raw Sewage Pump #3 Motor Outboard Bearing Vibration B	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00
PIT-004A	Raw Sewage Pump #4 Suction Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 15 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4
PIT-004B	Raw Sewage Pump #4 Discharge Pressure	N03	Pressure Indicating Transmitter	4-20 mA	0 – 50 psi	Cl. 1, Div. 2, Group D	Siemens	By Vendor	40 91 00 Item 2.3 Item 2.4
VE-004E, VT-004E	Raw Sewage Pump #4 Motor Outboard Bearing Vibration A	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00
VE-004F, VT-004F	Raw Sewage Pump #4 Motor Outboard Bearing Vibration B	N03	Vibration Transmitter	4-20 mA	0 – 1.0 in/s	Cl. 1, Div. 2, Group D	PCB Piezotronics	By Vendor	40 91 00

END OF SECTION

INDEX	INSTRUMENT TAG	SERVICE DESCRIPTION	P&ID	PROCESS FLUID	PIPE SIZE	PROCESS RANGE	POWER SUPPLY	LOCATION	AREA CLASS	MANUFACTURER	MODEL	TYPE	SPEC	COMMENT
0001	S030-STP1-FE-310-1	PRIMARY SLUDGE PUMP STATION 1 FLOW SENSOR B	BN1	Sludge	6 IN	0 - 1.730 MGD	N/A	PSPS-1	Class I, Div 2, Group D	TBD	TBD	Magmeter	40 91 00	N/A
0002	S030-STP1-FIT-310-1	PRIMARY SLUDGE PUMP STATION 1 FLOW INDICATING TRANSMITTER B	BN1	Sludge	N/A	N/A	120 VAC	PSPS-1	Class I, Div 2, Group D	TBD	TBD	Magmeter	40 91 00	N/A
0003	S030-STP2-FE-310-2	PRIMARY SLUDGE PUMP STATION 2 FLOW SENSOR B	BN2	Sludge	6 IN	0 - 1.730 MGD	N/A	PSPS-2	Class I, Div 2, Group D	TBD	TBD	Magmeter	40 91 00	N/A
0004	S030-STP2-FIT-310-2	PRIMARY SLUDGE PUMP STATION 2 FLOW INDICATING TRANSMITTER B	BN2	Sludge	N/A	N/A	120 VAC	PSPS-2	Class I, Div 2, Group D	TBD	TBD	Magmeter	40 91 00	N/A
0005	S020-GRT1-LE-313-1	GRIT HOPPER 1 LEVEL SENSOR	BN3	Grit	N/A	0 - TBD IN	N/A	Grit Building	Corrosive Area, Outdoor	TBD	TBD	Ultrasonic	40 91 00	N/A
0006	S020-GRT1-LIT-313-1	GRIT HOPPER 1 LEVEL TRANSMITTER	BN3	Grit	N/A	N/A	120 VAC	Grit Building	Corrosive Area, Outdoor	TBD	TBD	Ultrasonic	40 91 00	N/A
0007	S020-GRT1-LE-313-2	GRIT HOPPER 2 LEVEL SENSOR	BN3	Grit	N/A	0 - TBD IN	N/A	Grit Building	Corrosive Area, Outdoor	TBD	TBD	Ultrasonic	40 91 00	N/A
0008	S020-GRT1-LIT-313-2	GRIT HOPPER 2 LEVEL TRANSMITTER	BN3	Grit	N/A	N/A	120 VAC	Grit Building	Corrosive Area, Outdoor	TBD	TBD	Ultrasonic	40 91 00	N/A
0009	S060-CHL1-AE-001-1	CHLORINE CONTACT TANK 1 TSS ANALYZER SENSOR	EN1	Effluent	N/A	0 - 5000 mg/L	N/A	CCT-1	Corrosive Area, Outdoor	HACH	TBD	TSS	40 91 00	N/A
0010	S060-CHL1-AIT-001-0	CHLORINE CONTACT TANKS 1 & 2 TSS ANALYZER CONTROLLER	EN1	Effluent	N/A	N/A	120 VAC	CC Basins 1 & 2	Corrosive Area, Outdoor	HACH	sc4200 LXV524.99.11120	TSS	40 91 00	N/A
0011	S060-CHL2-AE-001-2	CHLORINE CONTACT TANK 2 TSS ANALYZER SENSOR	EN1	Effluent	N/A	0 - 5000 mg/L	N/A	CCT-2	Corrosive Area, Outdoor	HACH	TBD	TSS	40 91 00	N/A
0012	S060-CHL3-AE-002-3	CHLORINE CONTACT TANK 3 TSS ANALYZER SENSOR	EN1	Effluent	N/A	0 - 5000 mg/L	N/A	CCT-3	Corrosive Area, Outdoor	HACH	TBD	TSS	40 91 00	N/A
0013	S060-CHL3-AIT-002-0	CHLORINE CONTACT TANKS 3 & 4 TSS ANALYZER CONTROLLER	EN1	Effluent	N/A	N/A	120 VAC	CC Basins 1 & 2	Corrosive Area, Outdoor	HACH	sc4200 LXV524.99.11120	TSS	40 91 00	N/A
0014	S060-CHL4-AE-002-4	CHLORINE CONTACT TANK 4 TSS ANALYZER SENSOR	EN1	Effluent	N/A	0 - 5000 mg/L	N/A	CCT-4	Corrosive Area, Outdoor	HACH	TBD	TSS	40 91 00	N/A
0015	S136-VLT1-LSH-111	FEB VALVE VAULT 1 SUMP LEVEL SWITCH - HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 1	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0016	S136-VLT1-LSH-112	FEB VALVE VAULT 1 SUMP LEVEL SWITCH - HIGH HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 1	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0017	S136-VLT1-LSH-113	FEB VALVE VAULT 1 SUMP LEVEL SWITCH - HIGH HIGH HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 1	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0018	S136-VLT2-LSH-121	FEB VALVE VAULT 2 SUMP LEVEL SWITCH - HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 2	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0019	S136-VLT2-LSH-122	FEB VALVE VAULT 2 SUMP LEVEL SWITCH - HIGH HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 2	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0020	S136-VLT2-LSH-123	FEB VALVE VAULT 2 SUMP LEVEL SWITCH - HIGH HIGH HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 2	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0021	S136-VLT3-LSH-131	FEB VALVE VAULT 3 SUMP LEVEL SWITCH - HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 3	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0022	S136-VLT3-LSH-132	FEB VALVE VAULT 3 SUMP LEVEL SWITCH - HIGH HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 3	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A
0023	S136-VLT3-LSH-133	FEB VALVE VAULT 3 SUMP LEVEL SWITCH - HIGH HIGH HIGH	FN1	Effluent	N/A	N/A	120 VAC	FEB Valve Vault 3	Class I, Div 2, Group D	TBD	TBD	Float	40 91 00	N/A

