



**TECHNICAL SPECIFICATIONS
FOR THE CONSTRUCTION OF**

**TOWN OF ADDISON, TX
KELLWAY LIFT STATION BY-PASS**

Client Project # 2021-03C

**PUBLIC WORKS AND ENGINEERING DEPARTMENT
BID NUMBER 21-53**

VOLUME 2 OF 2

MARCH 2021

PREPARED BY



**3010 Gaylord Parkway
Suite 190
Dallas, Texas 75034
(972) 377-7480**



TOWN OF ADDISON, TEXAS

MAYOR

Joe Chow

COUNCIL MEMBERS

Paul Walden

Tom Braun

Ivan Hughes

Guillermo Quintanilla

Lori Ward

Marlin Willeesen

CITY MANAGER

Wesley Pierson

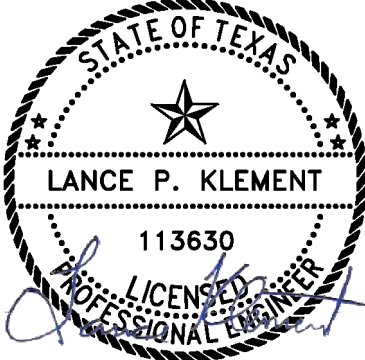

DIRECTOR OF PUBLIC WORKS AND ENGINEERING

Shannon Hicks, P.E.

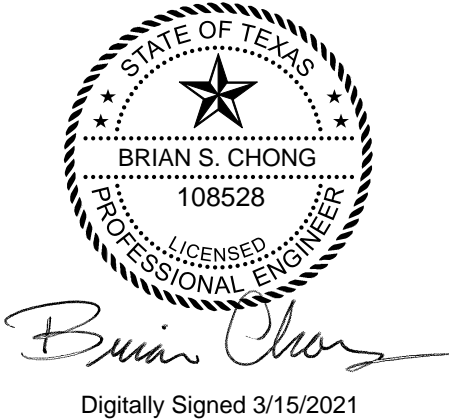

CERTIFICATIONS

**KELLWAY LIFT STATION BY-PASS PROJECT
GARVER PROJECT NO. 20W05015**

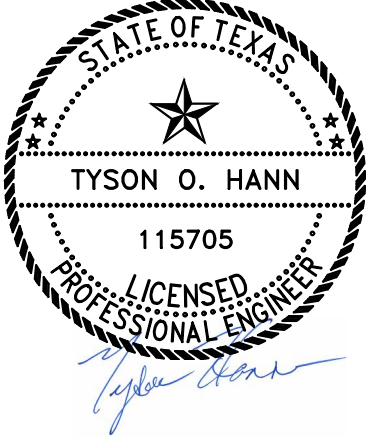
I hereby certify that the applicable portions of this project plans and specifications were prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of TX.

SEAL AND SIGNATURE	APPLICABLE DIVISION OR PROJECT RESPONSIBILITY
<p align="center">Lance Klement, P.E No 113630</p>  <p align="center">Digitally Signed 3/15/2021</p>	<p>Division 00 – Front Ends Division 01 – General Requirements</p>
<p align="center">Harry Elliott, P.E. No. 135729</p>  <p align="center">Digitally Signed 03/15/2021</p>	<p>Division 03 – Concrete</p>

CERTIFICATIONS

SEAL AND SIGNATURE	APPLICABLE DIVISION OR PROJECT RESPONSIBILITY
<p align="center">Brian Chong, P.E No. 108528</p>  <p align="center">Digitally Signed 3/15/2021</p>	<p align="center">Division 26 - Electrical</p>
<p align="center">Stephen Mobley, P.E. No. 117365</p> 	<p align="center">Division 31 – Earthwork Division 32 – Exterior Improvements</p>

CERTIFICATIONS

SEAL AND SIGNATURE	APPLICABLE DIVISION OR PROJECT RESPONSIBILITY
<p align="center">Tyson Hann, P.E. No. 115705</p>  <p align="center">Digitally Signed 03/15/2021</p>	<p>Division 02 – Existing Conditions Division 09 – Finishes Division 22 – Plumbing Division 33 – Utilities Division 40 – Process Integration Division 44 – Pollution Control Equipment</p>

GARVER, LLC CERTIFICATE OF AUTHORIZATION:
<p>TX ENGINEERING FIRM REGISTRATION NO. F-5713</p> <p>Expiration Date: 1/31/2022</p>

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DIVISION 1
GENERAL REQUIREMENTS

SECTION 01 11 00 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of:
 - 1. Work covered by Contract Documents.
 - 2. Activities of others within Project area.
 - 3. Coordination of Work required by Contractor.
 - 4. Provisions for future Work.
- B. Work covered by Contract Documents: The completed Work will provide Owner with various lift station improvements. More specifically, the Project includes, but is not limited to, construction of the following:
 - 1. Installation of a third pump and associated piping, valving, and appurtenances.
 - 2. Connection of pump suction lines in the existing lift station
 - 3. Installation of a bypass pumping connection to provide direct connection to the forcemain and bypass the lift station
 - 4. Installation of new pre-cast concrete manhole and piping between the lift station
 - 5. Connection between the new and existing manhole, piping between the existing manhole and the lift station, and a new wall core
 - 6. Bypass pumping during construction
- C. Except as specifically noted otherwise, provide and pay for:
 - 1. Insurance and bonds.
 - 2. Labor, materials, and equipment.
 - 3. Tools, equipment, and machinery required for construction.
 - 4. Utilities required for construction.
 - 5. Temporary facilities including sheeting and shoring.
 - 6. Traffic control and dust control measures.
 - 7. Other facilities and services necessary for proper execution and completion of the Work.
- D. Secure and pay for all permits including all Town of Addison permits, OSHA excavation permits, Department of Transportation permits, and any other government fees and licenses.
- E. Comply with codes, ordinances, regulations, orders, and other legal requirements of public authorities having bearing on the performance of the Work.

1.2 ACTIVITIES BY OTHERS

- A. Owner, utilities, and others may perform activities within Project area while the Work is in progress.
 - 1. Schedule the Work with Owner, utilities, and others to minimize mutual interference.
- B. Cooperate with others to minimize interference and delays.
 - 1. When cooperation fails, submit recommendations and perform Work in coordination with work of others as directed.
- C. Other on-going and potential projects that parallel the schedule of this project:
 - 1. None

1.3 COORDINATION OF WORK

- A. Maintain overall coordination of the Work.

- B. Obtain construction schedules from each subcontractor, and require each subcontractor to maintain schedules and coordinate modifications.
- C. Alternates: Alternates, if included, are specified in detail in the Bid Form and only those alternates that were selected by the Owner, as evidenced in the Agreement, are made a part of this Contract.

1.4 PROVISIONS FOR FUTURE WORK

- A. Provisions for future construction are as shown as detailed on drawings and in the specifications.

1.5 LOCATION OF WORK

- A. The Project is located at the Kellway Lift Station, 4245 Kellway Circle Addison, TX 75001.

1.6 OWNER FURNISHED EQUIPMENT

- A. For this project's delivery, the Owner shall not be providing and/or delivering any associated equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 11 60 – PROJECT MANUAL LANGUAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes description and requirements of:
 - 1. Explanation of Project Manual arrangement.
 - 2. Explanation of Project Manual language.
 - 3. Reference standards.
 - 4. Method of resolving conflicts of referenced standards between Contract Documents.

- B. Related Documents and Sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.2 REFERENCES

- A. Construction Specifications Institute (CSI):
 - 1. Manual of Practice - MasterFormat™.
 - 2. Manual of Practice - SectionFormat™.
 - 3. Manual of Practice - PageFormat™.

1.3 PROJECT MANUAL ARRANGEMENT

- A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.

- B. Sections are written in accordance with CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.

- C. Page format for Sections in the Project Manual is in accordance with CSI Page Format, except where departures have been deemed necessary.

1.4 PROJECT MANUAL LANGUAGE

- A. Specification Section Paragraphs entitled "Section Includes" summarizes briefly what is generally included in the section. Requirements of Contract Documents are not limited by "Section Includes" paragraphs. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the CONTRACTOR shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all". Assume missing portions by inference.

- B. Phrase "by ENGINEER" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.

- C. Phrase "to ENGINEER" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

- D. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
 - 1. When used as an appositive after designation of product, colons are used in place of words "shall be."

- E. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.
- F. Words "CONTRACTOR shall" are implied when direction is stated in imperative mood.
- G. Term "products" includes materials and equipment as specified in Section 01 60 00.

1.5 REFERENCE STANDARDS

- A. Use only applicable portions of referenced standards, ignoring payment stipulations and other provisions which change the duties of the ENGINEER or OWNER.
- B. Equate terms relating to designer to "ENGINEER."
- C. Notify ENGINEER when referenced standard, code, or specification conflicts with Contract Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 00 – WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of:
 - 1. General constraints for sequencing and scheduling the Work.
 - 2. Interruption of lift station operations
 - 3. Work affected by existing site and facility.
 - 4. Work restrictions and coordination between construction operations and plant operations, including:
 - a. Access to site
 - b. Use of site and premises.
 - c. Utilities.
 - d. Work by Others.
 - e. Work Sequence.
 - f. Temporary Services, Materials and Equipment.
- B. Related sections:
 - 1. Section 01 11 00 - Summary of Work.
 - 2. Section 01 26 00 - Contract Modification Procedures.
 - 3. Section 01 50 00 - Temporary Facilities and Controls.

1.2 GENERAL CONSTRAINTS ON SEQUENCE AND SCHEDULING OF WORK

- A. Water Projects:
 - 1. The existing Kellway Lift Station for the Town of Addison is an important facility in the process of pumping wastewater for the Town. Impairing the operational capabilities of this facility will result in serious financial damage to the Town.
 - 2. Conduct work in a manner that will not impair the operational capabilities of essential elements or reduce the capacity of the pump station.
 - 3. The status of the lift station shall be defined as “operational” during construction when the bypass connection is installed and existing pumping capacity is restored via bypass pumping.
- B. Work Sequence and Constraints:
 - 1. Utilize description of critical events in work sequence in this Section as a guideline for scheduling and undertaking the Work.
 - 2. Work sequence and constraints presented do not include all items affecting completion of the Work, but are intended to describe critical events necessary to minimize disruption of the existing facilities and to ensure compliance to the water quality standards as mandated by the Texas Department of Health.

1.3 INTERRUPTION OF FACILITY PROCESSES

- A. Execute the Work while the existing facility is in operation.
- B. Indicate required shutdowns of existing facilities or interruptions of existing operations on Progress Schedule. Shutdowns will be permitted to the extent that existing operation will not be jeopardized and identified constraints are satisfied.
- C. Submit written notification of required shutdowns of existing facilities at least 14 days prior to the planned date of shutdown.

- D. The ENGINEER and the Facility Personnel will evaluate the request based on the lift station's ability to reliably meet capacity demands.
- E. Do not begin alterations until ENGINEER's written permission has been received.
- F. Minimize shutdown times by thorough advanced planning. Have required equipment, materials, and labor on hand at time of shutdown.
- G. Where required to minimize process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.4 REQUIREMENTS FOR OPERATION OF LIFT STATION AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES

- A. Facilities or conditions required to keep the existing lift station operational include, but are not limited to, the following:
 1. Electrical power, including transformers, distribution wiring, and motor control centers.
 2. Piping for conveyance of potable water.
 3. All existing pumps.
 4. Fencing and gates.
 5. Lighting.
 6. Heating, ventilation, and air conditioning equipment.
 7. Instrumentation, meters, controls, and telemetry equipment.
 8. Safety equipment and features.
 9. Parking for City employees and vehicles required for operation and maintenance of the existing pump stations.
 10. Telephone system.
 11. Storm drainage.
 12. Other incidentals necessary to continually operate the facilities.
- B. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.
- C. Do not remove or demolish existing facilities required to keep the existing lift station operational at the capacities specified until the existing facilities are replaced by temporary or new facilities equipment. The replacement facilities shall have been tested and demonstrated to be operational prior to removing or demolishing existing facilities.

1.5 OPERATIONS AND MAINTENANCE ACCESS

- A. Provide safe, continuous access to process control equipment for plant operations personnel.

1.6 SHUTDOWN CONSTRAINTS

- A. Comply with Shutdown Constraints as described in Section 01 31 00, PROJECT MANAGEMENT AND COORDINATION, and described in General Terms as Follows:
 1. Provide 14 days advance notice to Engineer and Owner of need for a minor shutdown.
 2. Provide 30 days advance notice to Engineer and Owner of need for a major shutdown.
 3. Shutdowns will be allowed, but will be limited to low demand periods from 10:00 PM to 5:00 AM.
 4. Any shutdowns shall require a shutdown plan, including detailed schedule, backup tools and equipment, personnel involved, contingency plan, and any procedures involved in restarting the facility. Owner's approval of the Shutdown Plan is required prior to any shutdowns.

5. Contractor shall coordinate continuous 24-hour temporary pumping as necessary if the lift station needs to be offline for more than 2 hours during construction.

1.7 UTILITIES

- A. Provide advance notice to and utilize services of 811 for location and marking of underground utilities operated by utility agencies other than the OWNER. Contact information: Call 811 for marking of utilities.
- B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.

1.8 WORK BY OTHERS

- A. Where proper execution of the Work depends upon work by others, inspect and promptly report discrepancies and defects.

1.9 WORK SEQUENCE

- A. The project assumes that all project efforts will be delivered in a concurrent, logical fashion. The following sequences does not detail the integration of all work included in the Contract. The Contractor is responsible to perform all required work and coordinate that work with the continuing appropriate operation of the existing facilities. This possible sequence is included for informational purposes only. It is intended that Construction be performed in multiple phases as follows:
 1. The anticipated sequence of events at the lift station is as follows:
 - a. Install lift station bypass connection and temporary bypass pumping.
 - b. Drain and clean the wetwells.
 - c. Complete the following work concurrently.
 - d. Core the wetwells and install new wall pipes, valves, manhole, and manhole connections.
 - e. Install the common suction header, valves, new piping, and third pump, valves, spools, and appurtenances.
 - f. Install new electrical conduit, connections to the control panel, ultrasonic level detection, and stilling wells.

1.10 TEMPORARY SERVICES, MATERIALS, AND EQUIPMENT

- A. Locate temporary facilities in a manner that minimizes interference to OWNER's operation and maintenance personnel.
- B. Unless otherwise specified, install temporary pipelines of the same size as its connection to the existing facility at the downstream end of the pipeline.
- C. Provide piping of suitable material for the material being conveyed.
- D. Provide submittals on proposed temporary electrical and instrumentation components necessary to maintain existing facilities.
- E. Dewater and promptly clean basins and channels temporarily removed from service.
- F. Dimensions for all existing structures, piping, paving, and other nonstructural items are approximate. The CONTRACTOR shall field verify all dimensions and conditions and report any discrepancies to the ENGINEER a minimum of 14 days in advance of any construction in the area.

- G. Discrepancies between coordinates, bearings and lengths, and stationing shall be resolved in the following order of precedence:
1. Coordinates.
 2. Bearings and lengths.
 3. Stationing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00 – CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes description and requirements of:
 - 1. Proposal Requests.
 - 2. Claims.
 - 3. Change Orders and Written Amendments.
 - 4. Field Order Procedures.

1.2 PROPOSAL REQUEST

- A. Owner may, in anticipation of ordering an addition, deletion, or revision to the Work, request Contractor to prepare a detailed proposal of cost and times to perform contemplated change.
- B. Proposal request will include reference number for tracking purposes and detailed description of and reason for proposed change, and such additional information as appropriate and as may be required for Contractor to accurately estimate cost and time impact on the Project.
- C. Proposal request is for information only; Contractor is neither authorized to execute proposed change nor to stop Work in progress as result of such request.
- D. Contractor's written proposal shall be transmitted to Engineer promptly, but not later than 14 days after Contractor's receipt of Owner's written request. Proposal shall remain firm for a maximum period of 45 days after receipt by Engineer.
- E. Owner's request for proposal or Contractor's failure to submit such proposal within the required time period will not justify a claim for an adjustment in Contract Price or Contract Times (or Milestones).

1.3 CLAIMS

- A. Include, at a minimum:
 - 1. Specific references including:
 - a. Drawing numbers.
 - b. Specification section and article/paragraph number.
 - c. Submittal type, Submittal number, date reviewed, Engineer's comment, as applicable, with appropriate attachments.
 - 2. Stipulated facts and pertinent documents, including photographs and statements.
 - 3. Interpretations relied upon.
 - 4. Description of:
 - a. Nature and extent of claim.
 - b. Who or what caused the situation.
 - c. Impact to the Work and work of others.
 - d. Discussion of claimant's justification for requesting a change to price or times or both.
 - 5. Estimated adjustment in price claimant believes it is entitled to with documentation and justification.
 - 6. Requested Change in Contract Times: Include at least;
 - a. Progress schedule documentation showing logic diagram for request.
 - b. Documentation that float times available for Work have been used.
 - c. Revised activity logic with durations including sub-network logic revisions, duration changes, and other interrelated schedule impacts, as appropriate.

7. Documentation as may be necessary as set forth below for Work Change Directive, and as Engineer may otherwise require.

1.4 WORK CHANGE DIRECTIVES

A. Procedures:

1. Upon completion of Work covered by the Work Change Directive or when final Contract Times and Contract Price is determined, Contractor shall submit documentation for inclusion in a Change Order via the **Info Exchange** project website.
2. Engineer will:
 - a. Initiate, including a description of the Work involved and any attachments.
 - b. Affix signature, demonstrating Engineer's recommendation.
 - c. Engineer will update Owner monthly on the status of the Work Change Directives.
3. Owner will:
 - a. Affix signature, demonstrating approval of the changes involved.
 - b. Return one electronic copy to Engineer. Engineer will retain one electronic copy, send one electronic copy to the Resident Project Representative or other field representative, and forward one electronic copy to Contractor.
4. Contractor's documentation shall include but not be limited to:
 - a. Appropriately detailed records of Work performed to enable determination of value of the Work.
 - b. Full information required to substantiate resulting change in Contract Times and Contract Price for Work. On request of Engineer, provide additional data necessary to support documentation.
 - c. Support data for Work performed on a unit price or Cost of the Work basis with additional information such as:
 - 1). Dates Work was performed, and by whom.
 - 2). Time records, wage rates paid, and equipment rental rates.
 - 3). Invoices and receipts for materials, equipment, and subcontracts, all similarly documented.
 - d. Claim for additional cost must be made within 10 days of the directive by the Engineer. Claims on work made after 10 days will not be considered.

- B. Effective Date of Work Change Directive: Date of signature by Owner, unless otherwise indicated thereon.

1.5 CHANGE ORDERS OR WRITTEN AMENDMENTS

A. Procedure:

1. Engineer will prepare the proposed Change Order or Written Amendment and transmit an electronic copy of such with Engineer's written recommendation (Change Order only) and request to Contractor for signature.
2. Contractor shall, upon receipt, either:
 - a. Promptly execute the document, retaining one electronic copy for its file, and return one electronic copy via the **Info Exchange** project website to Engineer for Owner's signature, or
 - b. Return unsigned one electronic copy with written justification via **Info Exchange** project website for not executing Change Order or Written Amendment.
3. Engineer will, upon receipt of Contractor-executed copy, promptly forward Engineer's written recommendation and partially executed copy for Owner's signature, or if Contractor fails to execute the Change Order or Written Amendment, Engineer will promptly so notify Owner and transmit Contractor's justification to Owner.
4. Upon receipt of Contractor-executed Change Order or Written Amendment, Owner will promptly either:
 - a. Execute Change Order or Written Amendment, retaining one copy for its file and returning one electronic copy to Engineer, or

- b. Return to Engineer unsigned copy with written justification for not executing Change Order or Written Amendment.
 - 5. Upon receipt of Owner-executed Change Order or Written Amendment, Engineer will transmit one electronic copy to Contractor, one copy to Resident Project Representative or other field representative, and retain one electronic copy, or if Owner fails to execute the Change Order or Written Amendment, Engineer will promptly so notify Contractor and transmit Owner's justification to Contractor.
 - 6. Upon receipt of Owner-executed Change Order, Contractor shall:
 - a. Perform Work covered by Change Order or Written Amendment.
 - b. Revise Schedule of Values to adjust Contract Price and submit with next Application for Payment.
 - c. Revise progress schedule to reflect changes in Contract Times, if any, and to adjust times for other items of Work affected by change.
 - d. Enter changes in Project record documents after completion of change related Work.
- B. In signing a Change Order or Written Amendment, Owner and Contractor acknowledge and agree that:
 - 1. Stipulated compensation (Contract Price or Contract Times, or both) set forth includes payment for:
 - a. The Cost of the Work covered by the Change Order or Written Amendment.
 - b. Contractor's fee for overhead and profit.
 - c. Interruption of progress schedule.
 - d. Delay and impact, including cumulative impact, on other Work under the Contract Documents, and
 - e. Extended overheads.
 - 2. Change Order or Written Amendment constitutes full mutual accord and satisfaction for the change to the Work.
 - 3. Unless otherwise stated in the Change Order or Written Amendment, all requirements of the original Contract Documents apply to the Work covered by the Change Order or Written Amendment.

1.6 FIELD ORDER PROCEDURES

- A. Engineer will issue Field Orders, with one electronic copy to Contractor.
- B. Effective date of the Field Order shall be the date of signature by Engineer, unless otherwise indicated thereon.
- C. Contractor shall acknowledge receipt by signing and returning one electronic copy to Engineer.
- D. Field Orders will be incorporated into subsequent Change Orders, as a no-cost change to the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00 – PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of:
 - 1. Submittals Related to Payment Procedures.
 - 2. Cash Allowances.
 - 3. Schedule of Values.
 - 4. Schedule of Estimated Progress Payments.
 - 5. Payment.
 - 6. Nonpayment for Rejected or Unused Products.
 - 7. Partial Payment for Stored Materials and Equipment.
 - 8. Partial Payment for Undelivered, Project Specific Manufactured or Fabrication Equipment.

- B. Related sections:
 - 1. Section 01 50 00 – Temporary Facilities and Controls.

1.2 SUBMITTALS

- A. Informational Submittals:
 - 1. Schedule of Values: Submit on Contractor's standard form.
 - 2. Schedule of Estimated Progress Payments:
 - a. Submit with initially acceptable Schedule of Values.
 - b. Submit adjustments thereto with Application for Payment.
 - 3. Application for Payment.
 - 4. Final Application for Payment.

1.3 CASH ALLOWANCES

- A. Consult with Engineer in selection of products or services. Obtain proposals from Suppliers and installers and offer recommendations.

- B. Cash allowances will be administered in accordance with the General Conditions and as specified herein.

- C. Contractor Agrees:
 - 1. The Lump Sum Work includes the allowances specified and includes all Work to perform such items covered by the Cash Allowance as approved by Owner and Engineer.
 - 2. The Allowances include the cost of material and equipment required by the allowances to be delivered to the Site and applicable taxes.
 - 3. Contractor's cost for unloading, handling, labor, installation cost, overhead, profit, and other expenses for the allowance have been included in the Lump Sum Work and not in the allowance.
 - 4. Accept payment equal to the amount of the actual invoices for services and products without markup.

- D. Expenditure of any portion of Cash Allowances shall only be done with authorization by Owner and Engineer. Cash Allowances are estimated amounts and final payment shall be based on actual costs as authorized by Change Order and the Contract Price shall be correspondingly adjusted. The Cash Allowances are specifically for the purpose of the following items:

- E. Independent Testing Cash Allowance: This allowance is to cover costs of specified Quality Assurance testing to be provided by an independent testing laboratory, agency, and special inspectors retained by the Owner. Contractor shall hire independent testing laboratory, agency, and special inspectors as acceptable to the Owner. Authorization will only be given for independent testing services performed as part of field quality assurance specified to be provided by the Owner. Any re-testing or other testing desired or specified by the Contractor shall be the responsibility of the Contractor.
- F. Submit, with application for payment, invoice showing date of purchase, from which the purchase was made, the date of delivery of the product or service, and the price, including delivery to the Site and applicable taxes.

1.4 SCHEDULE OF VALUES

- A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement.
- B. Upon request of Engineer, provide support documentation to support the accuracy of the Schedule of Values.
- C. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.
- D. Lump Sum Work:
 - 1. Reflect Schedule of Values format included in conformed Bid Form, specified allowances, alternates, and equipment selected by Owner, as applicable.
 - 2. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, facility startup, and contract closeout separately.
 - 3. Break down by Division 2 through 44 with appropriate subdivision of each Specification for each Project facility. The apparent "low bidder" is required to deliver a Bid breakdown by specification within 2 working days after Bid opening.
- E. An unbalanced or front-end loaded schedule will not be acceptable.
- F. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.
- G. Submit Schedule of Values in a spreadsheet format compatible with latest version of Excel.

1.5 SCHEDULE OF ESTIMATED PROGRESS PAYMENTS

- A. Show estimated payment requests throughout Contract Times aggregating initial Contract Price.
- B. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

1.6 APPLICATION FOR PAYMENT

- A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.
- B. Use detailed Application for Payment Form suitable to Engineer.
- C. Provide separate form for each schedule as applicable.

- D. Include accepted Schedule of Values for each schedule or portion of Work, the unit price breakdown for the Work to be paid on unit price basis, a listing of Owner-selected equipment, if applicable, and allowances, as appropriate.
- E. Preparation:
 - 1. Round values to nearest dollar.
 - 2. List each Change Order executed prior to date of submission as separate line item. The totals will equal those shown on the Transmittal Summary Form for each schedule as applicable.
 - 3. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Engineer.
 - 4. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents as required by SC-7.11.B. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

1.7 PAYMENT

- A. General:
 - 1. Progress payments will be made monthly.
 - 2. The date for Contractor's submission of monthly Application for Payment shall be established at the Preconstruction Conference.
 - 3. Progress payment is contingent upon applications and Contractor progress, which is subject to withholdings by Owner.
- B. Payment for all the Work shown or specified in Contract Documents is included in the Contract Price. No measurement or payment will be made for individual items.
- C. Payment for Lump Sum Work covers all Work specified or shown in the Contract Documents.

1.8 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

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

1.9 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

- A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and preliminary operation and maintenance manuals are accepted by Engineer. Thereafter, partial payment for materials and equipment delivered and stored, but not yet incorporated in work, shall not exceed 90% of the equipment or material value.
- B. Final Payment: Will be made only for products incorporated in Work and following approval of final operations and maintenance manuals; remaining products, for which partial payments have

been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

1.10 PARTIAL PAYMENT FOR UNDELIVERED, PROJECT-SPECIFIC MANUFACTURED OR FABRICATED EQUIPMENT

A. Notwithstanding above provisions, partial payments for undelivered (not yet delivered to Site or not stored in the vicinity of Site) products specifically manufactured for this Project, excluding off the shelf or catalog items, will be made for products listed below when all following conditions exist:

1. Partial payment request is supported by written acknowledgment from Suppliers that invoice requirements have been met.
2. Equipment is adequately insured, maintained, stored, and protected by appropriate security measures.
3. Each equipment item is clearly marked and segregated from other items to permit inventory and accountability.
4. Authorization has been provided for access to storage Site for Engineer and Owner.
5. Equipment meets applicable Specifications of these Contract Documents.

B. Applicable Items:

Specification Section	Specific Product
44 42 56.46.1	Vertical Dry-Pit Centrifugal Pumps

C. Payment shall not exceed 15% of the equipment value, not including shipping and handling charges for undelivered, Project-specific manufactured equipment and will only be made following Shop Drawing approval.

D. Failure of Contractor to continue compliance with above requirements shall give cause for Owner to withhold payments made for such equipment from future partial payments.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of:
 - 1. Submittals Related to Project Management and Coordination.
 - 2. Utility Notification and Coordination.
 - 3. Work Sequencing /Constraints.
 - 4. Facility Operations.
 - 5. Adjacent Facilities and Properties.
 - 6. Owner's Occupancy.
 - 7. Partial Utilization by the Owner.
 - 8. Physical Conditions.
 - 9. Construction Photographs.
 - 10. Audio-Video Recordings.
 - 11. Cutting, Fitting and Patching.

- B. Related sections:
 - 1. Section 01 32 00 – Construction Progress Documentation.

1.2 SUBMITTALS

- A. Informational:
 - 1. Statement of Qualification (SOQ) for land surveyor or civil engineer.
 - 2. Photographs and other records of examination.
 - 3. Video Recordings: Submit one copy, including updated copy of project video log, within 5 days of being taken.

1.3 UTILITY NOTIFICATION AND COORDINATION

- A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.

- B. Before excavation contact, Texas One Call System, Inc., ph 811 to arrange for field location of known utilities.

1.4 WORK SEQUENCING/CONSTRAINTS

- A. Include the following work sequences in the Progress Schedule required under Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.

- B. This Section identifies several construction constraints that must be reflected in the Contractor project coordination. An overall outline is presented in this Section for the Construction coordination, demolition, and seasonal/process constraints that shall be considered during construction. The sequence of Work for this Project must reflect the constraints identified herein.

- C. Definitions:
 - 1. Dry weather periods shall, in general, be from June 15 through October 1. Actual dry weather periods shall be as determined by the Owner based on weather, flows entering plant, and plant operation requirements.
 - 2. Wet weather periods shall be any time period which is not within the defined dry weather periods.

3. Low flow period shall be from 2:00 a.m. to 6:00 a.m.
4. Minor Shutdown: Any shutdown requiring less than 8 hours.
5. Major Shutdown: Any shutdown other than a minor shutdown.

D. Shutdown of Pump Station Operations:

1. Provide 14 days advance notice to Engineer and Owner of need for a minor shutdown.
2. Provide 30 days advance notice to Engineer and Owner of need for a major shutdown.
3. Contractor shall schedule a shutdown coordination meeting with Owner and Engineer one week prior to each shutdown.
4. Do not proceed with work affecting a facility's operation without obtaining Owner and Engineer advance approval of the need for, and duration of, such work. The Owner will endeavor to grant Contractor requests where possible. However, because Owner's primary responsibility is to treat wastewater, the requested timing may not be possible.
5. Any and all plant shutdowns shall require a shutdown plan, including detailed schedule, backup tools and equipment, personnel involved, contingency plan, and any procedures involved in restarting the process or facility. Owner's approval of the Shutdown Plan is required prior to any shutdowns.
6. Shutdowns will be allowed but shall only be allowed in dry weather periods and with at least one flow equalization basin in operation. Shutdowns may be limited to low flow periods.
7. No minor or major shutdowns allowed within 7 days of a previous shutdown.

1.5 FACILITY OPERATIONS

- A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified, and to minimize the number of shutdowns of the plant and existing unit processes.
- B. Perform Work continuously during critical connections and changeovers, as required, to prevent interruption of Owner's operations.
- C. Conduct Work outside regular working hours on prior written consent of Owner to meet Project schedule and avoid undesirable conditions.
- D. Be responsible for planning, designing, and providing various temporary services, utilities, connections, temporary piping, bypass facilities and temporary connections, and similar items to maintain continuous operations of Owner's facility. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.
- E. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.
- F. Any tanks or pipelines requiring drainage prior to construction will be drained by the Owner's staff to the maximum extent possible utilizing existing piping and drains where they exist. Contractor shall provide temporary pumping and effort to complete drainage of tank or pipeline as required. Provide minimum 7 days' notice to Engineer and Owner of need to drain a facility, unless otherwise specified.
- G. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage in the written request. Provide temporary provisions for continuous power supply to critical existing facility components, is requested by Owner.

- H. Coordinate proposed work with Engineer and Owner before implementing unit shutdowns. Under no circumstances shall Work end if such actions may inadvertently cause a cessation of any facility operation. In such cases, remain onsite until necessary repairs are complete and facility is brought back online.
- I. Relocation of Existing Facilities:
 - 1. During construction, it is expected that minor relocations of Work will be necessary.
 - 2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment and structures, electrical conduit wiring, electrical duct bank, and other necessary items.
 - 3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
 - 4. Perform relocations to minimize downtime of existing facilities.
 - 5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.6 ADJACENT FACILITIES AND PROPERTIES

- A. Examination:
 - 1. After Effective Date of the Agreement and before Work at Site is started Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
 - 2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.
- B. Documentation:
 - 1. Record and submit documentation of observations made on examination inspections for signature of Engineer and Contractor and in accordance with paragraph Construction Photographs and Audio-Video Recordings.
 - 2. Upon receipt, Engineer will review, sign, and return one record copy of documentation to Contractor to be kept on file in field office. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.7 OWNER'S OCCUPANCY

- A. Owner will occupy the premises during the period of construction for the conduct of its normal operations. Cooperate with Owner in all construction operations to minimize conflict and to facilitate Owner usage.