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SECTION 40 96 15

PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 GENERAL

1.1 DESCRIPTION

A. Section 40 96 15 specifies the input/output (I/O) point list, which follows this Section and requirements for configuring the control system database.

B. Related Work Specified in Other Sections Includes, But is Not Limited to the Following:

1. Section 01 33 00 - Submittals
2. Section 40 80 50 - Process Control System Commissioning
3. Section 40 90 00 - Process Control System General Requirements
4. Section 40 90 50 - Process Control System Description
5. Section 40 91 00 - Process Control System Instruments

1.2 SUBMITTALS

A. General: Provide all submittals as specified herein, and as specified in Section 01 33 00 – Submittals.

B. Action Submittals

1. For each I/O attribute listed in the I/O list that cannot be used exactly as listed, submit an explanation of the reason for the deviation and propose a method to modify the I/O list information. Do not proceed with any configuration until a method of resolving deviations is accepted by the ENGINEER.

2. Include the control system I/O database information in the PLC specific submittals for Programmable Logic Controller Systems Hardware.

3. CONTRACTOR shall supplement and complete the information provided in the drawings and attached tables, including identification of all soft I/O for digital communication networks including Ethernet I/P. The Listing shall include the node address and addresses within the device. The addresses shall be coordinated by the CONTRACTOR so that node and segment addresses are unique within the Process Control System.

C. SYSTEM INTEGRATOR shall submit a complete I/O list for the PLC system that incorporates all existing I/O signals as well as new, modified and removed I/O signals and represents the final condition of PLC-F upon completion of the project.

D. Submittals for Closeout: Provide submittals as required below.

1. Section 01 78 90 - Contract Closeout.
2. Complete I/O List

1.3 I/O POINT LIST DESCRIPTION

A. The I/O point list shall be developed by the SYSTEM INTEGRATOR and submitted for OWNER/ENGINEER review.

B. The I/O list shall contain the information necessary to configure the PLC I/O interface hardware and to indicate range conversion or signal functions.