1.8 PARTIAL UTILIZATION BY THE OWNER

- A. Schedule operations for completion of portions of the Work, as designated under Work Sequence/Constraints, herein, for Owner's occupancy or separate operation prior to Substantial Completion of the entire Work.
- B. Unless agreed in writing prior to Owner's use, the following conditions shall apply:
 - 1. Contractor's Responsibilities:
 - a. Allow access for Owner's personnel.
 - b. Allow operation of ventilation and electrical systems.
 - c. All other responsibilities as specified in the General Conditions.
 - 2. Owner's Responsibilities:

- a. Operate ventilating systems and pay cost of same.
 - b. Assume responsibility of power requirements.
 - c. Assume responsibility for security and fire protection in utilized areas, but not extending to Contractor's materials and equipment in utilized areas.
 - d. Assume responsibility for property insurance of utilized areas.
3. Other Conditions of Owner's Use: The correction period for the occupied or separately operated portion of Work shall commence at the date of Substantial Completion for that separate part.

1.9 PHYSICAL CONDITIONS

- A. Exercise reasonable care to verify locations of existing subsurface facilities and utilities.
- B. Areas immediate and adjacent to planned excavations shall be thoroughly checked by means of visual examination and with electronic metal and pipe detection equipment for indications of underground utilities and facilities.
- C. Make exploratory excavation where existing underground facilities or utilities may potentially conflict with proposed excavations and facilities or where there is reasonable cause to verify the presence or absence of, or to obtain physical information regarding underground facilities or utilities. Conduct exploratory excavations as acceptable to and in the presence of Engineer prior to proceeding with major excavation in the area and sufficiently in advance of construction to avoid possible delays to Contractor's Work. Promptly take measurements, photographs, and obtain survey data.

1.10 CONSTRUCTION PHOTOGRAPHS

- A. Photographically document all phases of the project including preconstruction, construction progress, and post-construction.
- B. Engineer shall have the right to select the subject matter and vantage point from which photographs are to be taken.
- C. Photograph Format: Reference Section 01 34 00 for photograph requirements.
- D. Preconstruction and Post-Construction:
 - 1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take photographs of all areas of the Construction Site and property adjacent to perimeter of Construction Site.
 - 2. Particular emphasis shall be directed to structures both inside and outside the Site.
- E. Construction Progress Photos:
 - 1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
 - 2. Take photos as frequent as required to document all major aspects of construction. Coordinate with Engineer.

1.11 AUDIO-VIDEO RECORDINGS

- A. Prior to beginning Work on Construction Site or of a particular area of the Work, and again within 10 days following date of Substantial Completion, video-graph Construction Site and property adjacent to Construction Site.
- B. In the case of preconstruction recording, no Work shall begin in the area prior to Engineer's review and approval of content and quality of video for that area.

- C. Particular emphasis shall be directed to physical condition of existing vegetation, structures, and pavements within Construction Site and areas adjacent to and within the right-of-way or easement, and on Contractor storage and staging areas.
- D. Engineer shall have right to select subject matter and vantage point from which videos are to be taken.
- E. Video Format and Quality:
 - 1. Video:
 - a. Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections. Make sure sound is clear and free of distortion.
 - b. Electronically, and accurately display the month, day, year, and time of day of the recording.
 - 2. Audio:
 - a. Audio documentation shall be done clearly, precisely, and at a moderate pace.
 - b. Indicate date, project name, and a brief description of the location of taping, including:
 - 1). Facility name.
 - 2). Street names or easements.
 - 3). Addresses of private property.
 - 4). Direction of coverage, including engineering stationing, if applicable.
 - 3. Documentation:
 - a. Electronic File Name:
 - 1). Date of coverage in year-month-day-time format followed by a short description of video coverage.
 - 4. Transmission of Files:
 - a. Transmit electronic files via Info Exchange, or;
 - b. Place electronic files on flash drive with enough storage size to hold all videos being transmitted and deliver to Engineer via acceptable method to Engineer.
 - 5. Project Video Log: Maintain an ongoing log that incorporates above noted information for videos on Project.
 - 6. Reference specification Section 01 34 00 for additional requirements.

1.12 REFERENCE POINTS AND SURVEYS

- A. Location and elevation of benchmarks are shown on Drawings.
- B. Dimensions for lines and elevations for grades of structures, appurtenances, and utilities are indicated on the Drawings, together with the other pertinent information required for laying out Work. If conditions vary from those indicated, immediately notify Engineer.
- C. Any existing survey points or other control markers destroyed without proper authorization will be replaced by Owner of the survey points or control markers at the Contractor's expense.
- D. Contractor's Responsibilities:
 - 1. Provide additional survey and layout required to layout the Work.
 - 2. Locate and protect reference points prior to starting site preparation.
 - 3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
 - 4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
 - 5. Retain professional land surveyor or civil engineer registered in state of Project who shall perform or supervise engineering surveying necessary for additional construction staking and layout.
 - 6. Maintain complete accurate log of survey Work as it progresses as a Record Document.

7. On request of Engineer, submit documentation.
8. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
 - a. Establish control points, lines, and easement boundaries.
 - b. Check layout, survey, and measurement Work performed by others.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CUTTING, FITTING, AND PATCHING

- A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.
- B. Obtain prior written authorization of Engineer and Owner before commencing work to cut or otherwise alter:
 1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
 2. Weather- or moisture-resistant elements.
 3. Efficiency, maintenance, or safety of element.
 4. Work of others.
- C. Refinish surfaces to provide an even finish.
 1. Refinish continuous surfaces to nearest intersection.
 2. Refinish entire assemblies.
 3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and Work is evident in finished surfaces.
- D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown.
- E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.
- F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.
- G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

SECTION 01 31 19 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
 - 1. General Requirements.
 - 2. Qualifications of Meeting Participants.
 - 3. Preconstruction Conference.
 - 4. Progress Meetings.
 - 5. Pre-Installation Meetings.
 - 6. Post Construction Meeting.

1.2 GENERAL REQUIREMENTS

- A. Contractor will schedule physical arrangements for meetings throughout progress of Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.

1.3 QUALIFICATIONS OF MEETING PARTICIPANTS

- A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents.

1.4 PRECONSTRUCTION CONFERENCE

- A. Contractor shall be prepared to discuss the following subjects, as a minimum:
 - 1. Required schedules.
 - 2. Status of Bonds and insurance.
 - 3. Sequencing of critical path work items.
 - 4. Progress payment procedures.
 - 5. Project changes and clarification procedures.
 - 6. Use of site, access, office and storage areas, security and temporary facilities.
 - 7. Major product delivery and priorities.
 - 8. Contractor's safety plan and representative.
- B. Attendees will include:
 - 1. Owner's representatives.
 - 2. Contractor's office representative.
 - 3. Contractor's resident superintendent.
 - 4. Contractor's quality control representative.
 - 5. Subcontractor's representatives whom Contractor may desire or Engineer may request to attend.
 - 6. Engineer's representatives.
 - 7. Others as appropriate.
- C. Upon issuance of Notice to Proceed, or earlier when mutually agreeable, Engineer will arrange a preconstruction conference in a convenient place for most persons invited, in accordance with the General Conditions.

- D. Attending Preconstruction Conference: Contractor's superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to agenda.
- E. Contractor will preside at conference.
- F. Purpose of conference: To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, cost breakdown of major lump sum items, processing of submittals and applications for payment, and other subjects pertinent to execution of the Work.
- G. Agenda will include:
 - 1. Adequacy of distribution of Contract Documents.
 - 2. Distribution and discussion of list of major subcontractors and suppliers.
 - 3. Proposed progress schedules and critical construction sequencing.
 - 4. Major equipment deliveries and priorities.
 - 5. Project coordination.
 - 6. Designation of responsible personnel.
 - 7. Procedures and processing of:
 - a. Field decisions.
 - b. Proposal requests.
 - c. Submittals.
 - d. Change Orders.
 - e. Applications for Payment.
 - f. Record Documents.
 - 8. Use of premises:
 - a. Office, construction, and storage areas.
 - b. Owner's requirements.
 - 9. Construction facilities, controls, and construction aids.
 - 10. Shoring requirements and submittal of Contractor's geotechnical report.
 - 11. Temporary utilities.
 - 12. Safety and first aid procedures.
 - 13. Security procedures.
 - 14. Housekeeping procedures.
- H. Engineer will record minutes of meeting and distribute copies of minutes within 5 days of meeting to participants and interested parties.

1.5 PROGRESS MEETINGS

- A. Contractor will schedule regular progress meetings at site, conducted weekly, to review the Work progress, progress schedule, Shop Drawing and Sample submissions schedule, Application for Payment, contract modifications, and other matters needing discussion and resolution. At one meeting each month the Contractor's updated narrative progress report and overall schedule will be a topic of discussion.
- B. Attendees will include:
 - 1. Owner's representative(s), as appropriate.
 - 2. Contractor, Subcontractors, and Suppliers, as appropriate.
 - 3. Engineer's representative(s).
 - 4. Others as appropriate.
- C. Contractor shall:
 - 1. Conduct progress meetings at least once every week in Contractor's field office, Engineer's field office, or other mutually agreed upon place.

2. Distribute to each anticipated participant written notice and agenda of each meeting at least 2 days before meeting.
 3. Require attendance of Contractor's superintendent and subcontractors who are or are proximate to be actively involved in the Work, or who are necessary to agenda.
 4. Invite Owner, Engineer, utility companies when the Work affects their interests, and others necessary to agenda.
 5. Complete and bring Application for Payment and Progress Schedule to progress meeting.
 6. Prepare and distribute agenda.
- D. Contractor will preside at meetings.
- E. Purpose of progress meetings:
1. To expedite work of subcontractors or other organizations that are not meeting scheduled progress, resolve conflicts, and coordinate and expedite execution of the Work.
 2. Review progress of the Work, Progress Schedule, narrative report, Application for Payment, record documents, and additional items of current interest that are pertinent to execution of the Work.
 3. Verify:
 - a. Actual start and finish dates of completed activities since last progress meeting.
 - b. Durations and progress of activities not completed.
 - c. Reason, time, and cost data for Change Order Work that will be incorporated into Progress Schedule and application for payment.
 - d. Percentage completion of items on Application for Payment.
 - e. Reasons for required revisions to Progress Schedule and their effect on Contract Time and Contract Price.
- F. Discuss potential problems that may impede scheduled progress and corrective measures.
- G. Contractor will record minutes of meeting and distribute copies of minutes within 7 days of meeting to participants and interested parties.
- 1.6 QUALITY CONTROL AND COORDINATION MEETINGS
- A. Scheduled by Engineer on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of Work and work of other contractors.
- B. Attendees will include:
1. Contractor.
 2. Contractor's designated quality control representative.
 3. Subcontractors and Suppliers, as necessary.
 4. Engineer's representatives.
- 1.7 FACILITY STARTUP MEETINGS
- A. Schedule and attend a minimum of 2 facility startup meetings. The first of such meetings shall be held prior to submitting the Facility Startup Plan, as specified in Section 01 79 00, DEMONSTRATION AND TRAINING, and shall include preliminary discussions regarding such plan.
- B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.
- C. Attendees will include:
1. Contractor.

2. Contractor's designated quality control representative.
3. Subcontractors and equipment Manufacturer's representatives whom Contractor deems to be directly involved in facility startup.
4. Engineer's representatives.
5. Owner's operations personnel.
6. Others as required by Contract Documents or as deemed necessary by Contractor.

1.8 POST CONSTRUCTION MEETING

- A. Meet with and inspect the Work at 11 months after date of Substantial Completion with Owner and Engineer.
- B. Arrange meeting at least 7 days before meeting.
- C. Meet in Owner's office or other mutually agreed upon place.
- D. Inspect the Work and draft list of items to be completed or corrected.
- E. Review service and maintenance contracts and take appropriate corrective action when necessary.
- F. Complete or correct defective work and extend correction period accordingly.
- G. Require attendance of Superintendent, appropriate manufacturers and installers of major units of constructions, and affected subcontractors.

1.9 OTHER MEETINGS

- A. In accordance with Contract Documents and as may be required by Owner and Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00 – CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Preparation, submittal, and maintenance of computerized progress schedule and reports, contract time adjustments, and payment requests, including the following:
 - 1. Preliminary Schedule.
 - 2. Detailed Progress Schedule.
 - 3. Schedule Updates.
 - 4. Schedule Revisions.

1.2 SUBMITTALS

- A. Informational Submittals:
 - 1. Preliminary Progress Schedule: Submit at least 7 days prior to preconstruction conference.
 - 2. Detailed Progress Schedule:
 - a. Submit initial Detailed Progress Schedule within 45 days after Effective Date of the Agreement.
 - b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
 - 3. Submit with Each Progress Schedule Submission:
 - a. Contractor's certification that Progress Schedule submission is actual schedule being utilized for execution of the Work.
 - b. Electronic files compatible with latest version of the Contractor's selected software, or compatible with Microsoft Project, or compatible with Microsoft Excel.
 - c. Progress Schedule: Legible copies.
 - d. Narrative Progress Report: Same number of copies as specified for Progress Schedule.
 - 4. Prior to final payment, submit a final Updated Progress Schedule.

1.3 PRELIMINARY PROGRESS SCHEDULE

- A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 90 days, and a summary of balance of Project through Final Completion.
- B. Show activities including, but not limited to the following:
 - 1. Notice to Proceed.
 - 2. Permits.
 - 3. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, SUBMITTAL PROCEDURES.
 - 4. Early procurement activities for long lead equipment and materials.
 - 5. Initial Site work.
 - 6. Earthwork.
 - 7. Specified Work sequences and construction constraints.
 - 8. Contract Milestone and Completion Dates.
 - 9. Owner-furnished products delivery dates or ranges of dates.
 - 10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
 - 11. System startup summary.
 - 12. Project close-out summary.
 - 13. Demobilization summary.

- C. Update Preliminary Progress Schedule monthly; as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.
- D. Format: In accordance with Article Progress Schedule Critical Path Network.
- E. Update monthly to reflect actual progress and occurrences to date, including weather delays.

1.4 DETAILED PROGRESS SCHEDULE

- A. General: Comprehensive computer-generated schedule using a "Critical Path Method" (CPM), generally as outlined in Associated General Contractors of America (AGC) 580, "Construction Project Planning and Scheduling Guidelines." If a conflict occurs between the AGC publication and this Specification, this Specification shall govern. Adjust or confirm schedules in accordance with General Conditions on a monthly basis and submit to Engineer.
- B. Contents:
 1. Schedule shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
 2. Identify Work calendar basis using days as a unit of measure.
 3. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work.
 4. Identify the Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
 5. Reflect sequences of the Work, restraints, delivery windows, review times, Contract Times and Project Milestones set forth in the Agreement and Section 01 31 00, PROJECT MANAGEMENT AND COORDINATION.
 6. Include as applicable, at a minimum:
 - a. Obtaining permits, submittals for early product procurement, and long lead time items.
 - b. Mobilization and other preliminary activities.
 - c. Initial Site work.
 - d. Specified Work sequences, constraints, and Milestones, including
 - e. Substantial Completion date(s) Subcontract Work.
 - f. Major equipment design, fabrication, factory testing, and delivery dates.
 - g. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, SUMMARY OF WORK.
 - h. Site work.
 - i. Concrete Work.
 - j. Structural steel Work.
 - k. Architectural features Work.
 - l. Conveying systems Work.
 - m. Equipment Work.
 - n. Mechanical Work.
 - o. Electrical Work.
 - p. Instrumentation and control Work.
 - q. Interfaces with Owner-furnished equipment.
 - r. Other important Work for each major facility.
 - s. Equipment and system startup and test activities.
 - t. Project closeout and cleanup.
 - u. Demobilization.
 7. No activity duration exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 day and not more than 14 days, unless otherwise approved.
 8. Activity duration for Submittal review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from Engineer.

9. If Contractor provides an accepted schedule with an early completion date, Owner reserves the right to reduce Contract Times to match the early completion date by issuing a deductive Change Order at no change in Contract Price.

C. Network Graphical Display:

1. Plot or print on paper not greater than 30" x 42" or smaller than 22" x 34", unless otherwise approved.
2. Title Block: Show name of Project, Owner, date submitted, revision or update number, and the name of the scheduler. Updated schedules shall indicate data date.
3. Identify horizontally across top of schedule the time frame by year, month, and day.
4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
5. Indicate the critical path.
6. Show, at a minimum, the controlling relationships between activities.
7. Plot activities on a time-scaled basis, with the length of each activity proportional to the current estimate of the duration.
8. Plot activities on an early start basis unless otherwise requested by Engineer.
9. Provide a legend to describe standard and special symbols used.

D. Schedule Report:

1. 8-1/2" x 11" white paper, unless otherwise approved.
2. List information for each activity in tabular format, including, at a minimum:
 - a. Activity Identification Number.
 - b. Activity Description.
 - c. Original Duration.
 - d. Remaining Duration.
 - e. Early Start Date (Actual start on Updated Progress Schedules).
 - f. Early Finish Date (Actual finish on Updated Progress Schedules).
 - g. Late Start Date.
 - h. Late Finish Date.
 - i. Total Float.
3. Sort reports, in ascending order, as listed below:
 - a. Activity number sequence with predecessor and successor activity.

E. Cost -Loading:

1. Note the estimated cost to perform each Work activity, with the exception of Submittals or Submittal reviews, in the network in a tabular listing.
2. The sum of all activity costs shall equal the Contract Price. An unbalanced or front-end-loaded schedule will not be acceptable.
3. The accepted cost-loaded Progress Schedule shall constitute the Schedule of Values specified in Section 01 29 00, PAYMENT PROCEDURES.

1.5 PROGRESS OF THE WORK

A. Updated Progress Schedule shall reflect:

1. Progress of Work to within 5 working days prior to submission.
2. Approved changes in Work scope and activities modified since submission.
3. Delays in Submittals or re-submittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.
7. Report of changed logic.

B. Produce detailed sub schedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

- C. If Contractor fails to complete activity by its latest scheduled completion date and this Failure is anticipated to extend Contract Times (or Milestones), Contractor shall, within 7 days of such failure, submit a written statement as to how Contractor intends to correct nonperformance and return to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.
- D. Owner may order Contractor to increase plant, equipment, labor force or working hours if Contractor fails to:
 - 1. Complete an activity by its completion date.
 - 2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

1.6 SCHEDULE ACCEPTANCE

- A. Engineer's acceptance will demonstrate agreement that:
 - 1. Proposed schedule is accepted with respect to:
 - a. Contract Times, including Final Completion are within the specified times.
 - b. Specified Work sequences and constraints are shown as specified.
 - c. Access restrictions are accurately reflected.
 - d. Startup and testing times are as specified.
 - e. Submittal review times are as specified.
 - f. Startup testing duration is as specified and timing is acceptable.
 - 2. In all other respects, Engineer's acceptance of Contractor's schedule indicates that in the Engineer's judgment, the schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.
- B. Unacceptable Preliminary Progress Schedule:
 - 1. Make requested corrections; resubmit within 10 days.
 - 2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, during which time Contractor shall update schedule on a monthly basis to reflect actual progress and occurrences to date.
- C. Unacceptable Detailed Progress Schedule:
 - 1. Make requested corrections; resubmit within 10 days.
 - 2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.
- D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer's acceptance of Baseline Progress Schedule shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

1.7 ADJUSTMENT OF CONTRACT TIMES

- A. Reference the General Conditions and Section 01 26 00, CONTRACT MODIFICATION PROCEDURES.

- B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.
- C. Float:
 - 1. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.
 - 2. Use of float suppression techniques, such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited. Use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of Owner and Contractor.
 - 3. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs, which:
 - a. Impacts Project's critical path,
 - b. Consumes all available float or contingency time, and
 - c. Extends Work beyond contract completion date.
- D. Claims Based on Contract Times:
 - 1. Where Engineer has not yet rendered formal decision on Contractor's Claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, Contractor shall reflect an interim adjustment in the Progress Schedule as acceptable to Engineer.
 - 2. It is understood and agreed that such interim acceptance will not be binding on either Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.
 - 3. Contractor shall revise Progress Schedule prepared thereafter in accordance with Engineer's formal decision.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 90 – SAFETY PLAN

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Development and maintenance of a Construction Safety Plan.

1.2 REFERENCES

- A. OSHA.

1.3 CONSTRUCTION SAFETY PLAN

- A. Detail the Methods and Procedures to comply with Federal, and Local Health and Safety Laws, Rules and Requirements for the duration of the Contract Times. Include the following:
 1. Identification of the Certified or Licensed Safety Consultant, who will prepare, initiate, maintain and supervise safety programs, and procedures.
 2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.
 3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, and safety equipment used in multi-level structures.
 4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
 5. Procedures for reporting safety or health hazards.
 6. Procedures to follow to correct a recognized safety and health hazard.
 7. Procedures for investigation of accidents, injuries, illnesses and unusual events that have occurred at the construction site.
 8. Periodic and scheduled inspections of general work areas and specific work stations.
 9. Training for employees and workers at the jobsite.
 10. Methods of communication of safe working conditions, work practices and required personal protection equipment.
- B. Assume responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
 1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
 2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.
- C. Transmit to OWNER and ENGINEER copies of reports and other documents related to accidents or injuries encountered during construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of:
 - 1. Submittals Related to Project Submittals as related to:
 - a. Action Submittals
 - b. Informational Submittals
- B. Related sections:
 - 1. 01 29 00 – Payment Procedures.
 - 2. 01 31 00 – Project Management and Coordination.
 - 3. 01 32 00 – Construction Progress Documentation.
 - 4. 01 77 00 – Closeout Procedures.
 - 5. 01 78 23 – Operation and Maintenance Data.
 - 6. 01 79 00 – Demonstration and Training.

1.2 DEFINITIONS

- A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval.
- B. Informational Submittal: Information submitted by Contractor that does not require Engineer's approval.

1.3 PROCEDURES

- A. Direct Submittals to Engineer.
- B. Contractor will submit all submittals electronically using the **Info Exchange** project website to facilitate the transfer of submittals and related files.
- C. Transmittal of Submittal:
 - 1. Contractor shall:
 - a. Review each submittal and check for compliance with Contract Documents.
 - b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
 - 1). Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval and statement certifying that submittal has been reviewed, checked, and approved for compliance with Contract Documents.
 - 2). Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
 - 2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form. A blank Transmittal of Contractor's Submittal form may be provided by Engineer.
 - 3. Identify Each Submittal with the Following:
 - a. Numbering and Tracking System:
 - 1) Submittal No. 8300-001, etc.
 - b. Sequentially number each submittal.
 - c. Resubmission of submittal shall have original number with sequential alphabetic suffix (ie: Resubmittal No. 8300-001-A).
 - 1). Specification section and paragraph to which submittal applies.
 - 2). Project title and Engineer's project number.

- 3). Date of transmittal.
 - 4). Names of Contractor, subcontractor or Supplier and Manufacturer as appropriate.
4. Identify and describe each deviation or variation from Contract Documents.
- D. Format:
1. Do not base Shop Drawings on reproductions of Contract Documents.
 2. Package submittal information by individual Specification section. Do not combine different Specification sections together in submittal package, unless otherwise directed in Specification.
 3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
 4. Index with labeled tab dividers in orderly manner.
- E. Timeliness: Schedule and submit in accordance Schedule of Submittals, and requirements of individual Specification sections.
- F. Processing Time:
1. Time for review shall commence on Engineer's receipt of submittal.
 2. Engineer will act upon Contractor's submittal and transmit response to Contractor not later than 30 days after receipt, unless otherwise specified.
 3. Re-submittals will be subject to same review time.
 4. No adjustment of Contract Times or Price will be allowed due to delays in progress of Work caused by rejection and subsequent re-submittals.
- G. Re-submittals: Clearly identify each correction or change made.
- H. Incomplete Submittals:
1. Engineer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
 2. When any of the following are missing, submittal will be deemed incomplete:
 - a. Contractor's review stamp completed and signed.
 - b. Transmittal of Contractor's Submittal completed and signed.
 3. Submittals not required by Contract Documents will not be reviewed and will be returned stamped "Not Reviewed."
 4. Engineer will keep one electronic copy and return one electronic copy to Contractor.
- I. Coordination with Project:
1. It is the Contractor's responsibility to coordinate all equipment furnished with project elevations and dimensions. Approval of the submittal does not relieve the Contractor of the responsibility.
 2. Contractor shall be responsible for coordinating all project aspects and project changes with all submittals.
- 1.4 ACTION SUBMITTALS
- A. Prepare and submit Action Submittals required by individual Specification sections.
- B. Contractor will submit all submittals electronically using the **Info Exchange** project website to facilitate the transfer of submittals and related files.
- C. Shop Drawings:
1. Identify and Indicate:

- a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
 - b. Equipment and Component Title: Identical to title shown on Drawings.
 - c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
 - d. Project-specific information drawn accurately to scale.
- 2. Manufacturer's standard schematic drawings and diagrams as follows:
 - a. Modify to delete information that is not applicable to the Work.
 - b. Supplement standard information to provide information specifically applicable to the Work.
 - 3. Product Data: Provide as specified in individual Specifications.
 - 4. Foreign Manufacturers: When proposed, include following additional information:
 - a. Names and addresses of at least two companies that maintain technical service representatives close to Project.
 - b. Complete list of spare parts and accessories for each piece of equipment.
- D. Samples:
- 1. Copies: One, unless otherwise specified in individual Specifications.
 - 2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
 - a. Manufacturer name.
 - b. Model number.
 - c. Material.
 - d. Sample source.
 - 3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
 - 4. Full-size Samples:
 - a. Size as indicated in individual Specification section.
 - b. Prepared from same materials to be used for the Work.
 - c. Cured and finished in manner specified.
 - d. Physically identical with product proposed for use.
- E. Action Submittal Dispositions: Engineer will review, mark, and stamp as appropriate, and distribute marked-up copies as noted:
- 1. Furnish as Submitted:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal.
 - b. Distribution
 - 1). One electronic copy furnished to Resident Project Representative.
 - 2). One electronic copy retained in Engineer's file.
 - 3). One electronic copy returned to Contractor appropriately annotated.
 - 2. Furnish as Corrected or Noted:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
 - b. Distribution:
 - 1). One electronic copy furnished to Resident Project Representative.
 - 2). One electronic copy retained in Engineer's file.
 - 3). One electronic copy to Contractor appropriately annotated.
 - 3. Revise and Resubmit:
 - a. Make corrections or obtain missing portions, and resubmit.
 - b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
 - c. Distribution:
 - 1). One electronic copy furnished to Resident Project Representative.
 - 2). One electronic copy retained in Engineer's file.
 - 3). One electronic copy to Contractor appropriately annotated.
 - 4. Rejected:

- a. Contractor may not incorporate product(s) or implement Work covered by submittal.
- b. Distribution:
 - 1). One electronic copy furnished to Resident Project Representative.
 - 2). One electronic copy retained in Engineer's file.
 - 3). One electronic copy returned to Contractor appropriately annotated.

1.5 INFORMATIONAL SUBMITTALS

- A. General:
 - 1. Contractor will submit all submittals electronically using the **Info Exchange** project website to facilitate the transfer of submittals and related files.
 - 2. Refer to individual Specification sections for specific submittal requirements.
 - 3. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward electronic copies to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will retain one electronic copy and return one electronic copy with review comments to Contractor, and require that submittal be corrected and resubmitted.
 - 4. Application for Payment: In accordance with Section 01 29 00, PAYMENT PROCEDURES.
 - 5. Certificates:
 - a. General:
 - 1). Provide notarized statement that includes signature of entity responsible for preparing certification.
 - 2). Signed by officer or other individual authorized to sign documents on behalf of that entity.
 - 6. Welding: In accordance with individual Specification sections.
 - 7. Installer: Prepare written statements on Manufacturer's letterhead certifying that installer complies with requirements as specified in individual Specification sections.
 - 8. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
 - 9. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual Specification sections.
 - 10. Manufacturer's Certificate of Compliance: In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.
 - 11. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.
- B. Construction Photographs and Video: In accordance with Section 01 31 00, PROJECT MANAGEMENT AND COORDINATION, and as may otherwise be required in Contract Documents.
- C. Contract Closeout Submittals: In accordance with Section 01 77 00, CLOSEOUT PROCEDURES.
- D. Contractor-Design Data:
 - 1. Written and graphic information.
 - 2. List of assumptions.
 - 3. List of performance and design criteria.
 - 4. Summary of loads or load diagram, if applicable.
 - 5. Calculations.
 - 6. List of applicable codes and regulations.
 - 7. Name and version of software.
 - 8. Information requested in individual Specification section.

- E. Manufacturer's Instructions: Written or published information that documents Manufacturer's recommendations, guidelines, and procedures in accordance with individual Specification sections.
- F. Operation and Maintenance Data: As required in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
- G. Schedules:
 - 1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.
 - a. Show for Each, at a Minimum, the Following:
 - 1). Specification section number.
 - 2). Identification by numbering and tracking system as specified under Paragraph "Transmittal of Submittal".
 - 3). Estimated date of submission to Engineer, including reviewing and processing time.
 - b. On a monthly basis, submit updated schedule to Engineer if changes have occurred or re-submittals are required.
 - 2. Schedule of Values: In accordance with Section 01 29 00, PAYMENT PROCEDURES.
 - 3. Schedule of Estimated Progress Payments: In accordance with Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.
 - 4. Progress Schedules: In accordance with Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.
- H. Special Guarantee: Supplier's written guarantee as required in individual Specification sections.
- I. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.
- J. Submittals Required by Laws, Regulations, and Governing Agencies:
 - 1. Submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable Federal, State, or local governing agency or their representative.
 - 2. Transmit to Engineer for Owner's records one electronic copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.
- K. Test and Inspection Reports:
 - 1. General: Shall contain signature of person responsible for test or report.
 - 2. Factory:
 - a. Identification of product and Specification section, type of inspection or test with referenced standard or code.
 - b. Date of test, Project title and number, and name and signature of authorized person.
 - c. Test results.
 - d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
 - e. Provide interpretation of test results, when requested by Engineer.
 - f. Other items as identified in individual Specification sections.
 - 3. Field: As a minimum, include the following:
 - a. Project title and number.
 - b. Date and time.
 - c. Record of temperature and weather conditions.
 - d. Identification of product and Specification section.

- e. Type and location of test, Sample, or inspection, including referenced standard or code.
 - f. Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
 - g. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
 - h. Provide interpretation of test results, when requested by Engineer.
 - i. Other items as identified in individual Specification sections.
- 4. Testing and Startup Data: In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.
 - 5. Training Data: In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 34 00 – PHOTOGRAPHIC AND VIDEOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes Requirements for:
 - 1. Pre-construction photographs.
 - 2. Pre-construction videos.
 - 3. Post-construction photographs.
 - 4. Post-construction videos.
- B. The purpose of the photographs and videos is to document the condition of the facilities prior to the CONTRACTOR beginning work at the Project site and after Substantial Completion of the Work.
- C. Areas to be photographed and videoed shall include the site of the Work and all existing facilities either on or adjoining the Project site, including the interior of existing structures, that could be damaged as a result of the CONTRACTOR's Work.
- D. The scope of the photographic and videographic documentation shall be the sole responsibility of the CONTRACTOR, but shall be acceptable to the ENGINEER.
- E. Related sections:
 - 1. Section 01 31 00 – Project Management and Coordination
 - 2. Section 01 31 19 – Project Meetings.
 - 3. Section 01 33 00 – Submittal Procedures.
 - 4. Section 01 77 00 – Closeout Procedures.

1.2 SUBMITTALS

- A. Key Plan: Submit key plan of Project site with notation of vantage points marked for location and direction of each photograph. Include the same label information as the corresponding set of photographs.
- B. Photographs:
 - 1. Digital Media:
 - a. Provide photos as individual, indexed JPG files with the following characteristics:
 - 1) Compression shall be set to preserve quality over file size.
 - 2) Highest resolution JPG images shall be submitted. Resizing to a smaller size when high resolution JPGs are available shall not be permitted.
 - 3) JPG image resolution shall be 4000 by 3000 or higher.
 - 4) Images shall have rectangular clean images. Artistic borders, beveling, drop shadows, etc. are not permitted.
- C. Videos:
 - 1. Submit 4 copies of each video within 7 days of recording.
 - 2. Videos shall be submitted in a digital color video format on a DVD suitable for playback on a standard DVD player.
 - 3. Identification: On each copy provide a label with the following information:
 - a. Name of project.
 - b. Date video was recorded.

- D. Pre-Construction Photographs and Videos: Submit prior to beginning work at the Project site or prior to the Preconstruction Conference specified in Section 01 31 19, whichever occurs earlier. Reference Section 01 31 00 for additional requirements.
- E. Post-Construction Photographs and Videos: Submit with project closeout documents as specified in Section 01 77 00. Reference Section 01 31 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MEDIA

- A. Paper Media:
 - 1. Commercial grade, glossy surface, acid-free photographic paper.
- B. Digital Media:
 - 1. One hundred and twenty millimeters, 700-MB, 80-minute CD compatible with latest version of Microsoft Windows.
- C. Videos:
 - 1. One hundred and twenty millimeters, DVD compatible with standard DVD players.

PART 3 - EXECUTION

3.1 GENERAL

- A. Photographs (Paper and Digital Media):
 - 1. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
- B. Videos:
 - 1. Display continuous running time.
 - 2. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project Site.

END OF SECTION

SECTION 01 41 00 – REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Regulatory requirements:
 - 1. Building code.
 - 2. Electrical code.
 - 3. Energy code.
 - 4. Fire code.
 - 5. Mechanical code.
 - 6. Plumbing code.

1.2 REFERENCES

- A. International Code Council (ICC):
 - 1. International Building Code (IBC), 2015.
 - 2. International Existing Building Code (IEBC), 2015.
 - 3. International Energy Conservation Code (IECC), 2015.
 - 4. International Fire Code (IFC), 2015.
 - 5. International Mechanical Code (IMC), 2015.
 - 6. International Plumbing Code (IPC), 2015.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70: National Electrical Code, 2011.
- C. National Electric Code Council:
 - 1. National Electric Code (NEC), NFPA 70, 2011

1.3 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Building code:
 - a. International Building Code.
 - 2. Electrical code:
 - a. NFPA 70: National Electric Code.
 - 3. Energy conservation code:
 - a. International Energy Conservation Code.
 - 4. Fire code:
 - a. International Fire Prevention Code.
 - 5. Mechanical codes:
 - a. International Mechanical Code.
 - 6. Plumbing code:
 - a. International Plumbing Code.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

- A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in the General Conditions, and as may otherwise be required herein and in the individual Specification sections.
- B. Work specified by reference to published standard or specification of government agency, technical association or trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.
- C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.
- D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.
- E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.
- F. Copies of Standards and Specifications of Technical Societies:
 - 1. Copies of applicable referenced standards have not been bound in these Contract Documents.
 - 2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor's personnel, Subcontractors, Owner, and Engineer.

1.2 ABBREVIATIONS

- A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.
 - 1. AA Aluminum Association
 - 2. AABC Associated Air Balance Council
 - 3. AAMA American Architectural Manufacturers Association
 - 4. AASHTO American Association of State Highway and Transportation Officials
 - 5. ABMA American Bearing Manufacturers' Association
 - 6. ACI American Concrete Institute
 - 7. AEIC Association of Edison Illuminating Companies
 - 8. AGA American Gas Association
 - 9. AGMA American Gear Manufacturers' Association
 - 10. AI Asphalt Institute
 - 11. AISC American Institute of Steel Construction
 - 12. AISI American Iron and Steel Institute
 - 13. AITC American Institute of Timber Construction
 - 14. ALS American Lumber Standards
 - 15. AMCA Air Movement and Control Association
 - 16. ANSI American National Standards Institute
 - 17. APA The Engineered Wood Association
 - 18. API American Petroleum Institute

19.	APWA	American Public Works Association
20.	ARI	Air-Conditioning and Refrigeration Institute
21.	ASAE	American Society of Agricultural Engineers
22.	ASCE	American Society of Civil Engineers
23.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
24.	ASME	American Society of Mechanical Engineers
25.	ASNT	American Society for Nondestructive Testing
26.	ASTM	ASTM International
27.	AWI	Architectural Woodwork Institute
28.	AWPA	American Wood Preservers' Association
29.	AWPI	American Wood Preservers' Institute
30.	AWS	American Welding Society
31.	AWWA	American Water Works Association
32.	BHMA	Builders Hardware Manufacturers' Association
33.	CBM	Certified Ballast Manufacturer
34.	CDA	Copper Development Association
35.	CGA	Compressed Gas Association
36.	CIS PI	Cast Iron Soil Pipe Institute
37.	CMAA	Crane Manufacturers' Association of America
38.	CRSI	Concrete Reinforcing Steel Institute
39.	CS	Commercial Standard
40.	CSA	Canadian Standards Association
41.	CSI	Construction Specifications Institute
42.	DIN	Deutsches Institute für Normung e.V.
43.	DIPRA	Ductile Iron Pipe Research Association
44.	EIA	Electronic Industries Alliance
45.	EJCDC	Engineers Joint Contract Documents' Committee
46.	ETL	Electrical Test Laboratories
47.	FAA	Federal Aviation Administration
48.	FCC	Federal Communications Commission
49.	FDA	Food and Drug Administration
50.	FEMA	Federal Emergency Management Agency
51.	FIPS	Federal Information Processing Standards
52.	PM	Factory Mutual
53.	Fed. Spec.	Federal Specifications (FAA Specifications)
54.	FS	Federal Specifications and Standards (Technical Specifications)
55.	GA	Gypsum Association
56.	GANA	Glass Association of North America
57.	ID	Hydraulic Institute
58.	HMI	Hoist Manufacturers' Institute
59.	IBC	International Building Code
60.	ICBO	International Conference of Building Officials
61.	ICC	International Code Council
62.	ICEA	Insulated Cable Engineers' Association
63.	IFC	International Fire Code
64.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
65.	IESNA	Illuminating Engineering Society of North America
66.	IFI	Industrial Fasteners Institute
67.	IGMA	Insulating Glass Manufacturer's Alliance
68.	IMC	International Mechanical Code
69.	INDA	Association of the Non-woven Fabrics Industry
70.	IPC	International Plumbing Code
71.	ISA	Instrumentation, Systems, and Automation
72.	ISO	International Organization for Standardization
73.	ITL	Independent Testing Laboratory

74.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
75.	MIA	Marble Institute of America
76.	Mil.	Military Specifications
77.	MMA	Monorail Manufacturers' Association
78.	NAAMM	National Association of Architectural Metal Manufacturers
79.	NACE	NACE International
80.	NEBB	National Environmental Balancing Bureau
81.	NEC	National Electrical Code
82.	NECA	National Electrical Contractors Association
83.	NEMA	National Electrical Manufacturers' Association
84.	NESC	National Electrical Safety Code
85.	NETA	International Electrical Testing Association
86.	NFPA	National Fire Protection Association
87.	NHLA	National Hardwood Lumber Association
88.	NICET	National Institute for Certification in Engineering Technologies
89.	NIST	National Institute of Standards and Technology
90.	NRCA	National Roofing Contractors Association
91.	NRTL	Nationally Recognized Testing Laboratories
92.	NSF	NSF International
93.	NSPE	National Society of Professional Engineers
94.	NTMA	National Terrazzo and Mosaic Association
95.	NWWDA	National Wood Window and Door Association
96.	OSHA	Occupational Safety and Health Act (both Federal and State)
97.	PCI	Pre-cast/Pre-stressed Concrete Institute
98.	PEI	Porcelain Enamel Institute
99.	PPI	Plastic Pipe Institute
100.	PS	Product Standards Section-U.S. Department of Commerce
101.	RMA	Rubber Manufacturers' Association
102.	RUS	Rural Utilities Service
103.	SAE	Society of Automotive Engineers
104.	SDI	Steel Deck Institute
105.	SDI	Steel Door Institute
106.	SJI	Steel Joist Institute
107.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
108.	SPI	Society of the Plastics Industry
109.	SSPC	The Society for Protective Coatings
110.	SWI	Steel Window Institute
111.	TEMA	Tubular Exchanger Manufacturers' Association
112.	TCA	Tile Council of North America
113.	TIA	Telecommunications Industry Association
114.	UBC	Uniform Building Code
115.	UFC	Uniform Fire Code
116.	UL	Underwriters Laboratories Inc.
117.	UMC	Uniform Mechanical Code
118.	USBR	U.S. Bureau of Reclamation
119.	WCLIB	West Coast Lumber Inspection Bureau
120.	WWPA	Western Wood Products Association

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 40 – ABBREVIATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Abbreviations and meanings.

1.2 INTERPRETATIONS

- A. Interpret abbreviations by context in which abbreviations are used.

1.3 ABBREVIATIONS

A. Abbreviations Used to Identify Reference Standards:

1. AA Aluminum Association
2. AAMA Architectural Aluminum Manufacturers Association
3. AAN American Association of Nurserymen
4. AASHTO American Association of State Highway and Transportation Officials
5. ABC Associated Air Balance Council
6. ABPA Acoustical and Board Products Association
7. ACI American Concrete Institute
8. ACIL American Council of Independent Laboratories
9. ADC Air Diffusion Council
10. ABMA American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
11. AGA American Gas Association
12. AGC Associated General Contractors
13. AGMA American Gear Manufacturers' Association
14. AI Asphalt Institute
15. AIA American Institute of Architects
16. AIMA Acoustical and Insulating Materials Association
17. AISC American Institute of Steel Construction
18. AISI American Iron and Steel Institute
19. AITC American Institute of Timber Construction
20. AMCA Air Moving and Conditioning Association
21. AMG Arizona Masonry Guild
22. ANSI American National Standards Institute
23. APA American Plywood Association
24. API American Petroleum Institute
25. ARI Air Conditioning and Refrigeration Institute
26. ASAHCA American Society of Architectural Hardware Consultants
27. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
28. ASME American Society of Mechanical Engineers
29. ASTM ASTM International (Former name American Society for Testing and Materials. Still used in specifications.)
30. AWI Architectural Woodwork Institute
31. AWPA American Wood Preservers Association
32. AWPI American Wood Preservers Institute
33. AWS American Welding Society
34. AWSC American Welding Society Code
35. AWWA American Water Works Association
36. BHMA Builders Hardware Manufacturers Association
37. BIA Brick Institute of America
38. BSI Building Stone Institute

39.	CLFMI	Chain Link Fence Manufacturers Institute
40.	CPSC	U.S. Consumer Product Safety Commission
41.	CRA	California Redwood Association
42.	CRI	Carpet and Rug Institute
43.	CRSI	Concrete Reinforcing Steel Institute
44.	CS	Commercial Standards
45.	CSI	Construction Specifications Institute
46.	CTI	Ceramic Tile Institute
47.	DHI	Door and Hardware Institute
48.	EIFS	Exterior Insulation and Finish System
49.	EJCDC	Engineers Joint Contract Documents Committee
50.	FGMA	Flat Glass Marketing Association
51.	FIA	Factory Insurance Association
52.	FM	Factory Mutual
53.	FS	Federal Specifications
54.	FTI	Facing Tile Institute
55.	GA	Gypsum Association
56.	IAPMO	International Association of Plumbing and Mechanical Officials
57.	IBC	International Building Code
58.	ICBO	International Conference of Building Officials
59.	ICC	International Code Council
60.	IEEE	Institute of Electrical and Electronics Engineers
61.	MAG	Maricopa Association of Governments
62.	MIA	Marble Institute of America
63.	ML/SFA	Metal Lath/Steel Framing Association
64.	MS	Military Specifications
65.	NAAMM	National Association of Architectural Metal Manufacturers
66.	NAPA	National Asphalt Pavement Association
67.	NBHA	National Builders Hardware Association
68.	NCMA	National Concrete Masonry Association
69.	NEC	National Electrical Code
70.	NECA	National Electrical Contractors Association
71.	NETA	International Electrical Testing Association
72.	NEMA	National Electrical Manufacturers Association
73.	NFPA	National Fire Protection Association
74.	NFPA	National Forest Products Association
75.	NIST	National Institute of Standards and Technology
76.	NMWIA	National Mineral Wood Insulation Association
77.	NPCA	National Paint and Coatings Association
78.	NRCA	National Roofing Contractors Association
79.	NTMA	National Terrazzo and Mosaic Association
80.	NWMA	National Woodwork Manufacturer's Association
81.	PCA	Portland Cement Association
82.	PCI	Prestressed Concrete Institute
83.	PDCA	Paint and Decorating Contractors of America
84.	PDI	Plumbing and Drainage Institute
85.	PEI	Porcelain Enamel Institute
86.	PS	Product Standard
87.	RTI	Resilient Tile Institute
88.	SAE	Society of Automotive Engineers
89.	SCPA	Structural Clay Products Association
90.	SDI	Steel Door Institute
91.	SIGMA	Sealed Insulating Glass Manufacturers Association
92.	SJI	Steel Joist Institute
93.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
94.	SSPC	Society for Protective Coatings-Steel Structures Painting Council

95.	TCA	Tile Council of America
96.	UBC	Uniform Building Code (ICBO)
97.	UL	Underwriters Laboratories, Inc.
98.	UNS	Unified Numbering System
99.	USDA	United States Department of Agriculture
100.	VA	Vermiculite Association
101.	WCLA	West Coast Lumberman's Association
102.	WCLIB	West Coast Lumber Inspection Bureau
103.	WPA	Western Pine Association
104.	WPOA	Western Plumbing Officials Association
105.	WRC	Welding Research Council
106.	WSCPA	Western States Clay Products Association
107.	WWPA	Western Wood Products Association

B.	B.	Abbreviations Used in Specifications:
1.	a	year or years (metric unit)
2.	A	ampere or amperes
3.	am	ante meridian (before noon)
4.	ac	alternating current
5.	ac-ft	acre-foot or acre-feet
6.	atm	atmosphere
7.	AWG	American Wire Gauge
8.	bbf	barrel or barrels
9.	bd	board
10.	bhp	brake horsepower
11.	bil gal	billion gallons
12.	BOD	biochemical oxygen demand
13.	Btu	British thermal unit or units
14.	Btuh	British thermal units per hour
15.	bu	bushel or bushels
16.	C	degrees Celsius
17.	cal	calorie or calories
18.	cap	capita
19.	cd	candela or candelas
20.	cfm	cubic feet per minute
21.	Ci	curie or curies
22.	cm	centimeter or centimeters
23.	cmu	concrete masonry unit
24.	CO	carbon monoxide
25.	Co.	Company
26.	CO ₂	carbon dioxide
27.	COD	chemical oxygen demand
28.	Corp.	Corporation
29.	counts/min	counts per minute
30.	cu	cubic
31.	cu cm	cubic centimeter or centimeters
32.	cu ft	cubic foot or feet
33.	cu ft/day	cubic feet per day
34.	cu ft/hr	cubic feet per hour
35.	cu ft/min	cubic feet per minute
36.	cu ft/sec	cubic feet per second
37.	cu in	cubic inch or inches
38.	cu m	cubic meter or meters
39.	cu yd	cubic yard or yards
40.	d	day (metric units)
41.	day	day (English units)

42.	db	decibels
43.	DB	dry bulb (temperature)
44.	dc	direct current
45.	diam	diameter
46.	DO	dissolved oxygen
47.	DS	dissolved solids
48.	emf	electromotive force
49.	fpm	feet per minute
50.	F	degrees Fahrenheit
51.	ft	feet or foot
52.	fc	foot-candle or foot candles
53.	ft/day	feet per day
54.	ft/hr	feet per hour
55.	ft/min	feet per minute
56.	ft/sec	feet per second
57.	g	gram or grams
58.	G	gravitational force
59.	gal	gallon or gallons
60.	gal/day	gallons per day
61.	gal/min	gallons per minutes
62.	gal/sec	gallons per second
63.	gfd	gallons per square foot per day
64.	g/L	grams per liter
65.	gpd	gallons per day
66.	gpd/ac	gallons per day per acre
67.	gpd/cap	gallons per day per capita
68.	gpd/sq ft	gallons per day per square foot
69.	gph	gallons per hour
70.	gpm	gallons per minute
71.	gps	gallons per second
72.	h	hour or hours (metric units)
73.	ha	hectare or hectares
74.	hp	high point
75.	hp	horsepower
76.	hp-hr	horsepower-hour or horsepower-hours
77.	hr	hour or hours (English units)
78.	Hz	hertz
79.	ID	inside diameter
80.	ihp	indicated horsepower
81.	Inc.	Incorporated
82.	inch	inch
83.	inches	inches
84.	inches/sec	inches per second
85.	J	joule or joules
86.	JTU	Jackson turbidity unit or units
87.	k	kips
88.	K	kelvin
89.	K	thermal conductivity
90.	kcal	kilocalorie or kilocalories
91.	kcmil	thousand circular mils
92.	kg	kilogram or kilograms
93.	km	kilometer or kilometers
94.	kN	kilonewton or kilonewtons
95.	kPa	kilopascal or kilopascals
96.	ksi	kips per square inch
97.	kV	kilovolt or kilovolts

98.	kVA	kilovolt-ampere or kilovolt-amperes
99.	kW	kilowatt or kilowatts
100.	kWh	kilowatt hour
101.	L	liter or liters
102.	lb/1000 cu ft	pounds per thousand cubic foot
103.	lb/acre-ft	pounds per acre-foot
104.	lb/ac	pounds per acre
105.	lb/cu ft	pounds per cubic foot
106.	lb/day/cu ft	pounds per day per cubic foot
107.	lb/day/acre	pounds per day per acre
108.	lb/sq ft	pounds per square foot
109.	lin	linear, lineal
110.	lin ft	linear foot or feet
111.	lm	lumen or lumens
112.	log	logarithm (common)
113.	ln	logarithm (natural)
114.	lx	lux
115.	m	meter or meters
116.	M	molar (concentration)
117.	mA	milliampere or milliamperes
118.	max	maximum
119.	mCi	millicurie or millicuries
120.	meq	milliequivalent
121.	μF	microfarad or microfarads
122.	MFBM	thousand feet board measure
123.	mfr	manufacturer
124.	mg	milligram or milligrams
125.	mgd/ac	million gallons per day per acre
126.	mgd	million gallons per day
127.	mg/L	milligrams per liter
128.	μg/L	micrograms per liter
129.	μm	micrometer or micrometers
130.	mile	mile
131.	mil. gal	million gallons
132.	miles	miles
133.	min	minimum
134.	min	minute or minutes
135.	MLSS	mixed liquor suspended solids
136.	MLVSS	mixed liquor volatile suspended solids
137.	mm	millimeter or millimeters
138.	mol wt	molecular weight
139.	mol	mole
140.	Mpa	megapascal or megapascals
141.	mph	miles per hour
142.	MPN	most probable number
143.	mR	milliroentgen or milliroentgens
144.	Mrad	megarad or megarads
145.	mV	millivolt or millivolts
146.	MW	megawatt or megawatts
147.	N	newton or newtons
148.	N	normal (concentration)
149.	No.	number
150.	Nos	numbers
151.	NRC	noise reduction coefficient
152.	NTU or ntu	nephelometric turbidity unit
153.	oc	on center

154.	OD	outside diameter
155.	ORP	oxidation-reduction potential
156.	OT	ortho-tolidine
157.	OTA	ortho-tolidine-arsenite
158.	oz	ounce or ounces
159.	oz/sq ft	ounces per square foot
160.	Pa	pascal or pascals
161.	pl	plate or property line
162.	pm	post meridiem (afternoon)
163.	ppb	parts per billion
164.	ppm	parts per million
165.	ppt	parts per thousand
166.	pr	pair
167.	psf/hr	pounds per square foot per hour
168.	psf	pounds per square foot
169.	psi	pounds per square inch
170.	psia	pounds per square inch absolute
171.	psig	pounds per square inch gauge
172.	PVC	polyvinyl chloride
173.	qt	quart or quarts
174.	R	radius
175.	R	roentgen or roentgens
176.	rad	radiation absorbed dose
177.	RH	relative humidity
178.	rpm	revolutions per minute
179.	rps	revolutions per second
180.	S	second (metric units)
181.	S	Siemens (mho)
182.	SDI	sludge density index or silt density index
183.	sec	second (English units)
184.	SI	International System of Units
185.	sp	static pressure
186.	sp gr	specific gravity
187.	sp ht	specific heat
188.	sq	square
189.	cm ² or sq cm	square centimeter or centimeters
190.	sq ft	square feet or foot
191.	sq inch	square inch
192.	sq inches	square inches
193.	km ² or sq km	square kilometer or kilometers
194.	m ² or sq m	square meter or meters
195.	mm ² or sq mm	square millimeter or millimeters
196.	sq yd	square yard or yards
197.	SS	suspended solids
198.	STC	Sound Transmission Class
199.	SVI	sludge volume index
200.	TDS	total dissolved solids
201.	TKN	total Kjeldahl nitrogen
202.	TLM	median tolerance limit
203.	TOC	total organic carbon
204.	TOD	total oxygen demand
205.	TOW	top of weir
206.	TS	total solids
207.	TSS	total suspended solids
208.	TVS	total volatile solids

209.	U	U Factor/U Value
210.	U	Coefficient of Heat Transfer
211.	U	heat transfer coefficient
212.	UNS	Uniform Numbering System
213.	US	United States
214.	V	volt or volts
215.	VA	volt-ampere or volt-amperes
216.	W	watt or watts
217.	WB	wet bulb
218.	wg	water gauge
219.	wk	week or weeks
220.	wt	weight
221.	yd	yard or yards
222.	yr	year or years (English unit)

C. Abbreviations Used on Drawings: As listed on Drawings or in Specifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 00 – QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Quality control and control of installation.
 - 2. Tolerances.
 - 3. References.
 - 4. Mock-up requirements.
 - 5. Authority and duties of Owner's representative or inspector.
 - 6. Sampling and testing.
 - 7. Testing and inspection services.
 - 8. Contractor's responsibilities.

- B. Related sections:
 - 1. Section 01 45 24 - Special Tests and Inspections.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. When specified, products will be tested and inspected either at point of origin or at Work site:
 - 1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
 - 2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.
- I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.3 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

- B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM): E 329 - Standard for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- B. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- C. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- D. Obtain copies of standards where required by product specification sections.
- E. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.5 MOCK-UP REQUIREMENTS

- A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be comparison standard for remaining Work.
- D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.6 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

- A. Owner's Project Representative employed or retained by Owner is authorized to inspect the Work.
- B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.
- C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.
- D. Inspector will not:
 - 1. Alter or waive provisions of Contract Documents.
 - 2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
 - 3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor.
 - 4. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.

- E. Inspector will:
 - 1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
 - 2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.7 SAMPLING AND TESTING

- A. General:
 - 1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
 - 2. When specified in sections where products are specified:
 - a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
 - b. Test materials in accordance with standards of national technical organizations.
- B. Sampling:
 - 1. Furnish specimens of materials when requested.
 - 2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
 - 3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
 - 4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.
- C. Testing:
 - 1. Owner will employ and pay for services of independent testing laboratory to perform routine tests of materials to confirm compliance with requirements of Contract Documents:
 - a. Mill tests, soil compaction test, and other specified tests shall be paid for by Contractor.
 - 2. When protesting failed tests of material in place or to be used, take additional specimens and have specimens tested:
 - a. When original test proves to have been in error, file claim for reimbursement of direct costs for sampling and testing.
- D. Test standards:
 - 1. Perform sampling, specimen preparation, and testing of materials in accordance with specified standards, and when no standard is specified, in accordance with standard of nationally recognized technical organization.
 - 2. Physical characteristics of materials not particularly specified shall conform to standards published by ASTM, where applicable.
 - 3. Standards and publication references in Contract Documents shall be edition or revision in effect on date stipulated in the Contract Documents.

1.8 TESTING AND INSPECTION SERVICES

- A. Contractor will employ and pay for specified services of an independent firm; known as Contractor's independent testing firm, to perform Contractor quality control testing as required in the technical specifications for various work and materials.
- B. Owner will employ and pay for specified services of an "Owner's independent testing firm" to perform testing and inspection as required in the technical specifications for various work and

materials or stipulated in Section 01 45 24 to confirm Contractor's compliance with Contract Documents. If Engineer or Owner's independent testing firm is not properly certified to perform specialty inspections required by the building department, Owner will employ and pay for a quality specialty inspection firm to perform required testing and inspection.

- C. The Contractor's independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.
- D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
 - 1. Has authorization to operate in the state where the project is located.
 - 2. Meets "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.
 - 3. Meets requirements of ASTM E 329.
 - 4. Laboratory Staff: Maintain full time specialist on staff to review services.
 - 5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to National Bureau of Standards (NBS) or accepted values of natural physical constants.
 - 6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NBS during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.
- E. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.
- F. Reports will be submitted by Contractor's independent testing firm and by Owner's independent testing firm to Engineer, Contractor, and Owner in triplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents. Each report shall include:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Testing laboratory name, address, and telephone number.
 - 4. Name and signature of laboratory inspector.
 - 5. Date and time of sampling or inspection.
 - 6. Record of temperature and weather conditions.
 - 7. Date of test.
 - 8. Identification of product and specification section.
 - 9. Location of sample or test in Project.
 - 10. Type of inspection or test.
 - 11. Results of tests and compliance with Contract Documents.
 - 12. Interpretation of test results, when requested by Engineer.
- G. Contractor shall cooperate with Owner's independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 - 1. Notify Engineer and Owner's independent testing firm 48 hours prior to expected time for operations requiring testing.
 - 2. Make arrangements with Owner's independent testing firm and pay for additional samples and tests required for Contractor's use.
- H. Limitations of authority of testing Laboratory: Owner's independent testing firm or Laboratory is not authorized to:
 - 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency or laboratory may not approve or accept any portion of the Work.
 - 3. Agency or laboratory may not assume duties of Contractor.

4. Agency or laboratory has no authority to stop the Work.
 - I. Testing and employment of an Owner's independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
 - J. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.
 - K. The Owner's independent testing firm responsibilities will include:
 1. Test samples of mixes submitted by Contractor.
 2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
 6. Perform additional tests required by Engineer.
 7. Attend preconstruction meetings and progress meetings.
 - L. Owner's independent testing firm individual test reports: After each test, Owner's independent testing firm will promptly submit electronically and three hard copies of report to Engineer and to Contractor. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results. Include the following:
 1. Date issued.
 2. Project title and number.
 3. Name of inspector.
 4. Date and time of sampling or inspection.
 5. Identification of product and specifications section.
 6. Location in Project.
 7. Type of inspection or test.
 8. Date of test.
 9. Certified test results stamped and signed by a registered Engineer in the state that the project is located.
 10. Summary of conformance with Contract Documents.
 - M. Owner's independent testing firm will provide monthly report of certification to identify all work performed for special inspections and other contract requirements on this project. The following certified monthly report at a minimum will include but not limited to:
 1. Results of testing.
 2. Testing logs.
 3. Outstanding deficiencies.
 4. Various statistical data.
 5. Testing curves (up to 4 types) as required by the Engineer.
- 1.9 CONTRACTOR'S RESPONSIBILITIES
- A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.
 - B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

- C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.
- D. Furnish electronically and 5 hard copies of product test reports.
- E. Furnish incidental labor and facilities:
 - 1. To provide access to construction to be tested.
 - 2. To obtain and handle samples at Work site or at source of product to be tested.
 - 3. To facilitate inspections and tests.
 - 4. For storage and curing of test samples.
- F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 24 – SPECIAL TESTS AND INSPECTIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: This Section describes the requirements for providing special tests and inspections.
- B. Related sections:
 - 1. Section 01 45 00 - Quality Control.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - 2. ASTM C270, Standard Specification for Mortar for Unit Masonry.
 - 3. ASTM C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 4. ASTM C1019, Standard Test Method for Sampling and Testing Grout.
 - 5. ASTM C1314, Standard Test Method for Compressive Strength of Masonry Prisms.
- B. International Building Code (IBC).

1.3 DESCRIPTION

- A. This Section describes special tests and inspections of structural assemblies and components to be performed in compliance with IBC.
- B. These special tests and inspections are in addition to the requirements specified in Section 01 45 00, and by the individual Sections.
- C. The OWNER will employ one or more inspectors who will provide special inspections during construction.

1.4 INSPECTION

- A. Duties of Special Inspector:
 - 1. General: Required duties of the Special Inspector are described in IBC.

1.5 TESTS

- A. Selection of the material required to be tested shall be by the OWNER's Testing Laboratory and not the CONTRACTOR.

1.6 SPECIAL TESTING AND INSPECTIONS

- A. Testing laboratory: Special tests will be performed by the OWNER's testing laboratory as specified in Section 01 45 00.
- B. OWNER reserves the right to positive material identification tests.
 - 1. Contractor must make materials available for testing.

- C. The following types of work require special inspection as described in IBC. Refer to the following verification, testing and inspection schedules.
 - 1. Appendix A, Cast-In-Place Concrete Special Inspection Schedule.
 - 2. Appendix B, Essential Architectural, Mechanical and Electrical Inspection Schedule.
 - 3. Appendix C, Essential Masonry Special Inspection Schedule.
 - 4. Appendix D, Soils Verification And Inspection Schedule.
 - 5. Appendix E, Structural Steel Special Inspection Schedule.
 - 6. Appendix F. Other Special Inspection.

1.7 OTHER SPECIFIC TESTS

- A. Masonry shall be tested in accordance with IBC.
 - 1. Minimum strength of units shall be tested in accordance with ASTM C140.
 - 2. Minimum strength of grout shall be tested in accordance with ASTM C1019.
 - 3. Prior to construction, obtain samples of the aggregates, additives, and water; mix and test in laboratory in accordance with ASTM C270.
 - 4. During construction, sample and test masonry for consistency prior to use on each structure in accordance with ASTM C780.
 - 5. When approved by the building official, if installed masonry does not meet requirements, conduct prism tests in accordance with ASTM C1314.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE

- A. The CONTRACTOR shall allow time necessary for Special Inspections as listed above.
- B. Sufficient notice shall be given so that the Special Inspections can be performed. This includes time for off-site Special Inspectors to plan the inspection and travel to site.

3.2 PROCEDURE

- A. The Special Inspector will immediately notify the ENGINEER of any corrections required and follow notification with appropriate documentation.
- B. The CONTRACTOR shall not proceed until the work is satisfactory to the ENGINEER.

END OF SECTION

**APPENDIX A
CAST-IN-PLACE CONCRETE SPECIAL INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Inspection of reinforcing steel, including prestressing tendons, and placement.		–	X
2. Inspection of reinforcing steel welding.	IBC Table 1704.3, Item 5B	X	–
3. Inspect bolts to be installed in concrete prior to and during placement of concrete.		X	–
4. Verifying use of required design mix.		–	X
5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.		X	–
6. Inspection of concrete and shotcrete placement for proper application techniques.		X	–
7. Inspection for maintenance of specified curing temperature and techniques.		–	X

**APPENDIX B
ESSENTIAL ARCHITECTURAL, MECHANICAL AND ELECTRICAL
INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Suspended ceiling system including anchorage.		–	X
2. Anchorage of electrical equipment for emergency standby power.		–	X
3. Anchorage of other electrical or mechanical equipment on floors or roofs.		–	X
4. Anchorage of ducts.		–	X
5. Anchorage of pipes.		–	X
6. Steel storage racks supporting pipelines.		–	X
7. Elevator installation.		–	X

**APPENDIX C
ESSENTIAL MASONRY SPECIAL INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. From the beginning of masonry construction, the following shall be verified for compliance:			
a. Proportions of site-prepared mortar and grout.		–	X
b. Placement of masonry units and construction of mortar joints.		–	X
c. Placement of reinforcement and connectors.		–	X
d. Grout space prior to grouting.		X	–
e. Placement of grout.		X	–
2. The inspection program shall verify:			
a. Size and location of structural elements.		–	X
b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.		X	–
c. Specified size, grade and type of reinforcement.			X
d. Welding of reinforcing couplers.		X	–
e. Protection of masonry during cold weather (temperature below 40° F) or hot weather (temperature above 90° F).		–	X
3. Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed.		X	–
4. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.		–	X

**APPENDIX D
SOILS VERIFICATION AND INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Verify materials below footings are adequate to achieve the design bearing capacity.		–	X
2. Verify excavations are extended to proper depth and have reached proper material.		–	X
3. Perform classification and testing of controlled fill materials.		–	X
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of controlled fill.		X	–
5. Prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly.		–	X

**APPENDIX E
STRUCTURAL STEEL SPECIAL INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Material verification of high-strength bolts, nuts and washers:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		–	X
b. Manufacturer's certificate of compliance required.		–	X
2. Inspection of high-strength bolting:			
a. Bearing-type connections.		–	X
b. Slip-critical connections.		X	X
3. Material verification of structural steel:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		–	X
b. Manufacturers' certified mill test reports.		X	–
4. Material verification of weld filler materials:			
a. Identification markings to conform to AWS specification in the approved construction documents.		–	X
b. Manufacturer's certificate of compliance required.		–	X
5. Inspection of welding:			
a. Structural steel:		–	–
1) Complete and partial penetration groove welds.		X	–
2) Multi-pass fillet welds.		X	–
3) Single-pass fillet welds > 5/16".		X	–
4) Single-pass fillet welds ≤ 5/16".		–	X
5) Floor and deck welds.		–	X
b. Reinforcing steel:		–	–
1) Verification of weldability of reinforcing steel other than ASTM A706.		–	X
2) Reinforcing steel-resisting flexural and axial forces in boundary elements of special reinforced concrete shear walls and shear reinforcement.		X	–
3) Shear reinforcement.		X	–
4) "Form Saver" (reinforcing couplers).		X	–
6. Inspection of steel frame joint details for compliance with approved construction documents:			X
a. Details such as bracing and stiffening.		X	–
b. Member locations.		X	–
c. Application of joint details at each connection.		X	–
7. Seismic force resisting systems identified on structural plans.		X	–

**APPENDIX F
OTHER SPECIAL INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Shoring of Excavations.		–	X
2. Reinforced gypsum concrete.		–	X
3. Shotcrete.		–	X
4. Smoke control system.		–	X
5. Special grading, excavating, and filling.		–	X
6. Spray applied fire resistive material.		–	X
7. Special seismic resistance details.		–	X

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.
- B. Related sections:
1. Section 01 14 00 – Work Restrictions.
 2. Section 01 32 00 – Construction Progress Documentation
 3. Section 01 33 00 – Submittal Procedures
 4. Section 01 34 00 – Photographic and Videographic Documentation

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of Nurserymen: American Standards for Nursery Stock.
 2. Federal Emergency Management Agency.
 3. NFPA, National Fire Prevention Standard for Safeguarding Building Construction Operations.
 4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
 5. U.S. Department of Agriculture: Urban Hydrology for Small Watersheds.
 6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.