C. The SYSTEM INTEGRATOR shall populate all required data fields for each I/O signal. Data field definitions and requirements are provided in subsequent section in this specification.

D. The project Input/Output list included in Appendix A indicates all minimum required I/O for the project, including all hardwired I/O as well as soft I/O to be communicated between processors and Ethernet protocols, and shall not be considered a complete list, and shall be used as reference material.

E. The project scope includes modifications to an existing PLC system (PLC-F). The Input/Output list included in Appendix A contains instructions and notes with requirements for retaining, adding, modifying and removing I/O signals for the existing PLC system. These requirements have been provided in the following columns of the IO/O list in Appendix A:

1. NEW / MODIFY / RETAIN / REMOVE
2. NOTES

1.4 I/O POINT LIST DATA FIELD DEFINITIONS

A. INDEX: Indicates a sequential number used to reference the I/O (0001 through 9999)

B. I/O TAGNAME: An alphanumeric character string. The format of the I/O Tagname is defined as follows:

[Equipment Tag][B][CCC][D]

1. [Equipment Tag]: Indicates the Tagname associated with the equipment (instrument, pump, etc). Use the Antero Equipment ID Scheme as provided by the Client:

   Example:

   Flow Indicating Transmitter S030-STP1-FIT-310-1 = S030STP1FIT3101

2. [B]: Indicates the type of I/O defined as follows:

   I - Analog Input
   O - Analog Output
   S - Discrete Input
   C - Discrete Output

   Example:

   Analog Input signal from Flow Indicating Transmitter S030-STP1-FIT-310-1 = S030STP1FIT3101I

3. [CCC]: Suffix indicating the I/O description, and it is defined as follows:

I/O Description	I/O Suffix
ALARM	ALM
AUTO	AUT
CLOSE	CLS
CLOSED	CLD
FAULT	FLT
FLOW	FLO
GENERAL	GEN
HAND	HND
LEVEL	LVL
LOCAL	LOC
OPEN/OPENED	OPN
POSITION	POS
PRESSURE	PRE
REMOTE	REM
SPEED	SPD
START/RUNNING	STR
STOP	STO
STOPPED	STD
TEMPERATURE	TM
VIBRATION	VIB

   Example:

   Analog Input signal from Flow Indicating Transmitter S030-STP1-FIT-310-1 = S030STP1FIT3101IFLO

4. [D]: Indicates the determinant for the suffix, and applies to discrete statuses as follows:

   H: High
   HH: High-High
   L: Low
   LL: Low-Low
   1-9: Sequential

   Example:

   FEB Valve Vault 1 Sump Level High signal from Level Switch S136-VLT1-LSH-111

   I/O Tag Name: S136VLT1LSH111SLVLH

C. SERVICE DESCRIPTION: An alphanumeric character string up to 40 positions in length. Points described as SPARE denote pre-wired I/O.

D. I/O TYPE:

1. AI: Analog Input
2. AO: Analog Output
3. DI: Discrete Input
4. DO: Discrete Output
5. RTD: RTD Temperature Input
6. TC: Thermocouple Input

E. P&ID: Piping/Process and Instrumentation diagram where the I/O point can be referenced to.

F. SIGNAL TYPE: Indicates signal input/output type (4-20mA, SOFT I/O, 120VAC, N/A, etc.)

G. POWER SUPPLY: Indicates signal power supply (24 VDC, 120 VAC, 480 VAC, N/A, etc.)

H. SOURCE: Indicates signal power source (Loop, Field)

I. SCALE: Indicates lower and higher values of signal range (4-20mA or 0-10V for analog signals, N/A for discrete signals)

J. ENG RANGE: Indicates lower and higher values of the process variable input/output range in engineering units (0 - 100 psi, 0% - 100%, 3 - 15 MGD, etc.; N/A for discrete signals)

K. SP LL: Indicates the Low-Low Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks.

L. SP L: Indicates the Low Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks.

M. SP H: Indicates the High Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks.

N. SP HH: Indicates the High-High Setpoint associated with the signal for alarming and/or tripping purposes, and other control interlocks

O. ZERO STATE: Indicates the condition that exists when contact is de-energized (NOT RUNNING, NO START, NOT LOCAL, OFF, FAULT, TRIP, etc.). State depends on the normal state of the contact (normally closed or normally open).

P. ONE STATE: Indicates the condition that exists when contact is energized (RUNNING, START COMMAND, REMOTE, etc.). State depends on the normal state of the contact (normally closed or normally open).