1.3 SUBMITTALS

- A. Informational Submittals:
1. General: For products specified to be furnished under this Section, submit product data in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.
 2. For Temporary Piping Systems:
 - a. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
 - b. Submit product data for piping, fittings, appurtenances, restraints, supports, and all other components of the temporary piping system.
 - c. Submit all information at least 28 days prior to when each temporary piping system is scheduled to be installed and allow 14 days for review and comment by ENGINEER and OWNER.
 3. For Temporary Pumping Systems:
 - a. Submit pump data, performance curves, and other operating information as specified in Section 01 32 00, SAFETY PLAN.
 - b. Submit sketches showing layout of temporary pumping system, including pump quantity, configuration in wet well, and proposed piping layout specified in Paragraph 1.02 B.
 - c. Submit piping headloss calculations based on proposed temporary piping system layout.
 - d. Submit all information at least 28 days prior to when the temporary pumping system is scheduled to be installed and allow 14 days for review and comment by ENGINEER and OWNER.

4. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
5. Temporary Utility Submittals:
 - a. Electric power supply and distribution plans.
 - b. Water supply and distribution plans.
 - c. Drainage plans.
 - d. Sanitary sewer.
6. Temporary Construction Submittals:
 - a. Access Roads: Routes, cross-sections, and drainage facilities.
 - b. Parking area plans.
 - c. Contractor's field office, storage yard, and storage building plans, including gravel surfaced area.
 - d. Fencing and protective barrier locations and details.
 - e. Engineer's field office plans.
 - f. Staging area location plan.
 - g. Traffic and Pedestrian Control and Routing Plans: As specified herein, and proposed revisions thereto.
7. Temporary Control Submittals:
 - a. Noise control plan.
 - b. Plan for disposal of waste materials and intended haul routes.

1.4 MOBILIZATION

- A. Mobilization shall Include, but Not be Limited to, these Principal Items:
 1. Obtaining required permits.
 2. Moving Contractor's field office and equipment required for first month operations onto Site.
 3. Installing temporary construction power, wiring, and lighting facilities.
 4. Providing onsite communication facilities, including telephones.
 5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
 6. Arrange for and erection of Contractor's work and storage yard.
 7. Posting OSHA required notices and establishing safety programs and procedures.
 8. Have Contractor's superintendent at Site full time.
- B. Use area designated for Contractor's temporary facilities as shown on Drawings.

1.5 PROTECTION OF WORK AND PROPERTY

- A. Comply with Owner's safety rules while on Owner's property.
- B. Keep Owner informed of serious onsite accidents and related claims.
- C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

1.6 VEHICULAR TRAFFIC

- A. Traffic Routing Plan: Show sequences of construction affecting use of roadways, time required for each phase of the Work, provisions for decking over excavations and phasing of operations to provide necessary access, and plans for signing, barricading, and striping to provide passages for pedestrians and vehicles.

1.7 TEMPORARY UTILITIES

- A. Temporary Electrical Power:
 1. Arrange with local utility to provide adequate temporary electrical service.

2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
 3. Provide, maintain, and pay for electric power for performance of the Work except for power required for the final 7-day operational test:
 - a. When using permanent facilities, provide separate meter and reimburse OWNER for power used in connection with performance of the Work.
- B. Temporary Electrical Lighting:
1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by Occupational Safety and Health Administration (OSHA) and state agency which administers OSHA regulations where Project is located.
 2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
 - a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by CONTRACTOR for lighting.
- C. Temporary Heating, Cooling, and Ventilating:
1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
 2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.
- D. Temporary Water:
1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
 2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
 3. Pay for water used for construction prior to Substantial Completion. OWNER will provide water for 7-day final test.
- E. Temporary Sanitary Facilities:
1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
 2. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.
- F. Temporary Fire Protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.
- G. First Aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.
- H. Utilities in Existing Facilities: See Section 01 14 00, WORK RESTRICTIONS.
- 1.8 CONSTRUCTION AIDS
- A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.
- B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.
- C. Design temporary supports with adequate safety factor to assure adequate load bearing capability:

1. When requested, submit design calculations by professional registered engineer prior to application of loads.
 2. Submitted design calculations are for information and record purposes only.
- D. Accident Prevention:
1. Exercise precautions throughout construction for protection of persons and property.
 2. Observe safety provisions of applicable Laws and Regulations.
 3. Guard machinery and equipment, and eliminate other hazards.
 4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
 5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.
- E. Barricades:
1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
 2. Provide barriers with flashing lights after dark.
 3. Keep barriers in place until excavations are entirely backfilled and compacted.
 4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.
- F. Warning Devices and Barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- G. Hazards in Public Right-of-Way:
1. Mark at reasonable intervals, trenches and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
 - a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
 2. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
 - a. During hours of darkness, provide warning lights at close intervals.
- H. Hazards in Protected Areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.
- I. Above Grade Protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.
- K. Fences:
1. Enclose site of the Work with fence adequate to protect the Work against acts of theft, violence and vandalism.
 2. Enclose temporary offices and storage areas with fence adequate to protect temporary facilities against acts of theft, violence and vandalism.
 3. When entire or part of site is to be permanently fenced, permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to Substantial Completion.

4. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.
5. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
6. Fence temporary openings when openings are no longer necessary.

1.9 SECURITY

- A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.10 ACCESS ROADS

- A. General:
 1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
 2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.
- B. Off-Site Access Roads:
 1. Build and maintain graded earth roads.
 2. Build roads only in public right-of-way or easements obtained by OWNER.
 3. Obtain rights-of-way or easements when electing to build along other alignment.
- C. On-Site Access Roads:
 1. Maintain access roads to storage areas and other areas to which frequent access is required.
 2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
 3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
 4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

1.11 TEMPORARY CONTROLS

- A. Dust Control:
 1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
 2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.
- B. Noise Control:
 1. In inhabited areas, particularly residential, perform operations in manner to minimize noise.
 2. In residential areas, take special measures to suppress noise during night hours.
- C. Mud Control:
 1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.12 PROJECT SIGN

- A. Provide and maintain Project identification sign consisting of painted 8 foot wide by 4 foot high exterior grade plywood and minimum 10 foot long 4 by 4 lumber posts, set in ground at least 3 feet, with exhibit lettering by professional sign painter using no more than 5 sign colors:
 - 1. List at least the title of the Project, and names of the OWNER, ENGINEER, and CONTRACTOR.
- B. Erect Project identification sign where directed.

1.13 REMOVAL

- A. Remove temporary buildings and furnishings before inspection for Substantial Completion or when directed.
- B. Clean and repair damage caused by installation or use of temporary facilities.
- C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.
- D. Restore existing facilities used during construction to specified or original condition.

1.14 TEMPORARY PROCESS PIPING

- A. CONTRACTOR shall provide all piping, appurtenances, and other materials as required to provide temporary piping systems as specified herein, as indicated on the Drawings, and as needed to perform the Work.
- B. CONTRACTOR shall field route piping as needed and as field conditions dictate, unless otherwise indicated on the Drawings, and determine appropriate lengths of piping and quantity/type of pipe fittings needed to construct temporary piping system. Do not block access points such as stairs, doors, and walkways to existing facilities unless approved in writing by the OWNER.
- C. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
 - 1. When piping is buried, use concrete thrust block or mechanical restraints.
 - 2. When piping is exposed or under water, use mechanical or structural restraints.
 - 3. Determine thrust forces by multiplying the nominal cross sectional area of the piping by the operating pressure of the piping.
- D. Temporary piping systems shall be installed in a manner that will not damage existing or new facilities.
- E. Unless indicated otherwise, piping material, including gaskets, shall be suitable for the process fluid requiring temporary piping.
- F. After Temporary Piping System is no longer required:
 - 1. Remove temporary piping system.
 - 2. Clean and repair damage caused by installation or use of temporary piping system.
 - 3. Restore existing facilities to original condition.

1.15 TEMPORARY PROCESS PUMPING

- A. To achieve the Contractor's plan to complete the work, Contractor may require and shall provide temporary pumping system to pump flow as required to complete the work.

1. Anticipated pressure will vary based on headlosses developed and the final length of installed temporary piping. CONTRACTOR shall calculate headlosses and provide pump with sufficient pressure to meet flow requirements. Calculations shall be sealed and signed by a professional engineer registered in the state in which the project is located.
 2. Pump(s) shall be capable of passing a solid with a sphere size of 3 inches.
 3. Temporary pumps shall be capable of matching plant flow rates through the use of variable flow rate pumping. The use of cycled pumping (i.e., on/off) is not acceptable. Provide all wiring and controls necessary to match plant flow rate based on 4-20 mA signal available at the Operations Building.
 4. Provide and pay for all power required to operate temporary pumps.
 5. All electrical and instrumentation components will comply with applicable code requirements for the area where the temporary pump is located.
 6. Temporary pumping will be required 24 hours per day during the time period when pumping is required and is critical to the proper operation of the OWNER'S treatment plant. Provide 24-hour on-site supervision of pumps to ensure that pumps are always operational and performing as required. Notify the OWNER immediately if temporary pumping cannot be provided.
 7. CONTRACTOR shall be responsible for repairing any damage or reimbursing the OWNER for any regulatory fines or additional plant staff time resulting from the CONTRACTOR'S failure to maintain temporary pumping.
 8. Provide 100 percent backup (a.k.a., standby, redundant, etc.) pumping capacity equal to the required process flow rate. Backup system shall be capable of providing required pumping capacity immediately upon failure of primary pumping system.
 9. All necessary spare equipment and appurtenances shall be available on-site to allow immediate repair and/or replacement of any pumping system component that is not functioning properly.
- B. Providing temporary piping systems as specified in Paragraph 1.14.
- C. Temporary pumping of other process flows is not allowed unless approved in writing by the OWNER.
- D. After Temporary Process Pumping System is no Longer Required:
1. Remove temporary process pumping system.
 2. Clean and repair damage caused by installation or use of temporary process pumping system.
 3. Restore existing facilities to original condition.

PART 2 - PRODUCTS

2.1 FIELD OFFICES AND SHEDS

- A. CONTRACTOR's Field Office:
1. Maintain on Project Site weathertight space in which to keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.
 2. Provide field office with adequate space to examine documents, and provide lighting and telephone service in that space.
- B. ENGINEER's Field Office:
1. Provide separate field office on project site for the exclusive use of the ENGINEER, as follows:
 - a. Size: Approximately 12 feet by 56 feet, including a toilet room, with 8-foot minimum ceiling height.
 - b. Construction: Weathertight building constructed at the site, pre-manufactured building, or trailer, with a toilet room containing a water closet and lavatory,

- partitioned off from the working area. The water closet may be of the chemical type provided that it is a flush type with an approved holding tank.
- c. Walls and Ceiling: Insulated with finished interior surfaces.
 - d. Openings: At least 6 windows and 2 entrance doors, each with cylinder lock and 4 keys.
 - e. Exterior lighting over entrance door.
 - f. Twenty 110 volts AC duplex receptacles with at least 2 in each office.
2. Arrange and Pay For:
 - a. Janitorial service, including daily dusting, floor cleaning, and trash removal, and monthly comprehensive cleaning, including windows.
 - b. Heating, ventilating, and air conditioning equipment in operating condition.
 - c. Electric wiring, power, and lighting fixtures capable of providing at least 75 foot candles of light on work surfaces.
 - d. A continuous supply of toilet paper, paper hand towels and hand soap for each restroom.
 - e. Private telephone line.
 - f. Dedicated telephone line for facsimile (fax) machine.
 - g. Dedicated telephone line for computer modem.
 - h. Bottled drinking water service with dispenser.
 - i. Suitable restroom facilities with sinks with hot and cold water.
 3. Provide Following Furnishings and Equipment:
 - a. Four office desks with 6 drawers (2 with locks) and padded, upholstered swivel chairs.
 - b. One plan table not less than 36 inches by 96 inches.
 - c. One drafting table not less than 36 inches by 60 inches.
 - d. Two metal drafting stools with backs.
 - e. Twelve straight chairs.
 - f. Four swivel chairs.
 - g. Six metal filing cabinet, 18 inches by 30 inches by 52 inches, 4 drawers with locks.
 - h. One supply cabinet with not less than 15 square feet of shelves.
 - i. Four bookcases with not less than 12 linear feet of shelves for each bookcase.
 - j. One plan hold rolling stand of 12 binders, with binders.
 - k. Six wastebaskets.
 - l. Dry erase board 96 by 48 inches, magnetic.
 - m. Refrigerator, 6.0 cubic feet capacity.
 - n. Microwave oven, 1.0 cubic feet.
 - o. Field Office Data Service and Equipment: Provide one of the following data services (listed in order of preference and increasing cost) for the duration of the project. CONTRACTOR is responsible for all maintenance of service and hardware. Data service will be dedicated to the ENGINEER and not shared with any other party. The CONTRACTOR shall provide a durable and weather tight system for connecting the ENGINEER's trailer to the service provider's facilities at the jobsite boundary:
 - 1) Provide high-speed Internet access (DSL or cable modem); with a minimum 2.4 gigabit per second download/2.4 gigabit per second upload. This access must have a minimum of 8 (5 usable) IP addresses. In addition, it must provide an average round-trip delay of less than 150 ms to the ENGINEER's Internet gateway.
 - 2) Provide 1 ISDN BRI, coded for data use, and all associated usage charges. This BRI will be used to direct dial to the ENGINEER's remote access gateway located in the local area code where the project is located.
 - 3) Provide private line or frame-relay Internet access with a minimum 2.4 gigabit per second download/2.4 gigabit upload. This access must have a minimum of 8 (5 usable) IP addresses. In addition, it must provide an average round-trip delay of less than 150 ms to the ENGINEER's Internet gateway.
 - p. Provide new data service hardware corresponding with above options. CONTRACTOR is responsible for all maintenance of service and hardware:

- 1) For option 1 above, provide appropriate DSL or cable modem device. In addition, provide one Cisco ASA 5505 firewall with 3DES software, part number ASA5505-50-BUN-K9 and Cisco 4 hour response onsite Smartnet Maintenance for duration of project.
 - 2) For option 2 above, provide one Cisco 804 ISDN router, part number CISCO-804 and Cisco 4 hour response onsite Smartnet Maintenance for duration of project.
 - 3) For Option 3 Above, Provide the Following:
 - a) Visual Networks IP Enterprise central office T1 drop-and-insert CSU/DSU.
 - b) Cisco 2651 VPN router bundle, Cisco part number C2651-2FE/VPN/K9 and Cisco 4 hour response onsite Smartnet Maintenance for duration of project.
 - c) Serial interface card, Cisco part number WIC-1T.
 - d) Serial cable, Cisco part number CAB-V35MT.
- q. Field Office Local Area Network: Provide the following to create a local area network for the ENGINEER:
- 1) Install Category 5e cabling to support all specified computers, printers, and other network device. This cabling should be home-run to a patch panel and meet all applicable installation standards for CAT5e. Patch panel and jack locations to be coordinated with ENGINEER.
 - 2) Provide 10/100 Ethernet Switch sized to support all specified network devices for ENGINEER with an allowance for 50 percent growth/spare ports.
 - 3) Provide APC SmartUPS RT 1500 uninterruptable power supply, model SURTA1500XL.
 - 4) Provide Category 5e patch cables for all networking equipment; both for patch panel to switch connection and for wall jack to network device connection.
- r. Field Office Computer Systems: Furnish and install 4 new complete computer systems. CONTRACTOR is responsible for all maintenance of hardware and software. Each system shall consist of, as a minimum:
- 1) Motherboard or ENGINEER-approved alternate.
 - 2) Intel® Core I5 Quatro processor.
 - 3) Minimum 500 GB hard disk.
 - 4) Minimum 8 GB RAM.
 - 5) One parallel and 2 serial ports (not including modem).
 - 6) Minimum 4 USB ports.
 - 7) Fifty-six kilobit per second voice/data internal modem.
 - 8) Nineteen-inch color LCD monitor, 1280 x 1024, 0.25mm dot pitch, non-interlaced. Brand should be ViewSonic or Engineer-approved equivalent.
 - 9) Minimum 128 MB video card.
 - 10) One hundred and one key keyboard
 - 11) MS mouse and mouse pad
 - 12) Sony DRU-840A (20x max, dual format, DVD +/-R) drive, or equivalent sound card and speakers.
 - 13) Intel Etherexpress 10/100/1000 RJ-45 PCI network card.
 - 14) High definition graphics.
 - 15) Cables, connectors, and controller cards, as necessary, to provide a functioning system, including computer accessories.
 - 16) A/C surge suppressor with telephone line protection sized for computer system.
 - 17) Uninterruptable power supply, APC model SmartUPS 700 or equivalent.
 - 18) Four GB USB flash media storage device
 - 19) One hundred DVD-R media.
 - 20) Microsoft Windows 7 operating system.
 - 21) Microsoft Office 2013 Professional.
 - 22) Adobe Acrobat, latest version (full package, not just the free reader).

- 23) McAfee Virus Scan, latest version.
- 24) Current version of Business and Legal Reports Safety Training Presentations, Product Code 11006100.
- s. Field Office Printer:
 - 1) Provide a multifunctional printer with the capability of printing, copying, and scanning. The CONTRACTOR is responsible for all maintenance of equipment and related hardware and software. The printer shall consist of, as a minimum:
 - a) Double-sided printing capability.
 - b) Copy speed: 33 copies per minute.
 - c) Print speed: 30 prints per minute.
 - d) Up to 600 x 600 dpi resolution.
 - e) Original scan/copy paper size: up to 11" x 17".
 - f) Printer paper size: up to 11" x 17"
 - g) Dry, dual component toner.
 - h) Scan-to-File/ Folder/URL/FTP/Email functionality.
 - i) Full-Color VGA Touch Screen Control Panel.
 - j) 1.5 GB RAM + 250 GB HDD
 - k) Paper, toner, and other supplies for duration of project.
 - 2) Manufacturers:
 - a) Ricoh
 - b) Or equal
- t. AutoCAD LT for Windows by AutoDesk latest version.
- u. Digital Camera
 - 1) See Section 01 34 00 Photographic and Videographic Documentation for requirements.
 - 2) Two Spare batteries and chargers.
 - 3) Two 4 GB compact flash cards.
- v. One telephone answering machine.
- w. One facsimile (Fax) machine capable of providing the following functions:
 - 1) Unattended receiving operation for plain paper, commercial grade, 250 sheet cassette, programmable memory, and document feeder.
 - 2) Digital Modem Speed: 9,600 bits per second with automatic fallback to 7,200, 4,800, or 2,400 bits per second.
 - 3) The Terminal shall have the Following Features:
 - a) Resolution: 196 vertical by 203 horizontal lines per inch (lpi) resolution.
 - b) CCITG3, CCITG2 compatibility.
 - c) RJ11 series modular jack line connection.
 - d) Solid-state flatbed scanner.
 - e) Electro thermal recorder.
 - 4) Obtain and pay for a service contract with a local representative of the facsimile vendor or manufacturer for availability of a service representative to perform on-site service and repair.
 - 5) Provide all necessary paper and other materials required for proper operation of the facsimile.
- 4. Locate field office where directed.
- 5. Have field office ready for occupancy within 2 weeks after start of sitework.

PART 3 - EXECUTION

3.1 TEMPORARY UTILITIES

A. Power:

- 1. Electric power will be available at or near Site. Determine type and amount available and make arrangements for obtaining temporary electric power service, metering equipment,

- and pay all costs for electric power used during contract period, except for portions of the Work designated in writing by Engineer as substantially complete.
2. Cost of electric power will be borne by Contractor.
- B. Lighting: Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.
- C. Heating, Cooling, and Ventilating:
1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finishes from damage due to temperature or humidity. Costs for temporary heat shall be borne by Contractor.
 2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
 3. Pay all costs of installation, maintenance, operation, removal, and fuel consumed.
 4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
- D. Water:
1. Potable water is available at the site. Secure written permission for connection and use from Owner and meet requirements for use. Contractor shall pay cost to connect water during construction. Owner shall pay cost to for water used during construction.
 2. Include costs to connect and transport water to construction areas in Contract Price.
 3. Provide a means to prevent water used for testing from flowing back into source pipeline.
- E. Sanitary and Personnel Facilities:
1. Provide and maintain facilities for Contractor's employees, Subcontractors, and all other onsite employers' employees. Service, clean, and maintain facilities and enclosures.
- F. Telephone Service:
1. Contractor: Arrange and provide onsite telephone service for use during construction by Contractor. Pay costs of installation and monthly bills.
 2. Engineer: Arrange and provide onsite telephone system for use during construction. Pay for all installation and basic monthly billing charges.
 3. No incoming calls allowed to Owner's plant telephone system.
- G. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).

3.2 PROTECTION OF WORK AND PROPERTY

- A. General:
1. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate all activities with owner of said utility and perform all work to their satisfaction.
 2. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
 3. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
 4. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should

- service of a utility become interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
5. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
 6. Maintain original Site drainage wherever possible.
- B. Site Security:
1. Erect a temporary security fence for protection of existing facilities. Maintain fence throughout construction period. Obtain Engineer's written permission before removal of temporary security fencing.
 2. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.
- C. Barricades, Lights, Signs, and Equipment:
1. Provide as required by the Department of Transportation in the state having jurisdiction and in sufficient quantity to safeguard public and the Work.
 2. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
 3. Provide to protect existing facilities and adjacent properties from potential damage.
 4. Locate to enable access by facility operators and property owners.
 5. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.
 6. Locate barricades at the nearest intersecting public thoroughfare on each side of the blocked section.
 7. Illuminate barricades and obstructions with warning lights from sunset to sunrise.
- D. Trees and Plantings:
1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on the Drawings to remain undisturbed.
- E. Existing Structures:
1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor's operations, obtain approval of property owner and Engineer.
 2. Move mailboxes to temporary locations accessible to postal service.
 3. Replace items removed in their original location and a condition equal to or better than original.
- F. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.
- G. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.
- H. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

3.3 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning: Of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

B. Noise Control:

1. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:

1. Divert sanitary sewage and non-storm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Engineer's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and storm water flow, including dewatering pump discharges.
3. Comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, "Guidelines for Erosion and Sedimentation Control Planning," "Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity," and "Erosion and Sediment Control- Surface Mining in Eastern United States."
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

- D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.4 STORAGE YARDS AND BUILDINGS

- A. Coordinate requirements with Section 01 60 00, PRODUCT REQUIREMENTS.

- B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.

4. Provide, at a minimum, one temporary storage building or storage trailer to house specified spare part during the duration of construction and until spare parts are accepted by Owner and Engineer.

3.5 ACCESS ROADS

- A. Construct access roads as required and within easements, rights-of-way, or Project limits. Obtain Engineer's approval of access roads.
- B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.
- C. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.
- D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.
- E. Coordinate with Engineer detours and other operations affecting traffic and access. Provide at least 72 hours notice to Engineer of operations that will alter access to the Site.
- F. Where access road crosses existing fences, install and maintain gates.
- G. Upon completion of construction, restore ground surface disturbed by access road construction to original grade. Replace damaged or broken culverts with new culvert pipe of same diameter and material.

3.6 PARKING AREAS

- A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.
- B. Provide parking facilities for personnel working on the Project. No employee or equipment parking will be permitted on Owner's existing parking areas, except as specifically designated for Contractor's use.

3.7 VEHICULAR TRAFFIC

- A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.
- B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.
- C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.
- D. Coordinate traffic routing with that of others working in same or adjacent areas.

3.8 CLEANING DURING CONSTRUCTION

- A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.

- B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose.
- C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, dispose of such waste materials, debris, and rubbish offsite.
- D. At least weekly, brush sweep entry drive and roadways, and all other streets and walkways affected by the Work and where adjacent to the Work.

END OF SECTION

SECTION 01 60 00 – PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 DEFINITIONS

A. Products:

1. New items for incorporation in the Work whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by Manufacturer's product name, including make or model designation, indicated in Manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.2 DESIGN REQUIREMENTS

- ##### A.
- Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of latest edition of International Building Code (IBC) by International Code Council.

1.3 ENVIRONMENTAL REQUIREMENTS

- ##### A.
- Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at elevations shown on Drawings.
- ##### B.
- Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 0 °F to 104 °F.

1.4 PREPARATION FOR SHIPMENT

- ##### A.
- When practical, have the factory assemble products, mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.
- ##### B.
- Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.
- ##### C. Extra Materials, Special Tools, Test Equipment, and Expendables:
1. Furnish as Required by Individual Specifications.
 2. Schedule:
 - a. Ensure that shipment and delivery occur concurrently with shipment of associated equipment.
 - b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.
 3. Packaging and Shipment:
 - a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
 - b. Prominently Displayed on Each Package, the Following:

- 1). Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
 - 2). Applicable equipment description.
 - 3). Quantity of parts in package.
 - 4). Equipment manufacturer.
4. Deliver materials to the site.
 5. Notify Engineer upon arrival for transfer of materials.
 6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer. Upon receipt of Manufacturer's advance notice of shipment, promptly notify Engineer of anticipated date of equipment arrival.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.5 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in Manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with Manufacturer's instructions for unloading or as specified, and record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site, and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.6 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with Manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS. Provide Manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

C. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 °F. Protect electrical, instrumentation, and control products, and insulation against moisture, water, and dust damage. Connect and operate continuously all space heaters furnished in electrical equipment.

- D. Store fabricated products above ground on blocking or skids, prevent soiling or staining, and store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.
- E. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.
- F. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.
- G. Hazardous Materials: Prevent contamination of personnel, storage building, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide the Manufacturers standard materials suitable for service conditions unless otherwise specified in the individual Specifications.
- B. Where product specifications include a named Manufacturer, with or without model number, and also include performance requirements, named Manufacturer's products must meet the performance specifications.
- C. Like items of products furnished and installed in the Work shall be end products of one Manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, Manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.
- D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
- E. Provide interchangeable components of the same Manufacturer, for similar components, unless otherwise specified.
- F. Equipment, components, systems, sub-systems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, State, and local health and safety regulations.
- G. Regulatory Requirement: Coating materials shall meet Federal, State, and local requirements limiting the emission of volatile organic compounds and for worker exposure.
- H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated ½" mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.
- I. Authority Having Jurisdiction (AHJ):
 - 1. Provide the Work in accordance with the Texas Fire Code that incorporates the 2015 International Building Code [with Texas Amendments]. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing

laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.

2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

J. Equipment Finish:

1. Provide Manufacturer's standard finish and color, except where specific color is indicated.
2. If Manufacturer has no standard color, provide equipment with gray finish as approved by Engineer.

K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, hand wheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment Manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

2.2 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same Manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4" minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible. Oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform.
3. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
4. Provide constant-level oilers or oil level indicators for oil lubrication systems.
5. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.3 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.2 INSTALLATION

- A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.
- B. No shimming between machined surfaces is allowed.
- C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Repaint painted surfaces that are damaged prior to equipment acceptance.
- E. Do not cut or notch any structural member or building surface without specific approval of Engineer.
- F. Handle, install, connect, clean, condition, and adjust products in accordance with Manufacturer's instructions, and as may be specified. Retain a copy of Manufacturers' instruction at Site, available for review at all times.
- G. For material and equipment specifically indicated or specified to be reused in the Work:
 - 1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
 - 2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.3 FIELD FINISHING

- A. In accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS and individual Specification sections.

3.4 ADJUSTMENT AND CLEANING

- A. Perform required adjustments, tests, operation checks, and other startup activities.

3.5 LUBRICANTS

- A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

END OF SECTION

SECTION 01 72 20 – FIELD ENGINEERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of the required closeout procedures for the project:
 - 1. Providing and delivering informational submittals.
 - 2. Preparing, maintaining, providing and delivering Record Documents.
 - 3. Furnishing Releases from Agreements.
 - 4. Furnishing Evidence of Compliance with Requirements of Governing Authorities.
 - 5. Providing Warranties and Bonds.
 - 6. Providing Certificate of Final Completion.
- B. Related sections:
 - 1. Section 01 77 00 – Closeout Procedures.

1.2 QUALITY ASSURANCE

- A. Qualifications of Surveyor or Engineer: Registered civil engineer or land surveyor in state where Project is located.
- B. Accuracy of stakes, alignments, and grades may be checked randomly by ENGINEER:
 - 1. Notice of when checking will be conducted will be given.
 - 2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments or grades to be checked until checked.
 - 3. Do not assume that ENGINEER's check substitutes or complements required field quality control procedures.

1.3 CONSTRUCTION STAKES, LINES, AND GRADES

- A. Execute the Work in accordance with the lines and grades indicated.
- B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

1.4 SURVEY REFERENCE POINTS

- A. Basic reference line, a beginning point on basic reference line, and a benchmark will be provided, by OWNER.
- B. From these reference points, establish other control and reference points as required to properly lay out the Work.
- C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
 - 1. Make no changes or relocations without prior written notice.
 - 2. Replace Project control point, when lost or destroyed, in accordance with original survey control.
- D. Set monuments for principal control points and protect them from being disturbed and displaced;
 - 1. Re-establish disturbed monuments.
 - 2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

1.5 PROJECT SURVEY REQUIREMENTS

- A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.
- B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.
- C. Assume responsibility for accuracy of stakes, alignments, and grades by performing verifications and checking in accordance with standard surveying practice.

1.6 RECORD DOCUMENTS

- A. Prepare and submit Record Documents as specified in Section 01 77 00.
- B. Maintain complete, accurate log of control points and survey.
- C. Affix civil engineer's or land surveyor's signature and registration number to Record Drawing to certify accuracy of information shown.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 73 20 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cutting and patching existing and new construction.
- B. Related sections:
 - 1. Section 01 33 00 – Submittal Procedures.
 - 2. Section 01 60 00 – Product Requirements.

1.2 SUBMITTALS

- A. Submit in accordance with Section 01 33 00.
- B. Cutting and Patching Plan:
 - 1. Submit details of proposed construction before cutting and patching construction commences affecting:
 - a. Work of OWNER or of others.
 - b. Structural integrity of element of Project.
 - 2. Cutting and Patching Plan shall include the following:
 - a. Identification of Work.
 - b. Description of affected construction.
 - c. Necessity for cutting, patching, alteration, or excavation.
 - d. Description of proposed construction.
 - e. Scope of cutting, patching, alteration, or excavation. Verify locations of utilities and facilities which may exist by consulting with the OWNER, utility companies, and the Arkansas One Call System or other service available in area of Project (see dig/call information on the Drawings):

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with specifications and standards for products involved.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Provide adequate temporary support as necessary to ensure structural integrity of affected portion of Work.
- B. Provide devices and methods to protect other portions of Project from damage and persons from injury.
- C. Provide protection from elements for that portion of Project which may be exposed by cutting and patching, and maintain excavations free from water.

3.2 CUTTING AND PATCHING

- A. Cut, Fit, and Patch when Required to:

1. Make its several parts fit together properly.
 2. Remove and replace construction not conforming to Contract Documents.
 3. Remove samples of installed construction as specified for testing.
 4. Provide routine penetrations of nonstructural surfaces for installation of piping and electrical conduit.
- B. Execute cutting and demolition by methods which will prevent damage and will provide proper surfaces to receive installation of repairs.
- C. Openings in Existing Concrete and Masonry:
1. Create Openings by:
 - a. Saw cutting completely through concrete or masonry, or
 - b. Scoring edges of opening with saw to at least 1 inch depth on both surfaces (when accessible) and removing concrete or masonry by chipping.
 2. Do not allow saw cuts to extend beyond limits of opening.
 3. Make corners square and true by combination of core drilling and grinding or chipping.
 4. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.
- D. Sizing of Openings in Existing Concrete or Masonry:
1. Make openings sufficiently large to permit final alignment of pipe and fittings without deflections.
 2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
- E. Grouting Pipes in Place:
1. Sandblast concrete surfaces and thoroughly clean sand and other foreign material from surfaces prior to placing grout.
 2. Grout pipes, sleeves, castings, and conduits in place by pouring grout under a head of at least 4 inches. Vibrate grout into place. Completely fill the spaces occupied by pipes, sleeves, castings, and conduits.
 3. Water cure the grout.
- F. Connections to Existing Pipes:
1. Cut existing pipe square.
 2. Properly prepare the ends for the connection indicated on the Drawings.
 3. Repair any damage to existing lining and coating.
- G. Rehabilitate all areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains:
1. Fill areas in existing floors, walls, and ceilings from removed piping, conduit and fasteners with non-shrink grout and finish smooth.
 2. Remove Concrete Bases for Equipment and Supports by:
 - a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface. Do not cut existing reinforcement on floors.
 - b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
 - c. Patch with non-shrink grout to match adjacent grade and finish.
 3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.
- H. Treat Existing Concrete Reinforcement as Follows:

1. Where existing reinforcement is to remain, protect, clean, and extend into new concrete.
2. Where Existing Reinforcement is not to be Retained, Cut Off as Follows:
 - a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
 - b. Where concrete surface at the removal line is the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

END OF SECTION

SECTION 01 75 60 – TESTING, TRAINING, AND FACILITY START-UP

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for equipment and system testing and facility start up, including the following:
 - 1. Start-Up Plan.
 - 2. Performance Testing.
 - 3. General Start-Up and Testing Procedures.
 - 4. Functional Testing.
 - 5. Clean Water Testing.
 - 6. Operational Testing.
 - 7. Certificate of Proper Installation.
 - 8. Services of manufacturer's representatives.
 - 9. Training of OWNER's personnel.
 - 10. Final testing requirements for the complete facility.
- B. Related sections:
 - 1. Section 01 32 00 – Construction Progress Documentation.
 - 2. Division 26 Electrical Sections.

1.2 GENERAL TESTING, TRAINING, AND START-UP REQUIREMENTS

- A. Contract Requirements: Testing, training, and start-up are requisite to the satisfactory completion of the Contract.
- B. Perform clean water testing on all constructed facilities.
- C. Complete testing, training, and start-up within the Contract Times.
- D. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.
- E. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.
- F. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

1.3 START-UP PLAN

- A. Submit start-up plan for each piece of equipment and each system not less than 3 weeks prior to planned initial start-up of equipment or system.
- B. Provide detailed sub-network of Progress Schedule with the following activities identified:
 - 1. Manufacturer's services.
 - 2. Installation certifications.
 - 3. Operator training.
 - 4. Submission of Operation and Maintenance Manual.
 - 5. Functional testing.
 - 6. Performance testing.
 - 7. Operational testing.

- C. Provide testing plan with test logs for each item of equipment and each system when specified. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
- D. Provide summary of shutdown requirements for existing systems which are necessary to complete start-up of new equipment and systems.
- E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.4 PERFORMANCE TESTING

- A. Test equipment for proper performance at point of manufacture or assembly when specified.
- B. When Source Quality Control Testing is Specified:
 1. Demonstrate equipment meets specified performance requirements.
 2. Provide certified copies of test results.
 3. Do not ship equipment until certified copies have received written acceptance from ENGINEER. Written acceptance does not constitute final acceptance.
 4. Perform testing as specified in the equipment specification sections.
- C. Include costs associated with witnessing performance tests in the bid price. Include costs for one (1) OWNER's representative for travel, lodging, transportation to and from lodging, and \$50 (50 Dollars) for meal allowance per person per day.

1.5 GENERAL START-UP AND TESTING PROCEDURES

- A. Mechanical Systems: As specified in the individual equipment specification sections:
 1. Remove rust preventatives and oils applied to protect equipment during construction.
 2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
 3. Flush fuel system and provide fuel for testing and start-up.
 4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
 5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
 6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
 7. Perform cold alignment and hot alignment to manufacturer's tolerances.
 8. Adjust V-belt tension and variable pitch sheaves.
 9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
 10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
 11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.
- B. Electrical Systems: As specified in Division 26 and the individual equipment specification sections:
 1. Perform insulation resistance tests on wiring except 120 volt lighting, wiring, and control wiring inside electrical panels.
 2. Perform continuity tests on grounding systems.
 3. Test and set switchgear and circuit breaker relays for proper operation.
 4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.

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

- C. Instrumentation Systems: As specified in Division 26 and the individual equipment specification sections:
1. Bench or field calibrate instruments and make required adjustments and control point settings.
 2. Leak test pneumatic controls and instrument air piping.
 3. Energize transmitting and control signal systems, verify proper operation, ranges and settings.

1.6 FUNCTIONAL TESTING

- A. Perform checkout and performance testing as specified in the individual equipment specification sections.
- B. Functionally test mechanical and electrical equipment, and instrumentation and controls systems for proper operation after general start-up and testing tasks have been completed.
- C. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.
- D. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.
- E. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.7 CLEAN WATER TESTING

- A. Perform checkout and performance testing as specified in the individual equipment specification sections.
- B. Fill all facilities with clean water or secondary effluent.
1. Contractor shall coordinate with Owner for availability of water source. Generally, this water shall be available at the plant's effluent. Contractor shall be responsible for transporting clean water from the plant's effluent to the facility to be tested.
 2. Contractor shall be responsible for providing all temporary piping, hoses, pumps and temporary power to pump clean water to the facility to be tested.
- C. Operate facilities successfully for 72 hours (3 days) continuously.
- D. Contractor shall be responsible for providing, installing, and removing all temporary piping and valving required to perform Clean Water Testing for each facility.
- E. Functionally test mechanical and electrical equipment, and instrumentation and controls systems for proper operation after general start-up and testing tasks have been completed.
- F. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

- G. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.
- H. Conduct continuous 24-hour test under full load conditions. Replace parts which operate improperly.
- I. Following successful testing, Contractor shall coordinate removal of test water from tested facilities with Owner, develop a mutually acceptable schedule to bleed the test water in the existing plant stream. Contractor shall provide and operate all equipment and piping required to remove the test water from the tested facilities. Contractor shall not direct test water to the plant's process stream without the Owner's authorization. Contractor shall not direct test water to the plant's process stream in such a manner to provide an upset, an overloading or disruption to the plant's operations without the Owner's authorization.

1.8 OPERATIONAL TESTING

- A. After completion of operator training, conduct operational test of the entire facility. Demonstrate satisfactory operation of equipment and systems in actual operation.
- B. Conduct operational test for continuous 7-day period.
- C. OWNER will provide operations personnel, power, fuel, and other consumables for duration of each specified test.
- D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.
- E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

1.9 CERTIFICATE OF PROPER INSTALLATION

- A. At completion of Functional Testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:
 1. Has been properly installed, adjusted, aligned, and lubricated.
 2. Is free of any stresses imposed by connecting piping or anchor bolts.
 3. Is suitable for satisfactory full-time operation under full load conditions.
 4. Operates within the allowable limits for vibration.
 5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
 6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.
- B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
 1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.
 2. Control logic for equipment start-up, shutdown, sequencing, interlocks and emergency shutdown has been tested and is properly operating.
 3. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.10 TRAINING OF OWNER'S PERSONNEL

- A. Provide operations and maintenance training for items of mechanical, electrical and instrumentation equipment. Utilize manufacturer's representatives to conduct training sessions.
- B. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than 2 sessions per week.
- C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems 1 month prior to training session for that piece of equipment or system.
- D. Satisfactorily complete functional testing before beginning operator training.
- E. Provide training sessions for each work shift listed below during the time periods shown. Pooling of shifts will not be permitted unless accepted by OWNER.

Shift		
Day	Tuesday, 7 a.m.-11 a.m.	Thursday, 7 a.m.-11 a.m.
Swing	Wednesday, 3 p.m.-7 p.m.	Thursday, 3 p.m.-7 p.m.
Graveyard	Not required	Not required

- F. Training Sessions: Provide training sessions for equipment as specified in the individual equipment specification sections.
- G. The CONTRACTOR shall video all training sessions and provide a copy for the OWNER.
- H. The CONTRACTOR shall designate and provide one or more persons to be responsible for coordinating and expediting his/her training duties. The person or persons so designated shall be present at all training coordination meetings with the OWNER.
- I. The CONTRACTOR's coordinator shall coordinate the training periods with OWNER personnel and manufacturer's representatives, and shall submit a training schedule for each piece of equipment or system for which training is to be provided. Such training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

1.11 RECORD KEEPING

- A. Maintain and submit following records generated during start-up and testing phase of Project:
 - 1. Daily logs of equipment testing identifying all tests conducted and outcome.
 - 2. Logs of time spent by manufacturer's representatives performing services on the job site.
 - 3. Equipment lubrication records.
 - 4. Electrical phase, voltage, and amperage measurements.
 - 5. Insulation resistance measurements.
 - 6. Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 77 00 – CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of the required closeout procedures for the project:
 - 1. Providing and delivering informational submittals.
 - 2. Preparing, maintaining, providing and delivering Record Documents.
 - 3. Furnishing Releases from Agreements.
 - 4. Furnishing Evidence of Compliance with Requirements of Governing Authorities.
 - 5. Providing Warranties and Bonds.
 - 6. Providing Certificate of Final Completion.

- B. Related sections:
 - 1. 01 29 00 – Payment Procedures.
 - 2. 01 32 00 – Construction Progress Documentation.
 - 3. 01 72 20 – Field Engineering.
 - 4. 01 78 23 – Operation and Maintenance Data.
 - 5. 01 79 00 – Demonstration and Training.

1.2 SUBMITTALS

- A. Informational Submittals:
 - 1. Submit Prior to Application for Final Payment.
 - a. Record Documents: As required in General Conditions.
 - b. Approved Shop Drawings and Samples: As required in the General Conditions.
 - c. Operations and Maintenance Manuals: In accordance with Section 01 78 23, and as required in individual Specification sections.
 - d. Certificates of Testing and Inspection: As required in the General Conditions, these General Requirements sections, and the individual Specifications sections.
 - e. Training Sessions: In accordance with Section 01 79 00, and individual Specifications sections.
 - f. Certificate of Substantial Completion.
 - g. Special bonds, Special Guarantees, and Service Agreements.
 - 2. Form of Submittal:
 - a. Bind in commercial quality 8-1/2" by 11" three ring, side binders with hardback, cleanable, plastic covers.
 - 1). Label cover of each binder with typed or printed title Warranties and Bonds, with title of Project; name; address, and telephone number of Contractor and equipment Supplier, and name of responsible principal.
 - 2). Table of Contents: Neatly typed, in the sequence of the of the Project Manual, with each item identified with the number and title of the Specification section in which specified, and the name of the product or Work item.
 - 3). Separate each warranty or Bond with index tab sheets keyed to the Table of Contents. Provide full information, using separate typed sheets as necessary. List Subcontractor, Supplier, and Manufacturer, with name, address, and telephone number of responsible contact for service and warranty issues.
 - 3. Preparation of Submittal:
 - a. Obtain notarized warranties and Bonds, executed in duplicate by responsible Subcontractor, Supplier, and Manufacturer, within 10 days after completion of the applicable item or Work, except for items put into use with Owner's permission, leave date of beginning of time warranty until date of Substantial Completion is determined.
 - 4. Time of Submission: Submit within 10 days after the date of Date of Substantial Completion and prior to submission of Final Application of Payment.

- a. Spare parts and special tools as required by individual Specification sections.
- b. Consent of Surety to Final Payment: As required in General Conditions.
- c. Releases or Waivers of Liens and Claims: As required in General Conditions.
- d. Releases from Agreements.
- e. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00.
- f. Extra Materials: As required by individual Specification sections.

1.3 RECORD DOCUMENTS

- A. Quality Assurance:
 - 1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
 - 2. Accuracy of Records:
 - 3. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
 - 4. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
 - 5. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
 - 6. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.
 - 7. Maintain at Project site, available to OWNER and ENGINEER, 1 copy of the Contract Documents, shop drawings and other submittals, in good order.

1.4 RELEASES FROM AGREEMENTS

- A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.
- B. In the Event Contractor is Unable to Secure Written Releases:
 - 1. Inform Owner of the reasons.
 - 2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
 - 3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
 - 4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if:
 - 5. Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or
 - 6. Contractor is unable to contact or has had undue hardship in contacting grantor.

1.5 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

- A. Submit the Following:
 - 1. Certificate of Occupancy.
 - 2. Certificates of Inspection:
 - a. Mechanical.

- b. Electrical.

1.6 WARRANTIES AND BONDS

- A. Provide executed Warranty or Guaranty Form if required by Contract Documents.
- B. Provide specified additional warranties, guarantees, and bonds from manufacturers and suppliers.

1.7 CERTIFICATE OF FINAL COMPLETION

- A. When 7-day operational test has been successfully completed, ENGINEER will certify that new facilities are operationally complete. ENGINEER will submit a list of known items (punch list) still to be completed or corrected prior to contract completion.
- B. List of items to be completed or corrected will be amended as items are resolved by CONTRACTOR.
- C. When all items have been completed or corrected, submit written certification that the entire work is complete in accordance with the Contract Documents and request final inspection.
- D. Upon completion of final inspection, ENGINEER will either prepare a written acceptance of the entire work or advise CONTRACTOR of work not complete. If necessary, inspection procedures will be repeated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS

- A. General:
 - 1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
 - 2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
 - 3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.
- B. Preservation:
 - 1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
 - 2. Make documents and Samples available at all times for observation by Engineer.
- C. Making Entries on Drawings:
 - 1. Use an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
 - a. Make annotations with erasable colored pencil conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue

Dimensions:	Graphite
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2. Date entries.
 3. Call attention to entry by "cloud" drawn around area or areas affected.
 4. Legibly mark to record actual changes made during construction, including, but not limited to:
 5. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
 6. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work, and Reference to at least two measurements to permanent surface improvements.
 7. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
 8. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
 9. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
 10. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items that are described in previous subparagraph above.
 11. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
 12. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
 13. Make identification so descriptive that it may be related reliably to Specifications.
 14. Mark and record field changes and detailed information contained in submittals and change orders.
 15. Record actual depths, horizontal and vertical location of underground pipes, duct banks and other buried utilities. Reference dimensions to permanent surface features.
 16. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
 17. Identify location of spare conduits including beginning, ending and routing through pull boxes, and manholes. Record spare conductors, including number and size, within spare conduits, and filled conduits.
 18. Provide schedules, lists, layout drawings, and wiring diagrams.
- D. Maintain Documents Separate From Those Used for Construction:
1. Label documents "RECORD DOCUMENTS."
- E. Keep Documents Current:
1. Record required information at the time the material and equipment is installed and before permanently concealing.
- F. Deliver record documents with transmittal letter containing date, Project title, CONTRACTOR's name and address, list of documents, and signature of CONTRACTOR.
- G. During progress meetings, record documents will be reviewed to ascertain that changes have been recorded.
- H. Final Schedule Submittal in accordance with Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.

3.2 FINAL CLEANING

- A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.
1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner.
 2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
 3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
 4. Clean all windows.
 5. Clean and wax wood, vinyl, or painted floors.
 6. Broom clean exterior paved driveways and parking areas.
 7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
 8. Rake and clean all other surfaces.
 9. Remove snow and ice from access to buildings.
 10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
 11. Leave water courses, gutters, and ditches open and clean.
 12. Perform final cleaning prior to inspections for Final Acceptance.
 13. Employ skilled workers who are experienced in cleaning operations.
 14. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.
 15. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.
 16. Clean roofs, gutters, downspouts, and drainage systems.
 17. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
 - a. Police yards and grounds to keep clean.
 18. Remove dust, cobwebs, and traces of insects and dirt.
 19. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.
 20. Remove non-permanent protection and labels.
 21. Polish waxed woodwork and finish hardware.
 22. Wash tile.
 23. Wax and buff hard floors, as applicable.
 24. Wash and polish glass, inside and outside.
 25. Wash and shine mirrors.
 26. Polish glossy surfaces to clear shine.
 27. Vacuum carpeted and soft surfaces.
 28. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.
 29. Clean ducts, blowers and coils when units were operated without filters during construction.
 30. Clean light fixtures and replace burned-out or dim lamps.
- B. Use only cleaning materials recommended by Manufacturer of surfaces to be cleaned.

3.3 WASTE DISPOSAL

- A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
1. Prior to making disposal on private property, obtain written permission from OWNER of such property.
- B. Do not fill ditches, washes, or drainage ways which may create drainage problems.
- C. Do not create unsightly or unsanitary nuisances during disposal operations.

- D. Maintain disposal site in safe condition and good appearance.
- E. Complete leveling and cleanup prior to Final Acceptance of the Work.

3.4 TOUCH-UP AND REPAIR

- A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Final Acceptance.
- B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

3.5 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF PLANT FACILITIES

- A. Clean channels, pipe, basins, reservoirs, and tanks before running of 7-day test, or before facility goes on stream when 7-day test is not required.
- B. Wash, wherever practicable, or broom sweep channels, pipe, basins, reservoirs, and tanks.
- C. Disinfect piping intended to carry potable water as follows or in accordance with American Water Works Association Standards.
- D. Provide ample sampling outlets in pipe for testing.
- E. Fill pipe with chlorine solution of sufficient strength to retain residual of not less than 10 parts per million at end of 24 hours.
- F. After disinfection, rinse entire potable water system with potable water sufficient to reduce chlorine residual to not more than 0.6 parts per million throughout system before system is put into service.

3.6 CLOSEOUT DOCUMENTS

- A. Submit following Closeout Submittals upon completion of the Work and at least 7 days prior to submitting Application for Final Payment:
 - 1. Evidence of Compliance with Requirements of Governing Authorities.
 - 2. Project Record Documents.
 - 3. Operation and Maintenance Manuals.
 - 4. Warranties and Bonds.
 - 5. Keys and Keying Schedule.
 - 6. Evidence of Payment and Release of Stop Payment Notices as outlined in Conditions of the Contract.
 - 7. Release of claims as outlined in Conditions of the Contract.
 - 8. Survey Record Documents as specified in Section 01 72 20, FIELD ENGINEERING.
 - 9. Certificate of Final Completion.

END OF SECTION

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Summary includes: detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.
- B. Related sections:
 - 1. Section 01 77 00 – Closeout Procedures.

1.2 DEFINITIONS

- A. Preliminary Data: Initial and subsequent submissions for Engineer's review.
- B. Final Data: Engineer-accepted data, submitted as specified herein.
- C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.3 SEQUENCING AND SCHEDULING

- A. Equipment and System Data:
 - 1. Preliminary Data:
 - a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
 - b. Submit prior to shipment date.
 - 2. Final Data:
 - a. Submit Instructional Manual Formatted data not less than 30 days prior to equipment or system field functional testing.
- B. Materials and Finishes Data:
 - 1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
 - 2. Final Data: Submit within 10 days after final inspection.

1.4 DATA FORMAT

- A. Prepare preliminary data in the form of an instructional manual. Prepare final data in the form of an instructional manual and in electronic media format.
- B. Instructional Manual Format:
 - 1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
 - 2. Size: 8-1/2" x 11" minimum.
 - 3. Cover: Identify manual with typed or printed title "OPERATION AND MAINTENANCE DATA" and list:
 - a. Project title.
 - b. Designate applicable system, equipment, material, or finish.
 - c. Identity of separate structure as applicable.
 - d. Identity of general subject matter covered in manual.
 - e. Identity of equipment number and Specification section.
 - 4. Title Page:

- a. Contractor name, address, and telephone number.
 - b. Subcontractor, Supplier, installer, or maintenance contractor's name, address, and telephone number, as appropriate.
 - 1). Identify area of responsibility of each.
 - 2). Provide name and telephone number of local source of supply for parts and replacement.
5. Table of Contents:
- a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
 - b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
6. Paper: 20-pound minimum, white for typed pages.
7. Text: Manufacturer's printed data, or neatly typewritten.
8. Three-hole punched data for binding and composition; arrange printing so that punched holes do not obliterate data.
9. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Electronic Media Format:

- 1. Portable Document Format (PDF):
 - a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.
 - b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.
 - c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.

1.5 SUBMITTALS

A. Procedures of Submittal

- 1. Contractor shall:
 - a. Submit all submittals electronically using the **Info Exchange** project website to facilitate the transfer of submittals and related files.
 - b. Submit all required final hard copies and required electronic copies as specified herein.

B. Informational:

- 1. Data Outline: Submit one electronic copy via the **Info Exchange** website of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
- 2. Preliminary Data:
 - a. Submit one electronic copy for Engineer's review.
 - b. If data meets conditions of the Contract:
 - 1). One electronic copy will be returned to Contractor.
 - 2). One electronic copy will be forwarded to Resident Project Representative.
 - 3). One electronic copy will be retained in Engineer's file
 - c. If data does not meet conditions of the Contract:
 - 1). One electronic copy will be returned to Contractor with Engineer's comments (on separate document) for revision.
 - 2). Engineer's comments will be retained in Engineer's file.
 - 3). One electronic copy will be retained in Engineer's file.
 - 4). Re-submit one electronic copy revised in accordance with Engineer's comments.
- 3. Final Data: Submit two hard copies and one electronic copy in each format specified herein.

1.6 DATA FOR EQUIPMENT AND SYSTEMS

- A. Content for Each Unit (or Common Units) and System:
1. Product Data:
 - a. Include only those sheets that are pertinent to specific product.
 - b. Clearly annotate each sheet to:
 - 1). Identify specific product or part installed.
 - 2). Identify data applicable to installation.
 - 3). Delete references to inapplicable information.
 - c. Function, normal operating characteristics, and limiting conditions.
 - d. Performance curves, engineering data, nameplate data, and tests.
 - e. Complete nomenclature and commercial number of replaceable parts.
 - f. Original Manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
 - g. Spare parts ordering instructions.
 - h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, and terminals).
 2. As-installed, color-coded piping diagrams.
 3. Charts of valve tag numbers, with the location and function of each valve.
 4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
 - a. Format:
 - 1). Provide reinforced, punched, binder tab; bind in with text.
 - 2). Reduced to 8-1/2" x 11", or 11" x 17" folded to 8-1/2" x 11".
 - 3). Where reduction is impractical, fold and place in 8-1/2" x 11" envelopes bound in text.
 - 4). Identify Specification section and product on Drawings and envelopes.
 - b. Relations of component parts of equipment and systems.
 - c. Control and flow diagrams.
 - d. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
 5. Instructions and Procedures: Within text, as required to supplement product data.
 - a. Format:
 - 1). Organize in consistent format under separate heading for each different procedure.
 - 2). Provide logical sequence of instructions for each procedure.
 - 3). Provide information sheet for Owner's personnel, including:
 - a). Proper procedures in event of failure.
 - b). Instances that might affect validity of guarantee or Bond.
 - b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
 - c. Operating Procedures:
 - 1). Startup, break-in, routine, and normal operating instructions.
 - 2). Test procedures and results of factory tests where required.
 - 3). Regulation, control, stopping, and emergency instructions.
 - 4). Description of operation sequence by control Manufacturer.
 - 5). Shutdown instructions for both short and extended duration.
 - 6). Summer and winter operating instructions, as applicable.
 - 7). Safety precautions.
 - 8). Special operating instructions.
 - d. Maintenance and Overhaul Procedures:
 - 1). Routine maintenance.
 - 2). Guide to troubleshooting.
 - 3). Disassembly, removal, repair, reinstallation, and re-assembly.
 6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, CLOSEOUT PROCEDURES.

- B. Content for Each Electric or Electronic Item or System:
1. Description of Unit and Component Parts:
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data, nameplate data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Interconnection wiring diagrams, including control and lighting systems.
 2. Circuit Directories of Panelboards:
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
 3. List of electrical relay settings, and control and alarm contact settings.
 4. Electrical interconnection wiring diagram, including control and lighting systems.
 5. As-installed control diagrams by control Manufacturer.
 6. Operating Procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Safety precautions.
 - d. Special operating instructions.
 7. Maintenance Procedures:
 - a. Routine maintenance.
 - b. Guide to troubleshooting.
 - c. Adjustment and checking.
 - d. List of relay settings, control and alarm contact settings.
 8. Manufacturer's printed operating and maintenance instructions.
 9. List of original Manufacturer's spare parts, Manufacturer's current prices, and recommended quantities to be maintained in storage.
- C. Maintenance Summary:
1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
 2. Format: Use only 8-1/2" x 11" size paper.
 3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
 4. Recommended Spare Parts:
 - a. Data to be consistent with Manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
 - b. "Unit" is the unit of measure for ordering the part.
 - c. "Quantity" is the number of units recommended.
 - d. "Unit Cost" is the current purchase price.

1.7 DATA FOR MATERIALS AND FINISHES

- A. Content for Architectural Products, Applied Materials, and Finishes:
1. Manufacturer's data, giving full information on products:
 - a. Catalog number, size, and composition.
 - b. Color and texture designations.
 - c. Information required for reordering special-manufactured products.
 2. Instructions for Care and Maintenance:
 - a. Manufacturer's recommendation for types of cleaning agents and methods.
 - b. Cautions against cleaning agents and methods that are detrimental to product.
 - c. Recommended schedule for cleaning and maintenance.
 3. Content for Moisture Protection and Weather Exposed Products:
 4. Manufacturer's data, giving full information on products:
 - a. Applicable standards.
 - b. Chemical composition.

- c. Details of installation.
- 5. Instructions for inspection, maintenance, and repair.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 79 00 – DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of the required demonstration and training for the project:
 - 1. Providing and delivering informational submittals.
 - 2. Submitting required qualifications of Manufacturer's Representative.
 - 3. Preparing, maintaining, providing and delivering Manufacturer's Certificate of Compliance and Manufacturer's Certificate of Proper Installation.
 - 4. Furnishing required Training.
 - 5. Furnishing required Equipment Testing, Unit Process and Facility Performance Demonstration.
- B. Related Sections
 - 1. Section 01 31 19 – Project Meetings.
 - 2. Section 01 32 00 – Construction Progress Documentation.
 - 3. Section 01 78 23 – Operation and Maintenance Data.

1.2 DEFINITIONS

- A. Person-Day: One person for 8 hours within regular Contractor working hours.
- B. Facility: Entire Project, or an agreed-upon portion including all unit processes.
- C. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets Manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.
- D. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.
- E. Unit Process: As used in this Section, a unit process is a portion of the facility that performs a specific process function, such as, but not limited to:
 - 1. Vertical dry pit centrifugal pumps
- F. Facility Performance Demonstration:
 - 1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
 - 2. Such demonstration is for the purposes of:
 - a. Verifying to Owner entire facility performs as a whole, and
 - b. Documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.3 SUBMITTALS

- A. Informational Submittals:

1. Training Schedule: Submit not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.
2. Lesson Plan: Submit proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
3. Training Session Tapes: Furnish Owner with two complete sets of DVDs fully indexed and cataloged with printed label stating session and date taped.
4. Facility Startup and Performance Demonstration Plan.
5. Functional and performance test results.
6. Completed Unit Process Startup Form for each unit process.
7. Completed Facility Performance Demonstration/Certification Form.

1.4 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

- A. Authorized representative of the Manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment Manufacturer to issue the certifications required of the Manufacturer. Additional qualifications may be specified elsewhere.
- B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

1.5 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

- A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:
 1. Step-by-step instructions for startup of each unit process and the complete facility.
 2. Unit Process Startup Form (sample attached), to minimally include the following:
 - a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
 - b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
 - c. Startup requirements for each unit process, including water, power, chemicals, etc.
 - d. Space for evaluation comments.
 3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
 - a. Description of unit processes included in the facility startup.
 - b. Sequence of unit process startup to achieve facility startup.
 - c. Description of computerized operations, if any, included in the facility.
 - d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
 - e. Signature spaces for Contractor and Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Furnish Manufacturers' services when required by an individual specification section, to meet the requirements of this Section.
- B. Where time is necessary in excess of that stated in the Specifications for Manufacturer's services, or when a minimum time is not specified, the time required to perform the specified services shall be considered incidental.

- C. Schedule Manufacturer's services to avoid conflict with other onsite testing or other Manufacturer's onsite services.
 - D. Determine, before scheduling services, that all conditions necessary to allow successful testing have been met.
 - E. Only those days of service approved by Engineer will be credited to fulfill the specified minimum services.
 - F. When specified in individual specification sections, Manufacturer's onsite services shall include:
 - 1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
 - 2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by Manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
 - 3. Providing, on a daily basis, copies of all Manufacturer's representatives' field notes and data to Engineer.
 - 4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
 - 5. Resolution of assembly or installation problems attributable to or associated with, respective Manufacturer's products and systems.
 - 6. Assistance during functional and performance testing, and facility startup and evaluation.
 - 7. Training of Owner's personnel in the operation and maintenance of respective product as required.
 - 8. Additional requirements may be specified elsewhere.
 - G. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, PROJECT MEETINGS, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.
 - H. Contractor's Testing and Startup Representative:
 - 1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
 - 2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.
 - I. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.
 - J. Provide Subcontractor and equipment Manufacturer's with adequate staff to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.
 - K. Owner will:
 - 1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
 - 2. Operate process units and facility with support of Contractor.
 - 3. Provide labor and materials as required for laboratory analyses.
- 3.2 MANUFACTURER'S CERTIFICATE OF COMPLIANCE
- A. When specified in individual Specification section, submit prior to shipment of product or material.

- B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
- C. Signed by product Manufacturer certifying that product or material specified conforms to or exceeds specified. Attach supporting reference data, affidavits, and certifications as appropriate.
- D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.3 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

- A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this Section, shall be completed and signed by the equipment Manufacturer's representative.
- B. Such form shall certify that the signing party is a duly authorized representative of the Manufacturer, is empowered by the Manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to assure that the equipment is complete and operational.

3.4 TRAINING

- A. General:
 1. Furnish Manufacturer's representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
 2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
 3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
 4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.
- B. Training Schedule:
 1. List specified equipment and systems that require training services and show:
 - a. Respective Manufacturer.
 - b. Estimated dates for installation completion.
 - c. Estimated training dates.
 2. Allow for multiple sessions when several shifts are involved.
 3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by Manufacturer's representatives. Adjust schedule for interruptions in operability of equipment.
 4. Coordinate with Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.
- C. Lesson Plan: When Manufacturer or vendor training of Owner personnel is specified, prepare for each required course, containing the following minimum information:
 1. Title and objectives.
 2. Recommended types of attendees (e.g., managers, engineers, operators, maintenance).
 3. Course description and outline of course content.
 4. Format (e.g., lecture, self-study, demonstration, hands-on).
 5. Instruction materials and equipment requirements.
 6. Resumes of instructors providing the training.

- D. Pre-startup Training:
 - 1. Coordinate training sessions with Owner's operating personnel and Manufacturer's representatives, and with submission of operation and maintenance manuals in accordance with Section 01 78 23, OPERATIONS AND MAINTENANCE DATA.
 - 2. Complete at least 14 days prior to beginning of facility startup.
- E. Post-startup Training: If required in Specifications furnish and coordinate training of Owner's operating personnel by respective Manufacturer's representatives.
- F. Taping of Training Sessions:
 - 1. Furnish audio and color video taping of all instruction sessions, including Manufacturer's representatives, hands-on equipment instruction and classroom sessions.
 - 2. Video training DVDs shall be produced by a qualified, professional video specialist approved by Owner.
 - 3. Use DVD format, suitable for playback on standard equipment available commercially in the United States.