Q. LOCATION: Indicates the location (facility) associated with the I/O point.

R. PLC: Indicates the controller associated with the I/O point.

S. EQUIPMENT DESCRIPTION: Indicates the description of the type of equipment associated with the I/O point (Variable Frequency Drive, Vertical Turbine Pump, Motor-Operated Valve, Level Indicator, etc.).

T. FROM: Indicates origination of the I/O point (VFD, Pump, MOV, PIT, PLC, etc.).

U. TO: Indicates destination of the I/O point (VFD, Pump, MOV, PIT, PLC, etc.).

V. CONNECTION:

1. "SOFT (ETHERNET I/P)" is used to designate those I/O points that are transferred via ethernet connection between equipment and PLC.

2. "HARDWIRE" is used to designate those I/O points that are transferred via hardwired connection between equipment and PLC.

W. COMMENTS: Comments or notes, if required.

X. HMI/PLC TAGNAME: Indicates the designated programming tag for the I/O point. By SYSTEM INTEGRATOR.

Y. ETHERNET/IP ADDRESS: Indicates the IP address associated with the I/O point (for soft I/Os). By SYSTEM INTEGRATOR.

Z. RACK: Indicates the PLC Rack number associated with the I/O point (for hardwired I/Os). By SYSTEM INTEGRATOR.

AA. SLOT: Indicates the PLC I/O card slot number associated with the I/O point (for hardwired I/Os). By SYSTEM INTEGRATOR.

BB. POINT: Indicates the PLC I/O card channel number associated with the I/O point (for hardwired I/Os). By SYSTEM INTEGRATOR.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide a complete single I/O point list that includes all analog, digital, and control output signals in a single list. Start a new page for each associated PLC. Sort list according to the following criteria in descending priority: P&ID, PLC, I/O TAGNAME. After final sorting, generate INDEX number column starting from 0001 through as needed. The I/O lists included in this document shall not be considered complete lists, and shall only be used for reference.

B. Provide a list that includes all information not included in the I/O list described above, but that is developed internal to the PLCs, including diagnostic alarms for communications failure, I/O signal failure, and all internal PLC alarms.

C. Submit for review preliminary copies of the I/O point list during the shop drawing review phase. For final O&M documentation, provide five printed copies and two electronic copies in Microsoft Excel spreadsheet format for each list required.

PART 3 EXECUTION

3.1 GENERAL

A. Provide I/O address information to the RESIDENT PROJECT REPRESENTATIVE for each I/O point. Use slot and point designations.

1. Slot refers to the location of a field control module on a DIN mounting rail or chassis.

2. Point refers to the point location or address for the I/O point on the designated field control module/card.

B. Provide prewired I/O for points identified as SPARE in the description.

3.2 I/O CONFIGURATION

A. Implement the control system database fields in a consistent manner by using the following procedures:

1. Use abbreviations and acronyms already established in the Contract Documents. In particular, use the information in the I/O Point List.

2. Use only abbreviation or acronym for a word or group of words, respectively.

3. Use the same subject and word order within data fields.

4. Use the same term (either phrase, description, word or acronym) to denote the same meaning. Do not use multiple terms for a single meaning.

5. Use the I/O tagnames, service descriptions, logic state descriptions, ranges, and units of measurement exactly the same wherever the point is referenced.

6. Show I/O tagnames and service descriptions for all point references on documentation.

7. Maintain lists of acronyms and abbreviations used.

3.3 I/O HARDWARE CONFIGURATION

A. Partition the I/O among cards within an I/O enclosure to provide control loop integrity.

1. Place all inputs of the same I/O type associated with a device (e.g. pump, blower, clarifier, or other piece of equipment) on the same card.

2. Place all inputs of the same I/O type for devices arranged in process trains (e.g. a pump, its inlet valve and its outlet valve) on the same card or adjacent cards if more than one card is required to accommodate the points.

3. Place all outputs of the same I/O type associated with a device or group of devices in a process train on the same card or adjacent cards if more than one card is required to accommodate the points.

4. Where the preceding requirements specified in this paragraph would cause more than 20 percent spare points on a card, points for a device or process train may be split between two consecutive cards.

5. Make unused terminals resulting from partitioning the I/O into pre-wired spares. Provide pre-wired spare points with all cabling and termination internal to the PLC as done for other I/O points.