3.5 EQUIPMENT TESTING

- A. Preparation:
 - 1. Complete installation before testing.
 - 2. Furnish qualified Manufacturer's representatives, when required by individual Specification sections.
 - 3. Obtain and submit from equipment Manufacturer's representative Manufacturer's Certificate of Proper Installation Form when required by individual Specification sections.
 - 4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
 - a. Owner/Project Name.
 - b. Equipment or item tested.
 - c. Date and time of test.
 - d. Type of test performed (Functional or Performance).
 - e. Test method.
 - f. Test conditions.
 - g. Test results.
 - h. Signature spaces for Contractor and Engineer as witness.
 - 5. Cleaning and Checking: Prior to beginning functional testing:
 - a. Calibrate testing equipment in accordance with Manufacturer's instructions.
 - b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
 - c. Lubricate equipment in accordance with Manufacturer's instructions.
 - d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
 - e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - f. Check power supply to electric-powered equipment for correct voltage.
 - g. Adjust clearances and torque.
 - h. Test piping for leaks.
 - 6. Ready-to-test determination will be by Engineer-based at least on the following:
 - a. Acceptable Operation and Maintenance Data.
 - b. Notification by Contractor of equipment readiness for testing.
 - c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
 - d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
 - e. Availability and acceptability of Manufacturer's representative, when specified, to assist in testing of respective equipment.
 - f. Satisfactory fulfillment of other specified Manufacturer's responsibilities.

- g. Equipment and electrical tagging complete.
- h. Delivery of all spare parts and special tools.

B. Functional Testing:

- 1. Conduct as specified in individual Specification sections.
- 2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
- 3. Prepare Equipment Test Report summarizing test method and results.
- 4. When in Engineer's opinion, equipment meets functional requirements specified such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

- 1. Conduct as specified in individual Specification sections.
- 2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
- 3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
- 4. Type of fluid, gas, or solid for testing shall be as specified.
- 5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
- 6. Prepare Equipment Test Report summarizing test method and results.
- 7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.6 STARTUP OF UNIT PROCESSES

- A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.
- B. Startup sequencing of unit processes shall be as chosen by Contractor to meet schedule requirements.
- C. Make adjustments, repairs, and corrections necessary to complete unit process startup.
- D. Startup shall be considered complete when, in opinion of Engineer, unit process as operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.
- E. Significant Interruption: May include any of the following events:
 - 1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
 - 2. Failure to meet specified functional operation for more than 2 consecutive hours.
 - 3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
 - 4. Failure of any non-critical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
 - 5. As determined by Engineer.
- F. A significant interruption will require startup then in progress to be stopped. After corrections are made; start up test period and start from beginning again.

3.7 FACILITY PERFORMANCE DEMONSTRATION

- A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.
- B. Demonstrate proper operation of required interfaces within and between individual unit processes.
- C. After facility is operating, complete performance testing of equipment and systems not previously tested.
- D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility.
- E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic operation.

3.8 SUPPLEMENTS

- A. Supplements listed below, following "End of Section", are a part of this Specification:
 - 1. Manufacturer's Certificate of Proper Installation Form.
 - 2. Unit Process Startup Form.
 - 3. Facility Performance Demonstration/Certification Form.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER: _____ EQUIP. SERIAL NO: _____

EQUIP. TAG NO: _____ EQUIP. SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above referenced equipment/system has been:

(Check Applicable)

<input type="checkbox"/>	Installed in accordance with Manufacturer's recommendations.
<input type="checkbox"/>	Inspected, checked, and adjusted.
<input type="checkbox"/>	Serviced with proper initial lubricants.
<input type="checkbox"/>	Electrical and mechanical connections meet quality and safety standards.
<input type="checkbox"/>	All applicable safety equipment has been properly installed.
<input type="checkbox"/>	Functional tests.
<input type="checkbox"/>	System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments:

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate its equipment, and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20__.

Manufacturer: _____

By Manufacturer's Authorized Representative: _____
 (Authorized Signature)

UNIT PROCESS STARTUP FORM

OWNER: _____ PROJECT: _____

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure: (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):

Evaluation Comments:

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER: _____ PROJECT: _____

Unit Process Description: (List unit processes involved in facility startup):

Unit Processes Startup Sequence: (Describe sequence for startup, including computerized operations if any):

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ Date: _____, 20 ____

Engineer: _____ Date: _____, 20 ____

SECTION 01 80 01 – COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Responsibilities of the OWNER, ENGINEER, and CONTRACTOR during the Commissioning Phase of the Project.
- B. Related sections:
 - 1. Section 01 75 60 – Testing, Training, and Facility Start-Up.

1.2 DEFINITIONS

- A. Commissioning: The sequential process in which a newly constructed facility, comprised of concrete basins interconnected with hydraulic conveyance structures and equipped with miscellaneous process oriented equipment, is put into successful operation.
- B. Automatic/SCADA Operational Mode: The definition of the automatic/SCADA operational mode centers around the designed remote control and monitoring capability of the control system.
- C. Facility Start-Up
- D. Manual Operational Mode: This operational mode represents the lowest level of control philosophy utilized in the plant instrumentation and control design. For all practical purposes, this means that an operational control decision requiring equipment or process monitoring and/or control will require an individual to physically go to the local control for the associated task in order to operate the facility. Normal prestart-up activities of exercising of the equipment is traditionally accomplished in this mode. In the manual operational mode, the focus will be on verifying that the equipment and processes function correctly, independent of the instrumentation system and control system.
- E. Successful Operation: The resultant operation of all the processes and related controls in a manner that is consistent with the design intent and treatment objectives.

1.3 SUBMITTALS

- A. Preventive and Unscheduled Maintenance Plan: Submit detailed plan prior to start of 7-day test for providing all preventive and unscheduled maintenance of all equipment and facilities in the plant throughout the entire commissioning phase of the project prior to start of 7-day test.
- B. OWNER's Personnel Training Schedule and Plan: Submit detailed plan and schedule for training OWNER's personnel in accordance with Section 01 75 60, Testing, Training and Facility Start-Up.

1.4 REQUIREMENTS

- A. Commissioning Process will commence after successful completion of 7-day test and issuance of Substantial Completion to CONTRACTOR.
- B. Commissioning Process will be 30 days in duration.
- C. During the course of the Commissioning Process, the ENGINEER and OWNER will evaluate design related issues and recommend design modifications which shall be implemented by the CONTRACTOR through the Change Order process.

1.5 RESPONSIBILITIES

- A. Responsibilities listed do not relieve the CONTRACTOR from all other responsibilities and duties associated with project closeout as defined in the OWNER's agreement with the CONTRACTOR and DIVISION 01 of the Specifications.
1. CONTRACTOR's Responsibilities During the Commissioning Process:
 - a. All Change Order work resulting from the evaluation of design-related issues by the ENGINEER and OWNER.
 2. All preventive and unscheduled maintenance of all equipment and facilities in the plant. This shall include, but not be limited to the following:
 - a. Providing all lubricants.
 - b. Lubrication of all equipment in accordance with manufacturer's recommendations.
 - c. Perform all manufacturer recommended preventive maintenance.
 - d. Exercise all equipment not in use during Commissioning phase.
 - e. Repair all failed equipment.
 - f. Periodic check of all equipment alignment, vibration, and noise levels in accordance with Specifications.
 - g. Provide all parts required for equipment repair.
 - h. Provide all tools and miscellaneous equipment required for equipment repair.
 - i. Administration/logging/documentation of all preventive maintenance and repair work.
 - j. Cleanup associated with equipment failure and repair.
 - k. Daily cleanup of buildings.
 - l. Landscaping maintenance.
 - m. Roadway cleanup and maintenance.
 - n. Replacement of all HVAC filters.
 3. Warranty related issues/items.
 4. OWNER's personnel training required after successful completion of the 7-day testing.
 5. Assist in transition to Automatic/SCADA operational mode.
 6. Other contractual requirements including, but not limited to, incomplete work list.
- B. OWNER's Responsibilities During the Commissioning Process:
1. Provide all chemicals required for plant operations, including scheduling and securing of chemical deliveries to the plant and respective storage tanks.
 2. Perform all laboratory analysis required for plant operations.
 3. Review training schedules and plans, and schedule personnel training.
 4. Assisting ENGINEER in the evaluation of design related issues and recommendations of modifications to be implemented by the CONTRACTOR through the change order process.
 5. Provide staff for Commissioning.
 6. Operation of facilities.
- C. ENGINEER's Responsibilities During Commissioning Process:
1. Provide OWNER with programming support during the Commissioning Process.
 2. Provide liaison and coordination between CONTRACTOR and OWNER's activities.
 3. Administer Change Order work performed by CONTRACTOR.
 4. Provide coordination of all other project closeout related issues/items.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 81 00 – PROJECT DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Project design criteria such as temperature and site elevation.

1.2 PROJECT DESIGN CRITERIA

- A. All equipment and materials for the project are to be suitable for performance in the wastewater treatment plant environment and under following conditions:
 1. Design temperatures are:
 - a. Outdoor temperatures: 25 to 105 degrees Fahrenheit.
 - b. Indoor temperatures for the following buildings:
 - 1) Process areas: 55 to 85 degrees Fahrenheit.
 - 2) Electrical rooms: 60 to 85 degrees Fahrenheit.
 2. Design groundwater elevation: 605.00 Ft. El; this is the site's 100-year flood elevation.
 3. Frost line is assumed 36 inches below grade.
 4. Moisture conditions: Defined in individual equipment sections.
 5. Site elevation: Generally ranges from 612 to 615 feet above mean sea level.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 81 02 – SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Seismic design criteria for the following:
 - 1. Anchorage of mechanical and electrical equipment.
 - 2. Seismic design and design of anchorage for small tanks fabricated off site and shipped to the Project site.
 - 3. Other structures or items as specified or indicated on the Drawings.
- B. Related sections:
 - 1. Section 01 41 00 – Regulatory Requirements.

1.2 REFERENCES

- A. American Society of Civil Engineers (ASCE):
 - 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures

1.3 SYSTEM DESCRIPTION

- A. Design requirements:
 - 1. Design in accordance with the requirements of the building code as specified in Section 01 41 00:
 - a. Soil Site Class: D
 - b. Design spectral acceleration at short period, S_{DS} : 0.274g.
 - c. Design spectral acceleration at short period, S_{D1} : 0.123g.
 - d. Seismic Design Category: B
 - e. Importance Factor, I : 1.25
 - f. Component amplification factor, a_p : In accordance with ASCE 7-05, Tables 13.5.1 and 13.6-1.
 - g. Component response modification factor, R_p : In accordance with ASCE 7 05, Tables 13.5-1 and 13.6-1.
 - h. Component importance factor, I_p : 1.50.
 - 2. Do not use friction to resist sliding due to seismic forces.
 - 3. Do not use more than 60 percent of the weight of the mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.
 - 4. Do not use more than 60 percent of the weight of the tank for resisting overturning due to seismic forces.
 - 5. Use anchor bolts, bolts, or welded studs for anchors for resisting seismic forces. Anchor bolts used to resist seismic forces shall have a standard hex bolt head embedded in the concrete. Do not use anchor bolts fabricated from rod stock with an L or J shape.
 - 6. Do not use chemical anchors, concrete anchors, flush shells, powder actuated fasteners, sleeve anchors, or other types of anchors unless indicated on the Drawings or accepted in writing by the ENGINEER.
 - 7. Seismic forces must be resisted by direct bearing on the fasteners used to resist seismic forces. Do not use connections that use friction to resist seismic forces.

1.4 SUBMITTALS

- A. Shop drawings and calculations: Complete shop drawings and seismic calculations.
- B. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state where the Project is located.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

DIVISION 2
EXISTING CONDITIONS

SECTION 02 41 00 - DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Portions of buildings and other areas, equipment and materials selective demolition, and partial demolition work are as shown on Drawings and specified herein.
 - 2. Equipment and materials to be removed for construction and reinstalled for reuse or continued operation are as shown on the drawings and specified herein.

1.2 SUBMITTALS

- A. Shop Drawings: Plans showing all equipment and materials to be removed and reinstalled for reuse on continued operation including interim storage plans for each item.
- B. Quality Control Submittals:
 - 1. Schedule of demolition, as part of and consistent with the progress schedule specified in Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.
 - 2. Methods of demolition and equipment proposed to demolish each structure.
 - 3. Copies of any authorizations and permits required to perform Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Utilities:
 - 1. Notify Owner and appropriate utilities 72 hours prior to turning off affected services before starting demolition or alterations.
 - 2. Remove utility lines exposed by demolition excavation.
 - 3. Remove electric, sanitary, and storm drainage adjacent to buildings to be demolished.
 - 4. Excavate utility lines serving buildings to be demolished and provide a permanent leak-proof closure for water and gas lines.
 - 5. Plug sewer lines at locations shown or at limits of excavation if not shown with min. 2,000 psi compressive strength concrete plug to prevent groundwater infiltrating sewer systems. Length of plug shall be 5 feet minimum.
- B. Removal and Storage of Equipment for Reuse:
 - 1. Do not remove equipment and materials without approval of Engineer.
 - 2. Properly store and maintain equipment and materials in same condition as when removed.
 - 3. Engineer will determine condition of equipment and materials prior to removal.

3.2 DEMOLITION

- A. Drawings define minimum portion of equipment to be removed and structures to be modified. Unless otherwise shown, rough cuts or breaks may be made exceeding limits of demolition shown.
- B. Provide all demolition, removal, temporary storage, and reinstallation of existing equipment as required for implementation of the work.

- C. Core drill floor slabs, catch basins, and other concrete improvements to remain in place below ground, or break holes at structure's lowest point to allow water to freely migrate through.
- D. Remove piping from areas to be backfilled. Pipe, valves, and fittings adjacent to those to be removed may also be removed as salvage.
- E. Remove all materials associated with existing equipment that is to be removed or relocated.
- F. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
- G. Cut off drilled piers a minimum of 6 inches below bottom of new foundations.
- H. Demolish existing concrete structure to 18" below grade.

3.3 DISPOSAL

- A. Dispose of debris and other non-salvaged materials offsite in licensed landfills.

3.4 BACKFILLING

- A. Demolished Areas: Backfill to existing ground level, elevations shown, or foundation level of new construction.
- B. Backfill Material and Compaction:
 - 1. For fill in structures, use sand conforming to AHTD Standard Specifications for Highway Construction, Section 802.02(b) Fine Aggregate, otherwise conform to Section 31 23 23.13, FILL AND BACKFILL. Top 6" of backfill to grade shall be select fill conforming to Section 31 23 23.13 FILL AND BACKFILL and shall be compacted to 90% standard proctor density.
 - 2. Do not use demolition debris as backfill material.

3.5 SALVAGE

- A. Equipment and materials not reused or reinstalled, including all metals and piping within the limits of demolition, unless otherwise specified, shall be delivered to the Owner for scrap.

END OF SECTION

DIVISION 3
CONCRETE

SECTION 03 01 00 - CONCRETE SURFACE REPAIR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Resurfacing of concrete surfaces in preparation for finish materials.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T277, Standard Method of Test for Rapid Determination of the Chloride Permeability of Concrete.
 2. ASTM International (ASTM):
 - a. A 82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A 185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 - c. C 78, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
 - d. C 109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
 - e. C 309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - f. C 348, Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.
 - g. C 469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
 - h. C 496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - i. C 596, Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement.
 - j. C 666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - k. C 672, Standard Test Method for Scaling Resistance for Concrete Surfaces Exposed to Deicing Chemicals.
 - l. C 779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - m. C 882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - n. C 928, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repair.
 - o. C 1012, Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution.
 - p. C 1202, Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetration.
 - q. E 699, Criteria for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee.

1.3 DEFINITIONS

- A. Low Pressure Spray Mortar: Mortar designated by "S" before the product number, applied by low pressure spraying, or in small areas by hand troweling.

- B. Surface Repair Areas: Areas that are deemed to be defective and not meeting the density or surface specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, regardless of depth of the defective area.

1.4 SUBMITTAL

- A. Information Submittals:
 - 1. Mortar System:
 - a. Manufacturer's installation bulletin.
 - b. Manufacturer's recommended fabric size for mesh reinforcement.
 - 2. Written description of equipment proposed for hydro-demolition surface preparation.
 - 3. Certificates:
 - a. Certificate of Compliance that proposed product systems meet or exceed specified performance criteria when tested in accordance with Article FIELD QUALITY CONTROL.
 - b. Mortar system Manufacturer's Certificate of Proper Installation.
 - 4. Statements of Qualification:
 - a. Independent testing laboratory.
 - b. Mortar system Manufacturer's representative.
 - 5. Mortar system Manufacturer's proposed modified test procedures for ASTM C 109 and ASTM C 882 test methods.
 - 6. Independent testing laboratory test report.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Independent Testing Laboratory: Based on evaluation of laboratory submitted criteria in accordance with ASTM E 699.
 - 2. Mortar System Applicator: For low pressure spray mortar system in lieu of endorsement, complete mortar system manufacturer's demonstration in accordance with Article MANUFACTURER'S SERVICES.

PART 2 - PRODUCTS

2.1 LOW PRESSURE SPRAY MORTAR SYSTEM (FOR VERTICAL AND OVERHEAD REPAIRS)

- A. Mortar:
 - 1. One component, rheoplastic, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.
 - 2. Cured materials mixed to a flow of 70%, at five drops shall conform to the following criteria:
 - a. Minimum Slant Shear Bond Strength: 3,000 psi in 28 days in accordance with "modified" ASTM C 882 test method.
 - b. Minimum Compressive Strength: 11,000 psi at 28 days in accordance with ASTM C 109.
 - c. Minimum Direct Shear Bond Strength: 650 psi in 28 days in accordance with Michigan DOT.
 - d. Minimum Tensile Bond Strength (MBT In-House Test): 300 psi. in 28 days.
 - e. Minimum Flexural Properties: 1,250 psi in 28 days in accordance with ASTM C 348.
 - f. Modulus of Elasticity: 4.1 to 4.5 by 106 psi in accordance with ASTM C 469.
 - g. Maximum Permeability: 1,000 coulombs in accordance with AASHTO T 277.
 - h. System shall not produce a vapor barrier.
- B. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.

- C. Free of chlorides and other chemicals causing corrosion.
- D. Manufacturer and Product:
 - 1. Master Builders Technologies Co., Cleveland, OH; EMACO S88CA with Concreive liquid (LPL) bonding agent for hand applied areas.
 - 2. Sika Corp., Lyndhurst, NJ; SikaRepair 224.

2.2 POLYMER-MODIFIED REPAIR MORTAR (HORIZONTAL SURFACE REPAIR)

- A. Mortar: One component, polymer-modified, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar conforming to the following properties:
 - 1. Bond strength in accordance with ASTM C 1042 Test Method at 7 days: Minimum 1,750 psi.
 - 2. Modules of Elasticity: ASTM C469, minimum 2.0 by 10⁶ psi.
 - 3. Compressive Strength:
 - a. ASTM C 109 at 1 day: minimum 2,500 psi.
 - b. ASTM C 109 at 28 days: minimum 7,500 psi.
 - 4. Flexural Properties, ASTM C 348 at 28 days: minimum 1,200 psi.
 - 5. Permeability, AASHTO T 277: 800 coulombs maximum.
 - 6. Splitting Tensile Strength: ASTM C 496 at 7 days, minimum 450 psi.
 - 7. Drying Shrinkage, ASTM C 596 at 28 days: -0.090%.
 - 8. Freeze Thaw Resistance, ASTM C 666, at 300 cycles: 95% RDF.
 - 9. Abrasion Resistance: ASTM C 799, 60 minutes, 0.0165".
- B. Manufacturers and Products:
 - 1. Master Builders Technologies Co., Cleveland, OH; EMACO R 310
 - 2. Or approved equal.

2.3 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.4 ACCESSORIES

- A. Finishing Aid Manufacturer and Product: Master Builders Inc., Cleveland, OH; CONFILM.
- B. Flexible Cementitious Rebar Coating Manufacturer and Product: Master Builders Inc., Cleveland, OH; EMACO P22.

PART 3 - EXECUTION

3.1 GENERAL

- A. Where required because of deficiencies, concrete surface repair system shall be low pressure spray mortar for structural repairs.

3.2 PREPARATION

- A. Remove unsound and deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16" or as shown. Remove to provide for maximum thickness specified for mortar.
- B. High pressure water blasting machines with 16,000 to 20,000 psi minimum.

- C. Collect and dispose of water from removal operations in manner and location acceptable to Owner.
- D. Do not use power-driven jackhammers and chipping hammers, unless water blasting is prohibited due to potential damage to installed equipment.
- E. Remove concrete minimum of 1" clearance around rebar for application and bonding of new mortar to entire periphery of exposed rebar if the following surface conditions exist:
 1. 50% or more of periphery around rebar is exposed during removal of concrete.
 2. 25% or more of periphery around rebar is exposed during removal of concrete and corrosion has eventuated to the extent that loss of section has occurred.
 3. Bond between existing concrete and reinforcement has deteriorated.
- F. Clean exposed reinforcing bars of rust and concrete, and coat with flexible cementitious rebar coating.
- G. Maintain surface areas free of slurry where concrete has been removed. Remove slurry from prepared areas before new mortar is applied.
- H. Clean surface areas to be filled with new mortar of laitance and contamination by high pressure water blasting not more than 24 hours before applying bonding agent, Saturated Surface Dry (SSD) existing concrete at time of application of mortar.

3.3 LOW PRESSURE SPRAY MORTAR APPLICATION

- A. Mix mortar in mortar-concrete mixer attached to pump-spray equipment for spray application. Mix with a slow speed drill and jiffler type paddle or small mortar type mixer for hand trowel application.
- B. Apply mortar by low pressure spraying with a machine such as Moynotype, MEYCO DEQUNA Model 20.
- C. Finish mortar with a hand float application to smooth even surface matching adjacent concrete. Provide finishing aid at full strength.
- D. Bonding Agent:
 1. Hand apply bonding agent within 20 minutes of troweling on mortar. Prevent bonding agent from drying by reapplying bonding agent to maintain surface tackiness of coat.
 2. Work mortar firmly and quickly into area and compact with firm trowel stroke. Finish smooth with finishing aid at full strength.

3.4 POLYMER-MODIFIED REPAIR MORTAR APPLICATION FOR REPAIR OF HORIZONTAL SURFACES

- A. Mix mortar in mortar-concrete mixer.
- B. Hand Troweling: Apply (scrub in) a bond coat slurry of the repair mortar to the SSD prepared substrate before application of the mortar. Do not apply more of the bond coat than can be covered with mortar before the bond coat dries. Do not re-temper this bond coat.
- C. Place mortar into prepared area from one side to the other.
- D. Work material firmly into the side and bottom of patch to assure a good bond. Level repair mortar and screed to elevation of existing concrete.

- E. Finish to same texture as existing concrete around patch.
- F. Use self-leveling mixture where appropriate to obtain uniform or plane surface.

3.5 CURING

- A. Water fog nozzle all of the mortar systems prior to curing in accordance with mortar system Manufacturer's instructions.
- B. Commence water curing after mortar system application and when curing will not cause erosion of mortar.
- C. Continuously cure mortar system for a period of 7 days.
- D. Do not membrane cure, unless method is part of mortar system Manufacturer's instructions and approval has been obtained.
- E. Cure intermediate layers of mortar in accordance with manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

- A. Independent testing laboratory shall perform the following:
 - 1. Secure production samples of mixed materials during construction and test for compliance with the Specifications.
 - 2. Obtain actual core samples from the completed repair Work and test.
 - 3. Perform "modified" ASTM C 109 and ASTM C 882 test methods in accordance with manufacturer's approved modifications of testing procedures.
- B. Construction Testing:
 - 1. Production Samples:
 - a. Obtain mixed mortar material from shotcrete or spray equipment and produce samples, and cure samples prior to testing.
 - b. Provide minimum of three samples each test for each 1,000 square feet or portion thereof of mortar repair to be installed.
 - 2. Core Samples of In-Place Repair:
 - a. Obtain two core samples and test samples for each 2,000 square feet or portion thereof for actual repair Work:
 - b. Cores shall be either 2-1/2" or 3" in diameter and shall be cored through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness.
 - c. Sawcut the cores after removal to trim base concrete thickness to same thickness as mortar so that bond line is at center of repaired sample.
 - d. Samples shall be epoxy bonded to steel plates at each end using a bonding agent to prevent failure in bond to steel plates.
 - e. Sustain bond line without failure or movement with a minimum of 300 psi in direct tension. The tension test shall use eyebolts or threaded connectors tapped and threaded into base plate so that tension load is concentric with center of core sample.
- C. Repair and fill holes where core samples have been removed using same mortar used in repair.

3.7 MANUFACTURER'S SERVICES

- A. Provide mortar system manufacturer's representative at site for installation assistance, inspection and certification of proper installation, and training of mortar system applicators.

- B. Mortar System Manufacturer's Demonstration:
 - 1. Schedule a time for Manufacturer's demonstration of repair system proposed for the Project. Prepare mortar, to specified consistency, for testing and placement. Initiate curing on portions of each type of surface to be repaired to include overhead and vertical applications.
 - 2. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
 - 3. Demonstrate:
 - a. Mixing and application equipment capabilities and procedures, including the flow of material from nozzle or sprayer.
 - b. Nozzle operator and person in charge of low pressure sprayer, capabilities and ability to follow prescribed application procedures and properly operate equipment and apply surface repair materials.
 - 4. Make compression test samples during demonstration and deliver to an independent testing laboratory for testing at 1, 7, and 28 days. Take a core of the demonstration placement and test for tensile bond at 1 day.

3.8 PROTECTION

- A. Protect adjacent surfaces, and equipment, from being damaged by overshooting of low pressure spray mortar.

3.9 CLEANING

- A. Remove overshot mortar and deposited rebound materials as Work proceeds. Remove from Work, waste materials, unsound material from concrete surfaces, material chipped from walls, water used in preparation of application and finishing.

END OF SECTION

SECTION 03 15 00 – CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Waterstops.
 - 2. Joint fillers.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
 - 2. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - 3. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
 - 4. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - 5. ASTM D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
 - 6. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 7. ASTM D2240 - Standard Test Method for Rubber Property – Durometer Hardness.
- B. American National Standards Institute (ANSI):
 - 1. ANSI A135.4 - Basic Hardboard.
- C. U. S. Army Corps of Engineers (USACE):
 - 1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Polyvinyl chloride waterstops: Complete physical characteristics.
 - 2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.
- B. Samples:
 - 1. Polyvinyl chloride waterstop.
- C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.
- D. Quality control submittals:
 - 1. Certificates of Compliance:
 - a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
 - 2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.4 QUALITY ASSURANCE

- A. Mock-ups:

1. Welding demonstration:
 - a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

- B. Field joints:
 1. Polyvinyl chloride waterstops field joints: Shall be free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. Replace defective joints. Remove faulty material from the site and disposed of by the CONTRACTOR at its own expense.

- C. Inspections:
 1. Quality of welded joints will be subject to acceptance of the ENGINEER.
 2. Polyvinyl chloride waterstop: The following defects that represent a partial list that will be grounds for rejection:
 - a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
 - b. Exterior crack at joint, due to incomplete bond, which is deeper than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
 - c. Any combination of offset or crack which will result in a net reduction in the cross section of the waterstop in excess of 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
 - d. Misalignment of the joint, which will result in misalignment of the waterstop in excess of 1/2 inch in 10 feet.
 - e. Porosity in the welded joint as evidenced by visual inspection.
 - f. Bubbles or inadequate bonding.

PART 2 - PRODUCTS

2.1 WATERSTOPS

- A. Waterstops - Polyvinyl chloride (PVC):
 1. Manufacturers: One of the following or equal:
 - a. Vinylex Corporation.
 - b. Greenstreak Plastic Products Company, Inc.
 2. Type: Ribbed waterstop:
 - a. Construction joints: 6-inch wide ribbed type. Vinylex R638, Greenstreak 679, or equal.
 - b. Construction joints for slab to wall intersections: 4-inch wide ribbed type. Vinylex R4316T, Greenstreak 781, or equal.
 - c. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb. Vinylex RB638H, Greenstreak 732, or equal.
 - d. Expansion joints: 9-inch wide ribbed type with hollow center bulb or tear web. Vinylex RB938H, Greenstreak 735, or equal for expansion joints 1 inch and narrower, Vinylex TWB938, Greenstreak 739 or equal for expansion joints wider than 1 inch.
 3. Dumbbell type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
 4. Provide polyvinyl chloride waterstops complying with following requirements:
 - a. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of this Section.
 - b. No scrap or reclaimed material shall be used.
 5. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D 792	Not less than 1.3.
Hardness	ASTM D 2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D 638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D 638	Not less than 300 percent
Alkali Extraction	CRD-C-572	7 day weight change between minus 0.1 percent and plus 0.25 percent. Hardness change within 5 points.
Low Temperature Brittle Point	ASTM D 746	No sign of cracking or chipping at - 35 degrees Fahrenheit minimum.
Water Absorption	ASTM D 570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Tensile	CRD-C-572	Not less than 1,600 pounds per square inch.
Stiffness in Flexure	ASTM D 747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D 624	Not less than 225 pounds per inch.
Thickness	–	3/8 inch
Center Bulb		
6 inch Waterstops	–	7/8 inch or 1-inch nominal outside diameter.
9 inch Waterstops	–	1-inch nominal outside diameter. For expansion joints 1 inch and narrower and 2 inches for expansion joints wider than 1 inch.
Allowable Tolerances		
Width	–	Plus or minus 3/16 inch.
Thickness	–	Plus or minus 1/32 inch.

2.2 JOINT FILLERS

- A. Hardboard: 1/8-inch minimum thickness, in accordance with ANSI A135.4 Class 2.
- B. Preformed expansion joint materials:
 - 1. General:
 - a. Use specific type in applications as indicated on the Drawings.
 - b. No scrap or recycled material shall be used.
 - 2. Bituminous fiber expansion joint material:
 - a. Manufacturers: One of The following or equal:
 - 1). Tamms Industries, a division of Euclid Chemical Company: Hornboard/fiber.
 - 2). Approved equal.
 - 3. Synthetic sponge rubber expansion joint material:
 - a. Manufacturers: One of the following or equal:
 - 1). Tamms Industries, a division of Euclid Chemical Company: Cementone.
 - 2). Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Waterstops - General:

1. Waterstops shall be stored so as to permit free circulation of air around the waterstop material and to prevent direct exposure to sunlight.
2. Install waterstops in concrete joints where indicated on the Drawings.
3. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
4. In water-bearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
5. Provide waterstops that are continuous and in longest lengths practical.
6. Set waterstops accurately to position and line as indicated on the Drawings.
7. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
8. Position the waterstop so that symmetrical halves of the waterstop are equally divided between the concrete pours. The center axis of the waterstop shall be coincident with the centerline of the joint.
9. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
10. Use wires at not more than 24 inches on centers near outer edge of the waterstop to tie waterstops into position.
11. Special clips may be used in lieu of wires, at contractor's option.
12. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
13. When any waterstop is installed in the concrete on one side of a joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of sunlight during the entire exposure and until the exposed portion is embedded in concrete.
14. When placing concrete at waterstops in slabs, lift the edge of the waterstop while placing concrete below the waterstop. Manually force the waterstop against and into the concrete. Then cover the waterstop with fresh concrete.

B. Polyvinyl chloride waterstops:

1. Install waterstops so that joints are watertight.
2. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
 - a. The material shall not be damaged by heat sealing.
 - b. Make joints by overlapping then simultaneously cut the ends of the sections to be spliced so they will form a smooth even joint. Heat the cut ends with the splicing tool until the plastic melts. Press the 2 ends together until the plastic cools.
 - c. The continuity of the waterstop ribs and tubular center axis shall be maintained.
 - d. The splices shall have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.
3. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.
4. Joints for crosses and tees shall be factory prefabricated by the manufacturer.

C. Joints:

1. Construct construction, and expansion joints as indicated on the Drawings.
2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

D. Hardboard:

1. When indicated on the Drawings, face surface of joint filler with hardboard.
2. Other facing materials may be used provided they furnish equivalent protection and the material is acceptable to ENGINEER.
3. Hold boards in place by nails, waterproof adhesive, or other means acceptable to the ENGINEER.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place concrete, including concrete materials, concrete accessories, concrete mixture designs, placement procedures, and finishes, for the following:
1. Footings.
 2. Foundation walls.
 3. Slabs-on-grade.
 4. Suspended slabs.
 5. Concrete toppings.
 6. Building frame members.
 7. Building walls.
 8. Hydraulic (liquid containing) structures.
- B. Related Sections:
1. Section 03 01 00 - Concrete Surface Repair
 2. Section 03 15 00 - Concrete Accessories
 3. Section 03 60 00 - Grout

1.2 REFERENCES

- A. American Concrete Institute (ACI):
1. ACI 301 – Specifications for Structural Concrete
 2. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials
 3. ACI 305 - Hot Weather Concreting Standard
 4. ACI 306 - Cold Weather Concreting Standard
 5. ACI 318 - Building Code Requirements for Structural Concrete and Commentary
 6. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary
 7. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 8. ACI 302.1R – Guide for Concrete Floor and Slab Construction
 9. ACI 308.1 – Standard Specification for Curing Concrete
 10. Manual of Concrete Practice
- B. ASTM International (ASTM):
1. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 2. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 3. ASTM C33 - Standard Specification for Concrete Aggregates
 4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 5. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
 6. ASTM C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 7. ASTM C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 8. ASTM C94 - Standard Specification for Ready-Mixed Concrete
 9. ASTM C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement
 10. ASTM C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

11. ASTM C123 - Standard Test Method for Lightweight Particles in Aggregate
12. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
13. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
14. ASTM C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate
15. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
16. ASTM C150 - Standard Specification for Portland Cement
17. ASTM C156 - Standard Test Method for Water Loss [from a Mortar Specimen] Through Liquid Membrane-Forming Curing Compounds for Concrete
18. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
19. ASTM C171 - Standard Specifications for Sheet Materials for Curing Concrete
20. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete
21. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
22. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
23. ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
24. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
25. ASTM C295 – Standard Guide for Petrographic Examination of Aggregates for Concrete
26. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
27. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete
28. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
29. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
30. ASTM C1064 – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
31. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
32. ASTM C1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
33. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete
34. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
35. ASTM D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction
36. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
37. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness
38. ASTM E329 – Standard Specification for Agencies Engages in Construction Inspection, Testing, or Special Inspection
39. ASTM E1155 – Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
40. ASTM E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
41. ASTM E1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

- B. Exposed Concrete: Concrete surface that can be seen inside or outside of structures regardless whether concrete is above water, dry at all times, or can be seen when structure is drained.
- C. Hydraulic Structures: Liquid containing basins.
- D. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 3/16", cracks 0.005" wide and larger as well as any crack that leaks for liquid containing basins and below grade habitable spaces; cracks 0.010" wide and larger in non-fluid holding structures, spalls, chips, air bubbles greater than 3/4" in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form pop-outs, texture irregularities, and stains and other color variations that cannot be removed by cleaning.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Concrete Mixture Designs: For each concrete mixture.
 1. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 2. Indicate amounts of mixing water to be withheld for later addition at Project site.
 3. Submit Shrinkage Test Results for design mixtures. See 3.14 FIELD QUALITY CONTROL, E. Shrinkage Tests - 3 for shrinkage test requirements and limitations. Any Mix Design submitted without a Shrinkage Test will not be reviewed and will be returned to the Contractor as "Rejected".
- C. Welding certificates.
- D. Qualification Data: For manufacturer, testing agency.
- E. Material Certificates: For each of the following, signed by manufacturers:
 1. Cementitious materials.
 2. Admixtures.
 3. Curing compounds.
 4. Floor and slab treatments.
 5. Bonding agents.
 6. Adhesives.
 7. Vapor retarders.
 8. Semi-rigid joint filler.
 9. Joint-filler strips.
- F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- G. Field quality-control test and inspection reports.
- H. Course Aggregate Gradation.
- I. Fine Aggregate Gradation.
- J. One copy of each 30 consecutive strength test results and mix design used from a record of past performance or one copy of the laboratory trial mix design and results and one copy of the mix design proposed for each mixture and use under this contract. If the 30 consecutive strength tests are used, the test shall have been made within the 12 month period prior to this submittal.

- K. Material Test Reports: for the following, from a testing agency acceptable to the ENGINEER, indicating compliance with requirements:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- L. Ready-Mix concrete.
1. Provide delivery tickets for ready-mix concrete or weigh-masters certificate per ASTM C94 including weights of cement and each size aggregate and amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both coarse and fine aggregate. If water is added on the job the total water content shall not exceed the water content of the approved design mix.
 2. Keep record showing time and place of each pour (placement) of concrete, together with transit-mix delivery slips certifying the contents of the pour (placement).
 3. Furnish records to Engineer upon request.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm with a minimum of 5 years' experience in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 2. The criteria hereinafter set out are solely for the purpose of establishing required mixture proportions and do not constitute a basis for confirming the adequacy of concrete strength.
 - a. Required Average Strength above Specified Compressive Strength: Proportions, including water-cement ratio, shall be established on the basis either of laboratory trial batches or of field experience with the materials to be employed. The proportions shall be selected to produce an average strength of 28 days exceeding the specified compressive strength by the amount indicated below, when both air content and slump are the maximums permitted by the Specifications.
 - b. Determination of the required average strength shall be in accordance with ACI 318 "Building Code Requirements for Reinforced Concrete," except that if suitable data from trial batches or field experience cannot be obtained, permission will not be granted to base concrete proportions on the water-cement ratio limits set out in the above referenced code.
 - 1). Past Plant Performance: Proportions may be established on the actual field performance of the ready-mix producer. Where the concrete production facility has a record, based on at least 30 consecutive strength tests taken within the prior 12 months representing similar materials and conditions to those expected, the strength used as the basis for selecting proportions shall exceed the required $f'c$ by at least:
 - a). 400 psi if the standard deviation is less than 300 psi;
 - b). 500 psi if the standard deviation is 300 to 400 psi;
 - c). 700 psi if the standard deviation is 400 to 500 psi;
 - d). 900 psi if the standard deviation is 500 to 600 psi;
 - e). 1,200 psi if the standard deviation is above 600 psi or unknown.
 - 2). Strength data for determining standard deviation shall be considered to comply with the foregoing stipulations if they represent either a group of at least 30 consecutive tests or the statistical average of two groups totaling 30 or more tests. The tests used to establish standard deviation shall represent concrete produced to meet a specified strength or strengths within 1,000 psi of that

- specified for the proposed work. Changes in materials and proportions within the population of background tests shall not have been more closely restricted than they will be for the proposed work.
- 3). Strength data for determining standard deviation shall be considered to comply with the foregoing stipulations if they represent either a group of at least 30 consecutive tests or the statistical average of two groups totaling 30 or more tests. The tests used to establish standard deviation shall represent concrete produced to meet a specified strength or strengths within 1,000 psi of that specified for the proposed work. Changes in materials and proportions within the population of background tests shall not have been more closely restricted than they will be for the proposed work.
 - 4). Laboratory Trial Batches: When the ready-mix producer does not have a record of past performance, the combination of materials and the proportions selected shall be determined from trial mixes having proportions and consistencies suitable for the work based on ACI 211.1-77.
 - a) When laboratory trial batches are used as the basis for selecting concrete proportions, strength tests shall be made in accordance with "Method of Test for Compressive Strength of Molded Concrete Cylinders" (ASTM C39) on specimens prepared in accordance with "Method of Making and Curing Test Specimens in the Laboratory" (ASTM C192). A curve shall be established showing the relationship between water-cement ratio (or cement content) and compressive strength. The curve shall be based on at least three points representing batches which produce strengths above and below that required. Each point shall represent the average of at least three specimens tested at 28 days or the earlier age designation.
 - b) The average strength required shall exceed the specified compressive strength by 1,200 psi.
 - c) The maximum permissible water-cement ratio (or minimum cement content) for the concrete to be used in the structure shall be that shown by the curve to produce the average strength indicated, but in no case shall the water-cement ratio exceed 0.42 by weight.
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specifications for Structural Concrete."
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 3. ACI 350 "Code Requirements for Environmental Engineering Concrete Structures."
 4. ACI 318 "Building Code Requirements for Reinforced Concrete."
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

- G. Sequence of concrete placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.
- H. Pre-installation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 - 2. Review special inspection and testing and inspecting agency procedure for field quality control, concrete finishes and finishing, cold and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and re-shoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures and concrete protection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements products that may be incorporated into the work include, but are not limited to products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FORM-FACING MATERIALS

- A. See Section 03 11 00 CONCRETE FORMWORK for additional requirements.
- B. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints. Furnish on exposed surfaces and interior surfaces.
- C. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit. Permitted to furnish on below grade exterior surfaces
- D. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- F. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- G. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

- H. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- I. Form-Release Agent: As specified in Section 03 11 00 CONCRETE FORMWORK.

2.3 REINFORCEMENT ACCESSORIES

- A. Expansion Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
 - 1. All dowels shall be placed and securely anchored before placing concrete. All dowels shall be parallel with each other and perpendicular to the joint.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. Secure all reinforcement in place using steel chairs, supports, "A" bars and any other ACI approved product. Supports shall be spaced adequately to support the steel firmly in place.
 - 3. Charis will not be accepted to hold reinforcing clearance on walls.
- C. General:
 - 1. Accessories shall be subject to Engineer's approval.
 - 2. Tie wire- 18 gauge steel wire. Ends of wire shall be bent towards the interior part of the wall.
 - 3. Support above forms with fabricated steel chairs. Number of chairs shall be adequate to prevent sag during steel and concrete placement.
 - 4. Wall layer spacers shall be 1/4" ROUND "Z" BAR.
 - 5. Horizontal layer spacers shall be stand.
 - 6. Mechanical Connectors:
 - a. Approved Manufactures: Dayton Superior, Erico, or approved equal.
 - b. The mechanical connection shall meet the code requirements of developing in tension and compression as required by the referenced codes. Install per the manufacture's approved procedures.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement (Non-hydraulic Above Grade Structures): ASTM C150, Type I or II, or combination of Type I with fly ash.
 - 2. Portland Cement (Hydraulic and/or Below Grade Structures): ASTM C150 type II or combination of Type I with fly ash.
 - 3. Fly Ash: ASTM C618, Class C or F fly ash shall not exceed 15 percent of the cementitious materials, unless written approval is given by the Engineer.
- B. Normal-Weight Aggregates: ASTM C33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1" nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
 - 3. Fine aggregate:

- a. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
- b. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances.
- c. In no case shall total exceed percent listed.

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C117	3
Shale or Chert	ASTM C123	1
	ASTM C295*	1
Clay Lumps	ASTM C142	1
* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale or chert. If the results of Test Method C123 are less than 1 percent, Test Method C295 is not required.		

- d. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with ASTM C33.
4. Coarse aggregate:
- a. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
 - b. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.
 - c. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.
 - d. Coarse aggregate shall be washed prior to combining in concrete mix.

Item	Test Method	Percent
Shale or chert	ASTM C123	1.25
	ASTM C295**	1
Coal and lignite	ASTM C123	1/4
Clay lumps and friable particles	ASTM C142	1/4
Materials finer than Number 200 sieve	ASTM C117	1/2*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		
** Test Method C 123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C 295 is used to identify which of the lightweight particles are shale, chert, coal, or lignite. If the results of Test Method C 123 are less than 1.25 percent (the minimum combined percentage of shale, chert, coal and lignite), Test Method C 295 is not required.		

5. Grading:
- a. Aggregate for building elements and hydraulic structures: In accordance with ASTM C33, Size Number 57, except as otherwise specified or authorized in writing by the ENGINEER.

C. Water: ASTM C94 and potable (not recycled water).

2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 2. Retarding Admixture: ASTM C494/C494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 - a. Bayer Corporation.
 - b. ChemMasters.
 - c. Conspec Marketing & Manufacturing Co., Inc.; a Dayton Superior Company.
 - d. Davis Colors.
 - e. Elementis Pigments, Inc.

2.6 VAPOR RETARDERS

- A. Plastic Vapor Retarder: ASTM E1745, Class B. Include manufacturers' recommended adhesive or pressure-sensitive tape.
 - 1. Products:
 - a. Fortifiber Corporation: Moistop Ultra.
 - b. Revan Industries Inc.; Vapor Block 10.
 - c. Stego Industries, LLC; Stego Wrap, 15 mils.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.7 FLOOR AND SLAB TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
 - 1. Products:
 - a. Burke by Edoco; Titan Hard.
 - b. ChemMasters; Chemisil Plus.
 - c. ChemTec international; ChemTec One.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company
 - e. Curecrete Distribution Inc.; Ashford Formula.
 - f. Dayton Superior Corporation; Day-Chem sure Hard.
 - g. Euclid Chemical Company (The); Euco Diamond Hard.
 - h. Kaufman Products, Inc.; SureHard.
 - i. L&M Construction Chemicals, Inc.; Seal Hard.
 - j. Meadows, W. R., Inc.; Liqui-Hard.
 - k. Metalcrete Industries; Floorsaver.
 - l. Nox-Crete Products Group, Kinsman Corporation; Duranox.
 - m. Symons Corporation, a Dayton Superior Company; buff Hard.
 - n. US Mix Products Company; US Spec Industraseal.
 - o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS.

2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
1. Products:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edoco; BurkeFilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior company; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film.
 - f. Euclid Chemical Company (The); Eucobar.
 - g. Kaufman Products, Inc.; Vapor Aid.
 - h. Lambert Corporation; Lambco Skin.
 - i. L&M Construction Chemicals, Inc.; E-Con.
 - j. MBT Protection and Repair, Div., of ChemRex; Confilm.
 - k. Meadows, W. R., Inc; Sealtight Evapre.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
 - p. Unitex; Pro-Film.
 - q. US Mix Products Company; US Spec Monofilm ER.
 - r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
- B. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
1. Products:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. Burke by Edoco; Aqua Resin cure.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec Marketing & Manufacturing co., Inc., a Dayton Superior Company; W.B. Resin cure.
 - e. Dayton Superior Corporation; Day Chem Rez cure (J-11-W).
 - f. Euclid Chemical Company (The); Kurez DR VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; Aqua Kure-Clear.
 - i. L&M Construction Chemicals, Inc.; L&M Cure R.
 - j. Meadows, W. R., Inc.; 100 Clear.
 - k. Nox-Crete Products Group, Kinsman Corporation; Resom Cire E/
 - l. Sykkmons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.
 - m. Tamms Industries, Inc., Horncure WB 30.
 - n. Unitex; Hydro cure 309.
 - o. US Mix Products Company; US Spec Maxcure Resin Clear.
 - p. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A. Compatible with penetrating liquid floor treatment for surfaces specified to receive penetrating liquid floor treatment.

1. Products:
 - a. Burke by Edoco; Cureseal 1315 WB.
 - b. ChemMasters; Polyseal WB.
 - c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Sealcure 1315 WB
 - d. Euclid Chemical Company (The); Super Diamond Clear VOX.
 - e. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
 - f. Lambert Corporation; UV Safe Seal.
 - g. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - h. Meadows, W. R., Inc.; Vocomp-30.
 - i. Metalcrete Industries; Metcure 30.
 - j. Symons Corporation, a Dayton Superior Company; Cure 7 Seal 31 Percent E.
 - k. Tamms Industries, Inc.; LusterSeal WB 300.
 - l. Unitex; Hydro Seal 25.
 - m. US Mix Products Company; US Spec Radiance UV-25.
 - n. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.

2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D2240.
- C. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 1. Types IV and V, load bearing for bonding hardened or freshly mixed concrete to hardened concrete.

2.10 REPAIR MATERIALS

- A. See Sections 03 01 00, CONCRETE SURFACE REPAIR SYSTEMS.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage by weight of cementitious materials other than Portland cement in concrete as follows:
 1. Fly Ash: 15 percent of cementitious materials maximum, unless written approval is given by the Engineer.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement for non-hydraulic structures and 0.10 percent by weight of cement for hydraulic structures.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing or high-range water-reducing admixture in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.12 CONCRETE MIXTURES

- A. Proportion normal-weight concrete mixture as follows for all structural elements:
 1. Minimum Compressive Strength: 4,000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.42.
 3. Slump Limit: 8-inches Max for concrete with verified slump of 2 to 4-inches before adding high range water-reducing admixture or plasticizing admixture per ACI 301.
 4. Air content: 5 1/2%, $\pm 1.5\%$ at point of delivery.
- B. Proportion normal-weight concrete mixture as follows for all non-structural elements:
 1. Minimum Compressive Strength: 3,000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 3. Slump Limit: 8 inch for concrete with verified slump of 2" to 4": before adding high-range water-reducing admixture or plasticizing admixture per ACI 301.
 4. Air content: 5 1/2%, $\pm 1.5\%$ at point of delivery.

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and ASTM C1116, and furnish batch ticket information.
 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 PLACING CONCRETE

- A. Place no concrete without prior authorization of the Engineer.
- B. Do not place concrete until:
 1. Reinforcement is secure and properly fastened in its correct position and loose form ties at construction joints have been retightened.
 2. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
 3. Forms have been cleaned and oiled as specified.
- C. Do not place concrete in which initial set has occurred, or that has been retempered.

- D. Do not place concrete during rainstorms or high velocity winds.
 - E. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
 - F. Keep sufficient protective covering on hand at all times for protection of concrete.
 - G. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the Engineer.
 - H. Notify the Engineer in writing of readiness, not just intention, to place concrete in any portion of the work:
 - 1. Provide this notification in such time in advance of operations, as the Engineer deems necessary to make final inspection of preparations at location of proposed concrete placing.
 - 2. Place forms, reinforcement, screeds, anchors, ties, and inserts in place before notification of readiness is given to the Engineer.
 - 3. Depositing concrete:
 - a. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
 - b. Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
 - c. Do not drop concrete freely into place from height greater than 5 feet.
 - d. Use tremies for placing concrete where drop is over 5 feet.
 - e. Commence placement of concrete on slopes, starting at bottom of slope.
 - I. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
 - J. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
 - K. After concrete placement begins, continue concrete placement without significant interruption. Plan and implement precautions to prevent any delay, between layers being placed, from exceeding 20 minutes.
 - L. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
 - M. Placement of concrete for slabs, beams, or walkways:
 - 1. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
 - 2. Allow set time of not less than 1 hour for shrinkage.
- 3.2 FORMWORK: See Section 03 11 00, CONCRETE FORMWORK.
- 3.3 VAPOR RETARDERS
- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches and seal with manufacturers' recommended tape.

3.4 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer/Owner
 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one fourth of concrete thickness as follows:
 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Engineer.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. All embedded items such as wall pipes, embed frames, steel guide rails, channels, etc. (not including conduit and reinforcing) shall be considered "massive embedments" and are required to be kept above 32 deg F during placement and for the first 48 hours after placement. Contractor shall take the necessary measures; including insulated blankets, heated blankets, and heaters; to insure items are kept above 32 deg F. All other methods shall be submitted to the Engineer for approval.
 3. Do not use frozen materials or materials containing ice or snow.
 4. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Top 12-inches of subgrade shall be thawed prior to concrete placement. Contractor is responsible for verifying that the temperature for the top 12-inches of subgrade is above 32 deg F.
 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- G. Hot-Weather Placement: Comply with ACI 305 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is included in total amount of mixing water. Using liquid nitrogen to cool concrete is contractor's option, but liquid nitrogen should not replace water.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
 3. All other methods shall be submitted to the Engineer for approval.

3.6 CONCRETE WALL FINISHES

- A. Type W-1 (Ordinary Wall Finish or Coating):
 - 1. Patch tie holes.
 - 2. Knock off projections.
 - 3. Patch defective areas.

- B. Type W-2 (Smooth Wall Finish):
 - 1. Patch tie holes.
 - 2. Grind off projections, fins, and rough spots.
 - 3. Patch defective areas and repair rough spots resulting from form release agent failure or other reasons to provide smooth uniform appearance.

- C. Type W-5 (Finish for Painting):
 - 1. Patch tie holes.
 - 2. Grind off projections, fins, and rough spots.
 - 3. Patch and repair defective areas as specified for Type W-2.
 - 4. Apply paint or coating system as specified in Section 09 90 00 Painting and Protective Coatings.

3.7 CONCRETE SLAB FINISHES

- A. General:
 - 1. Finish slab concrete per the requirements of ACI 302.1R
 - 2. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
 - 3. Do not use "Jitterbugs" or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar, which will be weak and cause surface cracks or de-lamination, to accumulate.
 - 4. Do not dust surface with dry materials.
 - 5. Use evaporation retardant.
 - 6. Round off edges of slabs with a steel edging tool, except where a cove finish is shown. Steel edging tool radius shall be 1/4" for slabs subject to wheeled traffic.

- B. Type S-1 (Steel Troweled Finish):
 - 1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation, use evaporation retardant.
 - 2. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane with no coarse aggregate visible.
 - 3. Use sufficient pressure on wood floats to bring moisture to surface.
 - 4. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
 - 5. Burnish surface with an additional troweling. Final troweling shall produce a ringing sound from trowel.
 - 6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
 - 7. Power Finishing:
 - a. An approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.
 - b. Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.
 - c. Do first steel troweling for slab S-1 finish by hand.

- C. Type S-2 (Wood Float Finish):
 - 1. Finish slabs to receive fill and mortar setting beds by screeding with straight edges to bring surface to required finish plane.

2. Wood float finish to compact and seal surface.
 3. Remove laitance and leave surface clean.
 4. Coordinate with other finish procedures.
- D. Type S-5 (Broomed Finish):
1. Finish as specified for Type S-1 floor finish, except omit final troweling and finish surface by drawing a fine-hair broom lightly across the surface.
 2. Broom in same direction and parallel to expansion joints, or, in the case of inclined slabs, perpendicular to scope, except for round roof slab, broom surface in radial direction.
- E. Type S-6 (Sidewalk Finish):
1. Slope walks down 1/4" per foot away from structures, unless otherwise shown.
 2. Strike off surface by means of strike board and float with wood or cork float to a true plane, then flat steel trowel before brooming.
 3. Broom surface at right angles to direction of traffic or as shown.
 4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with a grooving tool.
- F. Type S-7: The top surfaces of basins in which raking mechanisms are to be installed
1. Slabs shall be finished by sweeping in cement grout with the mechanism. The cement grout to be used shall be composed of one part Portland cement and two parts sand.
 2. The sweeping-in process shall be performed under the supervision of a factory representative of the equipment manufacturer.
 3. The slab upon which the grout is to be applied shall receive a Type S-5 finish except that after leveling and floating, it shall be raked in such a manner as to provide a good bond for the grout. Raking shall develop a pattern with a depth of 1/4" every 2". Before grout is deposited on the slab, it shall be thoroughly cleaned, wet down with clean water and lightly dusted with neat cement immediately prior to placement of the grout.

3.8 SCHEDULE OF CONCRETE FINISHES

- A. Form Tolerances: As specified in Section 03 11 00, CONCRETE FORMWORK.
- B. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
EXTERIOR WALL SURFACES		
Above grade/exposed (above a point 12" below finish grade)	W-2	W-B
Backfilled (below a point 12" below final grade)	W-1	W-A
INTERIOR WALL SURFACES		
Hydraulic Structures including tanks, pump stations, flow channels, junction boxes, and basins	W-5	W-A
Buildings, pipe galleries, and other dry areas	W-5	W-B
EXTERIOR SLABS		
Exposed Roof slab or Slab-on-grade for non-hydraulic structures (includes slabs under open canopies)	S-5	
Roof slab or Top of Wall for Hydraulic Structures	S-1	
Other water holding tanks and basins	S-1	
Stairs and landings	S-5	
Sidewalks	S-6	

Other exterior slabs/pads	S-6	
Top surfaces of basins in which raking mechanisms are to be installed	S-7	
INTERIOR SLABS		
Non-Hydraulic areas such as pipe galleries and slabs-on-grade	S-1	
Hydraulic channels / Water Holding Structures	S-1	
Underside of elevated slabs	S-3	
Slabs to receive fill and mortar setting beds	S-2	

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.

- c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
- 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
- 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
- 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.11 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Do not apply to concrete that is less than 28 days' old.
 - 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.13 REPAIRING CONCRETE

A. General:

1. Any areas deemed as having excessive defects or considered to have a negative effect on the structural performance of the structure shall be removed to the extents approved by the Engineer. The Engineer has the option of calling for the removal of the entire section if the damage is such that a repair will not be a suitable option. All work required to correct the defect will be the responsibility of the Contractor and will be paid for by the Contractor.
2. Inject cracks as defined in 1.3.D Defective Areas with crack repair epoxy as specified in Section 03 01 00, CONCRETE SURFACE REPAIR.
3. Repair concrete surfaces defects as defined in 1.3.D Defective Areas using one of the materials specified in Section 03 01 00, CONCRETE SURFACE REPAIR. Select system, submit for review, and obtain approval from Engineer prior to use.
4. Prior to starting the repair work, obtain quantities of color-matched repair material and manufacturer's detailed instructions for use to provide a structural repair with finish to match adjacent surface.
5. Develop repair techniques with material manufacturer.
6. Dress surface of repair that will remain exposed to view to match color and texture of adjacent surfaces. Repair of concrete shall provide a structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.

B. Tie Holes:

1. Fill with nonshrink grout as specified in Section 03 60 00, GROUT.
2. Match color of adjacent concrete.
3. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

C. Alternate Form Ties-Through-Bolts:

1. Seal through-bolt hole by sandblasting or mechanically cleaning and roughening entire interior surface of hole, coating roughened surface with bonding agent and driving elastic vinyl plug and then dry packing entire hole on each side of plug with nonshrink grout, as specified in Section 03 60 00, GROUT. Use only enough water to dry pack grout. Dry pack while bonding agent is still tacky or remove bonding agent by mechanical means and reapply new bonding agent.
2. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

D. Exposed Metal Objects:

1. Metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, shall be removed by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair areas of chipped-out concrete per requirements of Section 03 01 00 CONCRETE SURFACE REPAIR SYSTEMS.

E. Blockouts at Pipes or Other Penetrations:

1. Meet details shown or submit proposed blockouts for review.
2. Use nonshrink, nonmetallic grout, Category I or II as specified in Section 03 60 00, GROUT.

3.14 FIELD QUALITY CONTROL

- #### A. Testing and Inspecting:
- Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Payment of the testing and inspection agency shall be by the Contractor from the contract allowance for independent testing in accordance with Section 01 29 00, PAYMENT PROCEDURES.

- B. Inspections:
1. Steel reinforcement placement.
 2. Headed bolts and studs.
 3. Verification of use of required design mixture.
 4. Concrete placement, including conveying and depositing.
 5. Curing procedures and maintenance of curing temperature.
 6. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C31/C31M.
 - a. Cast and laboratory cure two sets of three standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C39/C39M; test one set of three laboratory-cured specimens at 7 days and one set of three specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days. The third cylinder will be retained for subsequent testing if required by the Engineer.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 9. Test results shall be reported in writing to Engineer, Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155 48 hours after finishing. Specified overall values of flatness $F(f)=25$; and levelness $F(L)=20$; with minimum local values, $F(f)=17$ and $F(L)=15$.
1. $F(L)$ value only applies to elevated slabs after shoring has been removed.
- E. Shrinkage Tests:
1. Drying shrinkage tests shall be performed for the trial batch indicated in Paragraph CONCRETE MIXTURES FOR HYDRAULIC ELEMENTS for the first placement of each class of concrete for all structures noted in paragraph CONCRETE MIXTURES FOR HYDRAULIC ELEMENTS, and during construction to insure continued compliance with these Specifications. Number of field test to be determined by Engineer or Engineer's Field Representative.
 2. Drying shrinkage specimens shall be 4" by 4" by 11" prisms with an effective gauge length of 10"; fabricated, cured, dried, and measured in accordance with ASTM C157 modified as follows: specimens shall be removed from molds at an age of 23 ± 1 hours after trial batching, shall be placed immediately in water at $70 \text{ }^\circ\text{F} \pm 3 \text{ }^\circ\text{F}$ for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at $73 \text{ }^\circ\text{F} \pm 3 \text{ }^\circ\text{F}$. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 days. This length at age 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at $73 \text{ }^\circ\text{F} \pm 3 \text{ }^\circ\text{F}$ and 50% $\pm 4\%$ relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
 3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001" at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004", the results obtained from that specimen shall be discarded. Results of the shrinkage test shall be reported in graphical form Length Change (in) vs. Age (days) and Length Change (%) vs. Age (days) to the nearest 0.001% of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as indicated below.
 - a. Shrinkage Limitation: The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036% or 0.042%, respectively. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements.
 - b. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25%.
 - c. If the required shrinkage limitation is not met during construction, the Contractor shall take any or all of the following actions at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include

changing the source of aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage

- F. Water Leakage Tests: In accordance with ACI 350.1.
1. Purpose: Determine integrity and water tightness of finished concrete surfaces. Contractor shall perform and pay for all costs associated with water leakage tests. Report all test results to the Engineer.
 2. All water-holding Structures:
 - a. Perform leakage tests after concrete structure is complete and capable of resisting the hydrostatic pressure of the water test. The concrete shall have achieved its full design strength.
 - b. Perform leakage test before backfill, brick facing, or other work that will cover concrete wall surfaces is begun.
 - c. Install all temporary bulkheads, cofferdams, and pipe blind flanges, and close all valves. Inspect each to see that it provides a complete seal.
 - d. Fill with water to test level shown, or maximum liquid level if no test level is given. Maintain this level for 72 hours prior to the start of the test to allow water absorption, structural deflection, and temperature to stabilize.
 - e. Measure evaporation and precipitation by floating a partially filled, transparent, calibrated, open top container.
 - f. Measure the water surface at two points 180° apart, when possible where attachments such as ladders exist, at 24-hour intervals. Using a sharp pointed hook gauge and fixed metal measure capable of reading to 1/100 of an inch. Continue the test for a period of time sufficient to produce at least 1/2" drop in the water surface based on the assumption that leakage would occur at the maximum allowable rate specified or for 72 hours whichever is the lesser time.
- G. Acceptance Criteria:
1. Volume loss shall not exceed 0.075% of contained liquid volume in a 24-hour period, correcting for evaporation, precipitation, and settlement.
 2. No damp spots or seepage visible on exterior surfaces. A damp spot is defined as sufficient moisture to be transferred to a dry hand upon touching.
- H. Repairs When Test Fails: Dewater the structure; fill leaking cracks with crack repair epoxy as specified in Section 03 01 00, CONCRETE SURFACE REPAIR. Patch areas of damp spots previously recorded, and repeat water leakage test in its entirety until the structure successfully passes the test.

END OF SECTION

SECTION 03 60 00 - GROUT

PART 1 - GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. C 230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - b. C 1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- B. Cement Grout (Non-shrink).
 - 1. Corps of Engineers (COE):
 - a. CRD-C 611, Flow of Grout for Prep laced Aggregate Concrete.
 - b. CRD-C 621, Specification for Non-shrink Grout.

1.2 SUBMITTALS

- A. Product data for each type of product indicated.
- B. Certified test results verifying compliance with compressive strength, shrinkage and expansion requirements and manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of non-shrink and epoxy grout.
- C. Fine aggregate gradation.
- D. One copy of each 30 consecutive strength test results and mix design used from a record of past performance, or one copy of laboratory trial mix and design and results, and one copy of the mix design proposed for each cementitious mixture and use under this contract.
- E. Qualification for testing agency.
- F. Material test reports: For the following from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates, include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
 - 2. Non-shrink grout.
 - 3. Epoxy grout.
- G. Material certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Non-shrink grout.
 - 3. Epoxy grout.
- H. Field quality-control tests and observation reports.
- I. Ready mix concrete (Cement Grout)
 - 1. Provide delivery tickets for ready-mix concrete (cement grout) or weigh master's certificate per ASTM C 94, include weights of cement and each size aggregate and amount of water added at the plant and a record of placements. Record the amount of water added at the job site on the delivery ticket. Water added at the plant shall account for the moisture in aggregate. If water is added at the job site, then the total water content shall not exceed the water content of the approved design mix.

2. Keep records showing time and place of each placement of concrete, joint mortar bed material or cement grout, together with transit delivery slips certifying the contents of the placement. Furnish records to Engineer.