3.4 POINT DATA FIELDS

A. I/O point data fields may be subject to review and modification by the ENGINEER during the Shop Drawing review phase. Incorporate changes directed by the ENGINEER completely into the entire system, at no increase in contract price, subject to the following limitations:

1. Limit the total number of modifications to 35 percent of the total number of I/O points.

2. Each unique change will count as one modification. For example, modifying the description, range, and engineering unit on an analog input counts as three modifications.

3. Analog input alarm limit definition shall not be counted as a modification.

3.5 INPUT/OUTPUT LIST

A. The project Input/Output list included in Appendix A indicates all minimum required I/O for the project, including all hardwired I/O as well as soft I/O to be communicated between processors and Ethernet protocols, and shall not be considered a complete list, and shall be used as reference material. All I/O shall be available at the OWNER's SCADA system.

B. The I/O list does not include all details that must be coordinated during project implementation, such as final node addresses and registers for all I/O. However, columns have been provided in the I/O list attached to facilitate inclusion of this information as the project installation progresses. The SYSTEM INTEGRATOR shall be responsible for including additional hardwired or soft I/O as required for the PLC and PCS to function as described in Section 40 90 50 - Process Control System Description.

C. All Analog Points are required to have Trends and Records created on the existing Historian.

D. The CONTRACTOR shall follow the OWNER-approved format included herein. The attached I/O list can be provided to the CONTRACTOR in electronic form (Microsoft Excel) upon request.

E. For each PLC, the CONTRACTOR shall submit the required tag database submittals in the format attached, in both hardcopy and electronic form (Microsoft Excel).

F. Each submittal shall include all information coordinated with equipment vendors and suppliers for the systems integration work including, but not limited to:

1. Alarm settings and class
2. Terminal block information
3. Power source
4. PLC term no.
5. Final PLC register location

G. Additionally, for soft I/O communicated over Ethernet, the submittal shall include similar information coordinated with all equipment vendors and suppliers. For soft I/O include, but not be limited to:

1. Alarm settings and class
2. Communication segment tag
3. Node address on segment coordinated with all vendors and suppliers with equipment on that segment.
4. Final PLC register location.

3.6 SCHEDULES

A. See attached Appendix A for I/O list format.

END OF SECTION

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PLC-F Rack Layout Rack Layout

PLC "F" - CTI2500 PLC Rack Layout

Channel 1 Base 0					
Slot	**Card Type**	**I/O Designation**	**I/O Address**	**New / Modify / Retain / Remove**	**Notes**
1			961		
2					
3	32 Pt. Digital Input	X	1	Retain	
4	32 Pt. Digital Input	X	33	Retain	
5	32 Pt. Digital Input	X	65	Retain	
6	32 Pt. Digital Input	X	97	Retain	
7	8 Pt. Analog Input	WX	209	Retain	
8					
9	8 Pt. Analog Output	WY	201	Retain	
10	8 Pt. Analog Input	WX	921	New	Provide new Analog Input Card
11	8 Pt. Analog Input	WX	905	Retain	
12	8 Pt. Analog Input	WX	913	Retain	
13	8 Pt. Analog Input	WX	929	New	Provide new Analog Input Card
14	8 Pt. Analog Input	WX	193	Retain	
15					
16	32 Pt. Digital Output	Y	513	Retain	

PLC-F Rack Layout Rack Layout

Channel 1 Base 3					
Slot	**Card Type**	**I/O Designation**	**I/O Address**	**New / Modify / Retain / Remove**	**Notes**
1	32 Pt. Digital Input	X	617	Retain	
2	32 Pt. Digital Input	X	649	Retain	
3	32 Pt. Digital Output	Y	681	Retain	
4					
5	8 Pt. Analog Input	WX	713	Retain	
6	8 Pt. Analog Input	WX	729	Retain	
7	8 Pt. Analog Ouput	WY	737	Retain	
8					
9					
10					
11					
12					
13					
14					
15					
16					

PLC-F Rack Layout Rack Layout

Channel 1 Base 4

Slot	Card Type	I/O Designation	I/O Address	New / Modify / Retain / Remove	Notes
1	32 Pt. Digital Input	X	745	Retain	
2	32 Pt. Digital Output	Y	777	Retain	
3					
4					
5	8 Pt. Analog Input	WX	809	Retain	
6	8 Pt. Analog Ouput	WY	817	Retain	
7	8 Pt. Analog Input	WX	825	Retain	
8					
9					
10					
11					
12					
13					
14					
15					
16					

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SECTION 40 98 00

PROCESS CONTROL SYSTEM TRAINING

PART 1 GENERAL

1.1 REQUIREMENTS AND RESPONSIBILITIES

A. Section 40 98 00 specifies training requirements for the Process Control System (PCS), including operation, hardware, software, instrumentation, and any equipment affected by the modifications performed as part of the SSWWTP Flow Optimization Project, Plant Improvements.

B. CONTRACTOR: provide all labor, materials, equipment, and incidentals as shown, specified, and required to perform and coordinate all required training at times acceptable to OWNER and ENGINEER.

C. CONTRACTOR: retain the services of the SYSTEM INTEGRATOR to provide operation and maintenance training for all Control System components and systems, including instrumentation as specified herein, and identified in other sections.

D. CONTRACTOR: provide on-site training by an authorized representative of the equipment manufacturer for equipment not manufactured by the CONTRACTOR. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment and certified by the manufacturer as a trainer of that specific equipment.

E. CONTRACTOR: conduct all training in the normal eight-hour working shift (day, evenings, or midnights) until conclusion of the training course. Assign a full time instructor for training. Instructor shall not perform other duties throughout the period of each scheduled course. Schedule the training courses to meet the working requirements for each shift. Schedule training classes during day, evening, and midnight shifts to allow three shift training, if applicable.

F. The requirements of this specification supplement the requirements of Section 01 79 00 - Training.

G. Related Work Specified in Other Sections Includes, But is Not Limited to the Following:

1. Section 01 33 00 - Submittals
2. Section 01 79 00 - Training
3. Section 40 80 50 - Process Control System Commissioning

4. Section 40 90 00 - Process Control System General Requirements
5. Section 40 90 50 - Process Control System Description
6. Section 40 91 00 - Process Control System Instruments
7. Section 40 95 13 - Process Control System Panel Enclosure and Equipment
8. Section 40 96 15 - Process Control System IO List

1.2 SUBMITTALS

A. General: Provide all submittals as specified herein, and as specified in Section 01 33 00 - Submittals.

B. Action Submittals

1. Provide training plan, with a minimum of 30 days of prior notice, for training conforming to the requirements of Division 01. Include in the plan course outlines for each control system, equipment, instrumentation, and coordinated schedules for training to be provided at the OWNER's facilities. Schedule training to allow OWNER personnel to receive the training in a timely manner in accordance with the project and equipment startup schedule.

2. Identify which systems are covered by each of the training courses, and identify common topics and specialty topics unique to a system or a course.

3. Provide Lesson Plans, including course outline, for each class for review by OWNER/ ENGINEER.

4. Provide copies of training materials for each class for OWNER/ ENGINEER's review a minimum of eight weeks before the scheduled class, and provide the final training materials two weeks before the scheduled class.

5. Provide instructor/trainer qualifications and experience records.

1.3 ON-SITE TRAINING

A. Provide training for all aspects of the process control system. Training shall not be limited to instruments, software, computers, and hardware. The generic requirements for training are provided below. Prepare and replicate training specifically for all elements of the process control system.

B. The OWNER may record and/or videotape on-site training sessions at its option.

C. The ENGINEER may monitor any training course.

D. Generic Training Requirements:

1. Provide on-site operation and maintenance training by SYSTEM INTEGRATOR or VENDOR and the equipment manufacturer representatives prior to placing the equipment in continuous operation, conforming to the requirements of Section 01 79 00 - Training. Provide the services of equipment manufacturer's representatives for a minimum of eight hours for each type of instrument provided.

2. Training shall accomplish the following:

   a. Provide instruction covering use and operation of the equipment to perform the intended functions.

   b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.

   c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall facility monitoring and control system.

   d. Provide all instructions necessary to operate and utilize all system components.

   e. Provide all instruction necessary to monitor and control the system processes from the designated control panel.

   f. Explain procedures for control of the system during scheduled or unscheduled shutdown and the subsequent start-up.

   g. Provide instructions for regular maintenance and administration operations.

   h. Different phases of the training may be grouped for presentation by different personnel. Submit schedule and instructors for approval.

E. Training subjects shall include, but not be limited to the following:

1. An overview of each new major piece of equipment in the system (e.g., new controller, new input/output (I/O) module, new communication module, new instrument, etc.), and how each interacts with the process.

2. An overview of the control system with a discussion showing how the hardware and software react and influence the operation of the controlled processes.

2. The training shall be of the same format, content, and duration as the training described above. Provide additional emphasis or retraining for areas of weakness.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TRAINING

A. Provide the specified minimum instructor hours/number of sessions of training in accordance with Section 01 79 00 - Training.

END OF SECTION

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