J. Joint Mortar Bed: Provide material analysis and certification for each placement.

K. Shop Drawings:

1. Product data of grouts.
2. Curing method for grout.
3. Mix design of cement-sand grout mixture for pipe invert/structure fill.
4. Mix design of Joint Mortar Bed.

L. Information Submittals:

1. Manufacturer's written instructions for mixing of grout.
2. Manufacturer's Certificate of Compliance: Grout free from chlorides and other corrosion-causing chemicals.
3. Manufacturer's Certificate of Proper Installation.
4. Statements of Qualification: Non-shrink grout manufacturer's representative.
5. Test Reports: Test report for 24-hour evaluation of non-shrink grout.

1.3 QUALIFICATIONS

A. Manufacturer's qualifications for cement grout and joint mortar bed: A firm experienced in manufacturing ready-mixed concrete products and a firm that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade I, Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.

C. Source limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source and obtain admixtures through one source from a single manufacturer.

1.4 QUALIFICATIONS

A. Non-shrink Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer, with minimum of 1 year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Non-shrink Grout Test Form, attached at the end of this section. Independent testing laboratory to certify that testing was conducted within last 18 months.

1.5 GUARANTEE

A. Manufacturer's guarantee shall not contain disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished.

- B. Manufacturer guarantees participation with Contractor in replacing or repairing grout found defective due to faulty materials, as determined by industry standard test methods.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand and source throughout project:
 - 1. Portland Cement (Nonhydraulic Above Grade Structures): ASTM C 150, Type I or II or combination of Type I with fly ash.
 - 2. Portland Cement (Hydraulic and Below Grade Structures): ASTM C 150 Type II or combination of Type I with fly ash.
FLY ASH: ASTM C 618, CLASS F, FLY ASH SHALL NOT EXCEED 15 PERCENT.
- B. Fine aggregates: ASTM C 33, Class 4S or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. Aggregates shall be free of materials with deleterious reactivity to alkali in cement. Aggregates for cement grout and/or mortar bed shall be provided from the same source as aggregate for the cast-in-place concrete.
- C. Water: ASTM C 94 and potable.

2.2 ADMIXTURES

- A. Comply with Section 03 30 00 Cast-In-Place Concrete.

2.3 NONSHRINK GROUT SCHEDULE

- A. Furnish non-shrink grout for applications in grout category in the following schedule:

Application	Temperature Range		Max. Placing Time	
	40 to 100 °F	20 min	20 min	Greater than 20 min
Filling tie hole	I	I	I	I
Machine bases 25 hp or less	II	II	II	II
Through-bolt openings	II	II	II	II
Patching Concrete Walls	II	II	II	II
Machine bases 26 hp and up	III	III	III	III
Base plates and/or soleplates with vibration, thermal movement, etc.	III	III	III	III
Other applications not listed	II	II	II	II

2.4 NONSHRINK GROUT

- A. Category I:
 - 1. Nonmetallic and non gas-liberating.
 - 2. Prepackaged natural aggregate grout requiring only the addition of water.
 - 3. Test in accordance with ASTM C1107:
 - a. Flowable consistency 140%, five drops in 30 seconds, in accordance with ASTM C 230.
 - b. Flowable for 15 minutes.
 - 4. Grout shall not bleed at maximum allowed water.

5. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
 - a. Chemrex, Inc., Shakopee, MN; Set Grout.
 - b. Euclid Chemical Co., Cleveland, OH; NS Grout.
 - c. Dayton Superior Corp., Miamisburg, OH; 1107 Advantage Grout.
 - d. US MIX Products, Denver, CO; US Spec Multi-Purpose Grout.
 - e. L & M Construction Chemicals, Inc., Omaha, NE; Duragrout.
 - f. Master Builders.

B. Category II:

1. Nonmetallic, non gas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency - at specified times or temperatures.
4. Test in accordance with COE CRD-C 621 and ASTM C 1107, Grade B:
 - a. Fluid consistency 20 to 30 seconds in accordance with COE CRD-C 611.
 - b. Temperatures of 40, 80, and 100 °F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready- mix truck.
8. Manufacturers and Products:
 - a. Chemrex, Inc., Shakopee, MN; Master Flow 928.
 - b. Five Star Products Inc., Fairfield, CT; Five Star 100.
 - c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
 - d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.
 - e. L & M Construction Chemicals, Inc., Omaha, NE; Crystex.
 - f. Master Builders.

C. Category III

1. Metallic and nongas-liberating flowable fluid.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with CRD-C 621 and ASTM C 1107, Grade B:
 - a. Fluid consistency 20 to 30 seconds in accordance with CRD-C 611.
 - b. Temperatures of 40 and 100 °F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready-mix truck.
8. Manufacturers and Products: Chemrex, Inc., Shakopee, MN; EMBECO 885.

2.5 TOPPING GROUT AND CONCRETE/GROUT FILL

- A. Where fill is thicker than 3-inches, structural concrete 03 30 00, CAST-IN-PLACE CONCRETE, may be used when accepted by the Engineer.
- B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water and admixtures proportioned and be mixed as indicated. Bonding Agent shall be used to enhance adhesion to basin concrete. Materials and procedures indicated for normal concrete in Section 03 30 00, CAST-IN-PLACE CONCRETE, shall apply unless indicated otherwise.

- C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Topping grout in clarifiers shall contain between 750 and 8900 pounds of cement per cubic yard with a maximum water cement ratio of 0.42.
- D. Aggregate shall be graded as follows:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2 inch	100
3/8 inch	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

- E. Final mix design shall be as determined by trial mix design as indicated in Section 03 30 00, except that drying shrinkage tests are not required.
- F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 30 00.
- G. Strength: Minimum compressive strength of topping grout and concrete/grout fill at 28 days shall be 4000 psi.
- H. Topping grout used in clarifiers shall contain fiber reinforcing. Fiber shall be 100 percent virgin polypropylene fibrillated fibers specifically manufactured in a blended gradation for use as concrete secondary reinforcement. Fibers shall be added at a rate of 1.5 pounds per cubic yard of concrete. Fibers shall conform to ASTM C 1116 – Fiber Reinforced Concrete and Shotcrete. Type III.

2.6 CEMENT-GROUT (CEMENT-SAND GROUT) MIXTURE FOR PIPE INVERT/STRUCTURE FILL

- A. Prepare design mixture proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301. Submit proposed mixture design to Engineer for review. Comply with Section 03 30 00 Cast-In-Place Concrete and as follows.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based upon laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete and cement grout as follows:
 - 1. Fly Ash, 15 percent, Class F.
- C. Admixtures: All materials other than Portland cement, water and aggregates that are added to the concrete or cement grout, shall be subject to the approval of the Engineer. If so approved, use admixtures according to manufacturer’s written instructions.
 - 1. Use water reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- D. Minimum compressive strength: 2000 psi at 28 days.
- E. Minimum cementitious material of 846 pounds (9 bags) per cubic yard of cement grout.

- F. Air content: ASTM C 94, 5 percent, plus or minus 1.0 percent at point of delivery.
- G. Aggregate shall be sand, three parts sand to one part cementitious material by volume. The sand gradation shall be such that 100% shall pass the No. 16 sieve and not more than 30% shall be retained on a No. 30 sieve.
- H. Water – cementitious material ratio. The Contractor shall submit a proposed mix design to the Engineer for review. The amount of water shall be the minimum amount of water necessary to make a workable mixture.
- I. Slump: Maximum of 4 inches.

2.7 JOINT MORTAR BED

- A. Joint Mortar Bed: Mortar placed on horizontal construction joints shall be a mixture of cement, sand and water in the same proportions used in the approved 4000 psi cast-in-place concrete mix design and/but with the coarse aggregate omitted.

PART 3 - EXECUTION

3.1 NONSHRINK GROUT

- A. General: Mix, place, and cure non-shrink grout in accordance with grout Manufacturer's representative's training instructions.
- B. Form Tie or Through-Bolt Holes: Provide non-shrink grout, Category I and II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug as specified in Division 03, and bonding agent in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. Grouting Machinery Foundations:
 1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material.
 2. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts.
 3. Form with watertight forms at least 2" higher than bottom of plate.
 4. Fill space between bottom of machinery base and original concrete in accordance with Manufacturer's representative's training instructions.

3.2 CEMENT GROUT

- A. Place cement grout topping over concrete slabs where indicated on the drawings. Place in accordance with the procedures of this section and the manufacturer's or suppliers of equipment recommendations. The finish surface of the grout topping shall be similar to a steel trowel finish and which will facilitate the proper operation of the mechanical equipment. The finish of the structural slab below the cement grout topping shall be a heavy broom finish.
- B. Where cement grout is to be placed without mechanical equipment, the fresh surface of the cement grout shall be a smooth trowel finish. Placement procedure of cement grout at areas with mechanical equipment includes:
 1. Notify Project Representative or Engineer a minimum of 48 hours in advance of placement.
 2. Make a trial cement grout batch of not less than 1/2 cubic yard to allow time for adjustment in mix design if required.
 3. Clean the exposed structural slab by sandblasting and washing clean.

4. Thoroughly broom a neat cement paste containing an epoxy binder into the concrete slab surface immediately ahead of placing the cement grout topping.
5. Where applicable, install level and true mechanical screed equipment over the floor slab to provide a minimum thickness of 2 inches +/- 1/4 inch. In areas where the distance between the mechanical screed and the structural slab is less than the above clearances, grind surface as directed by Engineer to provide such clearance. The mechanical screed shall operate at a speed acceptable to the cement grout topping placement procedures. Screeding procedures shall account for the effects of differential temperatures on the mechanical screed equipment.
6. Place cement grout topping in a continuous operation. If grouting operations are interrupted, clean the edge of the previously placed topping by water jetting and add a coat of cement paste to provide a bond to the fresh topping.
7. Temporarily equip the mechanical screed mechanism on at least two arms with a 2-inch by 10 inch continuous wood plate with light gauge metal angles and surface plates or channels. The bottom of the screed plates or steel plates shall be adjustable and set to elevations which allow the proper operation of equipment and as recommended by the equipment manufacturer or supplier.
8. Screed the topping immediately after consolidation with vibrators or tampers and provide a steel trowel finish.
9. Cure cement grout topping with water and cover with PVC sheeting to prevent damage from foot traffic for seven days. When/if the cement grout topping is found not to be acceptable, remove and replace. Cement grout topping not acceptable shall include, but is not limited to, poor bonding with the concrete slab, low strength, excessive cracking and unevenness in finish or elevation.

3.3 JOINT MORTAR BED

- A. Joint Mortar Bed: Immediately prior to placement of fresh concrete at horizontal joints, or as indicated, place joint mortar bed to cover horizontal joint and protect water stop as applicable. Spread uniformly and work into all irregularities of the surface. The water cement ratio of the joint mortar bed shall not exceed that of the concrete being placed and the consistency of the mortar shall be suitable for placing and working. The fresh concrete shall then be immediately placed in a time and manner so that the joint mortar bed and the fresh concrete mix to form a homogenous concrete meeting all requirements.

3.4 NON-SHRINK GROUT

- A. Non-Shrink grout:
 1. Used for repair of holes and defects and at locations indicated where epoxy grout is not indicated. Execution shall follow manufacturer's recommendations.
 2. Base plates and equipment where indicated. Execution shall follow manufacturer's recommendations.

3.5 EPOXY GROUT

- A. Epoxy Grout: Used to embed all anchor bolts and reinforcing steel set in grout, specific machinery base plates as indicated and at other locations where indicated. Execution shall follow manufacturer's recommendations.

3.6 FIELD QUALITY CONTROL

- A. Evaluation and Acceptance of Non-shrink Grout:
 1. Consistency: As specified in Article NON-SHRINK GROUT. Grout with consistencies outside range requirements shall be rejected.
 2. Segregation: As specified in Article NON-SHRINK GROUT. Grout when aggregate separates shall be rejected.

3.7 MANUFACTURER'S SERVICES

- A. General: Coordinate demonstrations, training sessions, and applicable site visits with grout manufacturer's representative.

3.8 SUPPLEMENTS

- A. The supplement listed below, following "END OF SECTION," is part of this Specification.
 - 1. 24-hour Evaluation of Non-shrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

(Test Lab Name)

(Address)

(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain five bags of each type of grout.
1. From intended grout supplier for Project.
2. Five bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

- A. Product data and warranty information contained in company literature and data? Yes_____ No_____
- B. Literature and bag information meet specified requirements? Yes_____ No_____
- C. Manufacturer guarantees grout as specified in Article GUARANTEE? Yes_____ No_____
- D. Guarantee extends beyond grout replacement value and allows participation with CONTRACTOR in replacing and repairing defective areas? Yes_____ No_____
- E. Water demands and limits printed on bag? Yes_____ No_____
- F. Mixing information printed on the bag? Yes_____ No_____
- G. Temperature restrictions printed on bag? Yes_____ No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____
2. List expiration date. _____
3. Weigh bags and record weight. _____

ENGINEER will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of five bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10 gallon pail.
2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
3. Use maximum water allowed per water requirements listed in bag instructions.
4. Mix grout to maximum time listed on bag instructions.
5. In accordance with COE CRD-C611 (flow cone) determine time of mixed grout through the flow cone. _____ seconds
6. Add water to attain 20 to 30 second flow in accordance with COE CRD-C611.
7. Record time of grout through cone at new water demand. _____ seconds
8. Record total water needed to attain 20 to 30 second flow. _____ pounds
9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, COE CRD-C621 will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
3. Cover top of both cans with glass or plastic plate preventing evaporation.
4. Maintain 38 to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.
5. Visually check for bleeding of water at 15-minute intervals for 2 hours.
6. Perform final observation at 24 hours.
7. If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and III):

1. Divide the remaining grout into two 3 gallon cans. Place the cans into the 40 °F and 100 °F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4-inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.

2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take a COE CRD-C611 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 and 100 degrees F.
 - a. 20 min _____, sec. @ 40 degrees F.
 - b. 40 min _____, sec. @ 40 degrees F.
 - c. 60 min _____, sec. @ 40 degrees F.
 - d. 20 min _____, sec. @ 100 degrees F.
 - e. 40 min _____, sec. @ 100 degrees F.
 - f. 60 min _____, sec. @ 100 degrees F.

All Category II and III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

_____ _____
 Qualified Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with COE CRD-C621 for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.
2. Store cubes at 70 degrees F for 24 hours.
3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are under 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

 Signature of Independent Testing Laboratory

 Date Test Conducted

DIVISION 9
FINISHES

SECTION 09 90 00 - PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Exposed, buried, and submerged metal, exposed PVC and CPVC, exposed FRP, and aluminum and dissimilar metals, to be protective painted, whether specifically mentioned or not, except as specified otherwise. Prime coat structural steel surfaces. Exterior concrete surfaces will not be protective painted unless specifically indicated. Interior concrete surfaces will be protective painted as specified herein.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. D 16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - b. D 4541 - Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.
 2. NACE International (NACE):
 - a. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
 - b. SP0188-06 - Discontinuity (Holiday) Testing of Protective Coatings.
 3. National Association of Pipe Fabricators (NAPF):
 - a. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
 4. NSF International (NSF):
 - a. 61 - Drinking Water System Components - Health Effects.
 5. Society for Protective Coatings (SSPC):
 - a. QP1, Standard Procedure for Evaluating Qualifications of Painting Contractors.
 - b. QP2, Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint.
 - c. SP COM - Surface Preparation Commentary for Steel and Concrete Substrates.
 - d. SP-1 - Solvent Cleaning.
 - e. SP-2 - Hand Tool Cleaning.
 - f. SP-3 - Power Tool Cleaning.
 - g. SP-5 - White Metal Blast Cleaning.
 - h. SP-6 - Commercial Blast Cleaning.
 - i. SP-7 - Brush-Off Blast Cleaning.
 - j. SP 8, Pickling.
 - k. SP-10 - Near-White Blast Cleaning.
 - l. SP 11-T, Power Tool Cleaning to Bare Metal.
 - m. SP 13, Surface Preparation of Concrete.
 - n. Guide No. 3, PA, Guide to Safety in Painting Applications.
 6. U.S. Environment Protection Agency (EPA):
 - a. Method 24 - Surface Coatings.
 7. NACE International (NACE):
 - a. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
 - b. SP0188-06 - Discontinuity (Holiday) Testing of Protective Coatings.
 8. National Association of Pipe Fabricators (NAPF):
 - a. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
 9. NSF International (NSF):
 - a. 61 - Drinking Water System Components - Health Effects.

10. Society for Protective Coatings (SSPC):
 - a. QP1, Standard Procedure for Evaluating Qualifications of Painting Contractors.
 - b. QP2, Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint.
 - c. SP COM - Surface Preparation Commentary for Steel and Concrete Substrates.
 - d. SP-1 - Solvent Cleaning.
 - e. SP-2 - Hand Tool Cleaning.
 - f. SP-3 - Power Tool Cleaning.
 - g. SP-5 - White Metal Blast Cleaning.
 - h. SP-6 - Commercial Blast Cleaning.
 - i. SP-7 – Brush-Off Blast Cleaning.
 - j. SP 8, Pickling.
 - k. SP-10 – Near-White Blast Cleaning.
 - l. SP 11-T, Power Tool Cleaning to Bare Metal.
 - m. SP 13, Surface Preparation of Concrete.
 - n. Guide No. 3, PA, Guide to Safety in Painting Applications.
11. U.S. Environment Protection Agency (EPA):
 - a. Method 24 - Surface Coatings.

1.3 DEFINITIONS

- A. Terms used in this section:
 1. Submerged metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.
 2. Submerged concrete and masonry surfaces: Surfaces which are or will be:
 3. Underwater.
 4. In structures which normally contain water.
 5. Below tops of walls of water containing structures.
 6. Exposed surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.
 7. Dry film thickness (DFT): Thickness of fully cured coating, measured in mils.
 8. Volatile organic compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.
 9. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.
 10. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.
 11. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
 12. FRP: Fiberglass Reinforced Plastic.
 13. HCl: Hydrochloric Acid.
 14. MDFT: Minimum Dry Film Thickness.
 15. MDFTPC: Minimum Dry Film Thickness per Coat.
 16. Mil: Thousandth of an inch.
 17. Military Specification-Paint.
 18. PSDS: Paint System Data Sheet.
 19. SFPG: Square Feet per Gallon.
 20. SFPGPC: Square Feet per Gallon per Coat.
 21. SP: Surface Preparation.

1.4 PERFORMANCE REQUIREMENTS

- A. Coating materials shall be especially adapted for use in wastewater treatment plants.
- B. Coating materials used in contact with potable water supply systems shall be certified to NSF 61.

1.5 SUBMITTALS

- A. General: Submit in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.
- B. Shop Drawings:
 - 1. Schedule of proposed coating materials.
 - 2. Schedule of surfaces to be coated with each coating material.
- C. Product Data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips:
 - 1. Data Sheets:
 - a. For each paint system, furnish a Paint System Data Sheet (PSDS), the Manufacturer's Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system. The PSDS form is appended to the end of this section.
 - b. Submit required information on a system-by-system basis.
 - c. Furnish copies of paint system submittals to the coating applicator.
 - d. Indiscriminate submittal of Manufacturer's literature only is not acceptable.
 - e. Regulatory requirements: Submit data concerning the following:
 - f. Volatile organic compound limitations.
 - g. Coatings containing lead compounds and PCBs.
 - h. Abrasives and abrasive blast cleaning techniques, and disposal.
 - i. NSF certification of coatings for use in potable water supply systems.
- D. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.
- E. Certificates: Submit in accordance with requirements for Product Data.
- F. Manufacturer's Instructions: Include the following:
 - 1. Special requirements for transportation and storage.
 - 2. Mixing instructions.
 - 3. Shelf life.
 - 4. Pot life of material.
 - 5. Precautions for applications free of defects.
 - 6. Surface preparation.
 - 7. Method of application.
 - 8. Recommended number of coats.
 - 9. Recommended dry film thickness (DFT) of each coat.
 - 10. Recommended total dry film thickness (DFT).
 - 11. Drying time of each coat, including prime coat.
 - 12. Required prime coat.
 - 13. Compatible and non-compatible prime coats.
 - 14. Recommended thinners, when recommended.
 - 15. Limits of ambient conditions during and after application.
 - 16. Time allowed between coats (minimum and maximum).
 - 17. Required protection from sun, wind, and other conditions.
 - 18. Touch-up requirements and limitations.
 - 19. Minimum adhesion of each system submitted in accordance with ASTM D 4541.
- G. Manufacturer's Representative's Field Reports.
- H. Operations and Maintenance Data: Submit as specified in Section 01 77 00 CLOSEOUT PROCEDURES.

1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
2. Reports on visits to project site to observe and approve coating application procedures.
3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are "shop coated."

1.6 QUALITY ASSURANCE

- A. Quality Assurance Submittals:
1. Quality Assurance plan.
 2. Qualifications of coating applicator including List of Similar Projects and List of References substantiating experience.
 3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
 4. If the Manufacturer of finish coating differs from that of shop primer, provide both Manufacturers' written confirmation that materials are compatible.
 5. Manufacturer's written instructions and special details for applying each type of paint.
 6. Manufacturers' Certification of Proper Installation.
- B. Certifications: All paints and coatings to be used on this project comply with current federal, state, and local VOC regulations
- C. Applicator qualifications:
1. Minimum of 5 years' experience applying specified type or types of coatings under conditions similar to those of the Work:
 2. Provide qualifications of applicator and references listing 5 similar projects completed in the past 2 years.
 3. Manufacturer approved applicator when manufacturer has approved applicator program.
 4. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
 5. Approved and licensed by elastomeric polyurethane (100 percent solids) manufacturer to apply 100 percent solids elastomeric polyurethane system.
 6. Applicator of off-site application of coal tar epoxy shall have successfully applied coal tar epoxy on similar surfaces in material, size, and complexity as on the Project.
- D. Regulatory requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible volatile organic compound limits and do not contain lead:
1. Do not use coal tar epoxy in contact with drinking water or exposed to ultraviolet radiation.
 2. Perform surface preparation and painting in accordance with recommendations of the following:
 3. Paint Manufacturer's instructions.
 4. SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.
 5. Federal, state, and local agencies having jurisdiction.
- E. Samples:
1. Reference Panel:
 - a. Prior to start of surface preparation, furnish a 4" by 4" steel panel for each grade of sandblast specified herein, prepared to specified requirements.
 - b. Provide panel representative of the steel used; prevent deterioration of surface quality.
 - c. Upon approval of Engineer, panel to be reference source for inspection.
 - d. Unless otherwise specified, before painting work is started, prepare minimum 8" by 10" samples with type of paint and application specified on similar substrate to which paint is to be applied.
 - e. Furnish additional samples as required until colors, finishes, and textures are approved.

- f. Approved samples to be the quality standard for final finishes.
- g. Field samples:
- h. Prepare and coat a minimum 100 square foot area between corners or limits such as control or construction joints of each system.
- i. Approved field sample may be part of Work.
- j. Obtain approval before painting other surfaces.

F. Pre-installation conference: Conduct as specified in Section 01 31 19 PROJECT MEETINGS.

G. Compatibility of coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

H. Services of coating manufacturer's representative: Arrange for coating manufacturer's representative to attend pre-installation conferences. Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be "shop primed and coated".

I. Contract Closeout Submittals: Special guarantee.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle products as specified in Section 01 60 00 PRODUCT REQUIREMENTS.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver new unopened containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

- 1. Do not deliver materials aged more than 12 months from manufacturing date.

D. Store coatings in well-ventilated facility that provides protection from the sun, weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

F. Shipping:

- 1. Where pre-coated items are to be shipped to the site, protect coating from damage. Batten coated items to prevent abrasion.
- 2. Use nonmetallic or padded slings and straps in handling.

1.8 PROJECT CONDITIONS

A. Surface moisture contents: Do not coat surfaces that exceed manufacturer specified moisture contents, or when not specified by the manufacturer, the following moisture contents:

- 1. Plaster and gypsum wallboard: 12 percent.
- 2. Masonry, concrete, and concrete block: 12 percent.
- 3. Interior located wood: 15 percent.
- 4. Concrete floors: 7 percent.

B. Do not apply coatings:

- 1. Under dusty conditions or adverse environmental conditions, unless tenting, covers, or other such protection is provided for structures to be coated.

2. When light on surfaces measures less than 15 foot-candles.
 3. When ambient or surface temperature is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
 4. When relative humidity is higher than 85 percent.
 5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
 6. When surface temperature exceeds the manufacturer's recommendation.
 7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
 8. Apply clear finishes at minimum 65 degrees Fahrenheit.
- C. Provide fans, heating devices, dehumidifiers, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
- D. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 55 degrees Fahrenheit for 24 hours before, during and 48 hours after application of finishes.
- E. Dehumidification and heating for coating of digester interiors, wet wells, and high humidity enclosed spaces:
1. Provide dehumidification and heating of digester interior spaces in which surface preparation, coating application, or curing is in progress according to the following schedule:
 - a. October 1 to April 30: Provide continuous dehumidification and heating as required to maintain the tanks within environmental ranges as specified in this Section and as recommended by the coating material manufacturer. For the purposes of this Section, "continuous" is defined as 24 hours per day and 7 days per week.
 - b. May 1 to September 30: Provide temporary dehumidification and heating as may be required to maintain the tanks within the specified environmental ranges in the event of adverse weather or other temporary condition. At CONTRACTOR's option and at his sole expense, CONTRACTOR may suspend work until such time as acceptable environmental conditions are restored, in lieu of temporary dehumidification and heating. Repair or replace any coating or surface preparation damaged by suspension of work, at CONTRACTOR's sole expense.
 2. Equipment requirements:
 - a. Capacity: Provide dehumidification, heating, and air circulation equipment with minimum capacity to perform the following:
 - 1) Maintain the dew point of the air in the tanks at a temperature at least 5 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is underway.
 - 2) Reduce dew point temperature of the air in the tanks by at least 10 degrees Fahrenheit in 20 minutes.
 - 3) Maintain air temperature in the tanks at 60 degrees minimum.
 - b. Systems:
 - 1) Internal combustion engine generators: May be used; CONTRACTOR shall obtain all required permits and provide air pollution and noise control devices on equipment as required by permitting agencies.
 - 2) Dehumidification: Provide desiccant or refrigeration drying. Desiccant types shall have a rotary desiccant wheel capable of continuous operation. No Liquid, granular, or loose lithium chloride drying systems will be allowed.
 - 3) Heating: Electric, indirect combustion, or steam coil methods may be used. Direct fired combustion heaters will not be allowed during abrasive blasting, coating application, or coating cure time.
 3. Design and submittals:
 - a. CONTRACTOR shall prepare dehumidification and heating plan for this project, including all equipment and operating procedures.

- b. Suppliers of services and equipment shall have not less than 3 years' experience in similar applications.
 - c. Supplier: The following or equal:
 - 1) Cargocaire Corporation (Munters) or equal.
 - d. Submit dehumidification and heating plan for ENGINEER's review.
4. Monitoring and performance:
- a. Measure and record relative humidity and temperature of air, and structure temperature twice daily (beginning and end of work shifts) to verify that proper humidity and temperature levels are achieved inside the work area after the dehumidification equipment is installed and operational. Test results shall be made available to the ENGINEER upon request.
 - b. Interior space of the working area and tank(s) shall be sealed and a slight positive pressure maintained as recommended by the supplier of the dehumidification equipment.
 - c. The filtration system used to remove dust from the air shall be designed so that it does not interfere with the dehumidification equipment's ability to control the dew point and relative humidity inside the reservoir.
 - 1) The air from the tank, working area, or dust filtration equipment shall not be recirculated through the dehumidifier during coating application or when solvent vapors are present.

1.9 SEQUENCING AND SCHEDULING

- A. Sequence and Schedule: As specified in Section 01 14 00 WORK RESTRICTIONS.

1.10 SPECIAL GUARANTEE

- A. Furnish Manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of work specified in this Specification section found *defective* during a period of 1 year after the date of Substantial Completion.
- B. Contractor and paint Manufacturer shall jointly and severally furnish guarantee.

1.11 MAINTENANCE

- A. Extra materials: Deliver as specified in Section 01 77 00. Include minimum 1 gallon of each type and color of coating applied:
 - 1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
 - 2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type, and color.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Special coatings: One of the following or equal:
 - 1. Carboline: Carboline, St. Louis, MO.
 - 2. Ceilcote: International Protective Coatings, Berea, OH.
 - 3. Dampney: The Dampney Company, Everett, MA.
 - 4. Devoe: International Protective Coatings, Louisville, KY.
 - 5. Dudick: Dudick, Inc., Streetsboro, OH.
 - 6. GET: Global Eco Technologies, Pittsburg, CA.

7. Henkel: Henkel North America, Madison Heights MI.
8. IET: Integrated Environmental Technologies, Santa Barbara, CA.
9. Induron Protective Coatings, Birmingham, AL.
10. PPG Amercoat: PPG Protective & Marine Coatings, Brea, CA.
11. Raven Lining Systems, Broken Arrow, OK.
12. Rustoluem : Rustoleum Corp., Sommerset, NJ.
13. Sanchem: Sanchem, Chicago, IL.
14. Superior: Superior Environmental Products, Inc., Addison, TX.
15. S-W: Sherwin-Williams Co., Cleveland, OH.
16. Tnemec: Tnemec Co., Kansas City, MO.
17. Wasser: Wasser High Tech Coatings, Kent, WA.
18. ZRC: ZRC Worldwide Innovative Zinc Technologies, Marshfield, MA.

2.2 PREPARATION AND PRETREATMENT MATERIALS

- A. Metal pretreatment: As manufactured by one of the following or equal:
 1. Henkel: Galvaprep 5.
 2. International: AWLGrip Alumiprep 33.
- B. Surface cleaner and degreaser: As manufactured by one of the following or equal:
 1. Carboline Surface Cleaner No.3.
 2. Devoe: Devprep 88.
 3. S-W: Clean and Etch.

2.3 COATING MATERIALS

- A. Wax coating: As manufactured by the following or equal:
 1. Sanchem: No-Ox-Id A special.
- B. High solids epoxy (self-priming) not less than 72 percent solids by volume: As manufactured by one of the following or equal:
 1. Carboline: Carboguard 891.
 2. Devoe: Bar Rust 233H.
 3. Induron: PE-70
 4. PPG Amercoat: Amerlock 2.
 5. S-W: Macropoxy 646.
 6. Tnemec: HS Epoxy Series 104.
- C. Aliphatic or aliphatic-acrylic polyurethane: As manufactured by one of the following or equal:
 1. Carboline: Carbothane 134 VOC.
 2. Devoe: Devthane 379.
 3. PPG Amercoat: Amershield VOC.
 4. S-W: High Solids Polyurethane [CA].
 5. Tnemec: Endura-Shield II Series 1075 (U).
- D. Epoxy Novolac: Multi-component aggregate-filled epoxy system specifically designed for exposure to municipal wastewater. As manufactured by one of the following or equal:
 1. Sauereisen: Sewergard No. 210, 210S, or 210GL
 2. Carboline: Plasite 4550 S
 3. Devoe: Devmat 100
 4. Raven 410
- E. High temperature coating 150 to 350 degrees Fahrenheit: As manufactured by one of the following or equal:
 1. Carboline: Thermaline 4900.

2. Dampney: Thermalox 245 Silicone - Zinc Dust.
 3. PPG Amercoat: Amerlock 2/400 GFK.
- F. High temperature coating 400 to 1,000 degrees Fahrenheit (dry): As manufactured by one of the following or equal:
1. Carboline: Thermaline 4700.
 2. Dampney: Thermolox 230C Series Silicone.
 3. Devoe: HT-12, High Heat Silicone.
- G. High temperature coating up to 1,400 degrees Fahrenheit: As manufactured by the following or equal:
1. Dampney: Thermalox 240 Silicone Ceramix.
- H. Asphalt varnish: AWWA C 500.
- I. Coal tar: Where coal tar, coal tar epoxy, or coal tar mastic are specified or indicated on the Drawings, use coal tar epoxy substitute in their place. Coal tar shall not be allowed.
- J. Coal tar epoxy substitute: As manufactured by one of the following or equal:
1. [Devoe: Devtar 5A HS.
 2. S-W: Macropoxy 646 Black.]
- K. Vinyl ester: Glass mat reinforced, total system 125 mils DFT. As manufactured by one of the following or equal:
1. Carboline: Semstone 870.
 2. Ceilcote: 6640 Ceilcrete.
 3. Dudick: Protecto-Flex 800.
 4. Tnemec: Chembloc Series 239SC.
- L. Elastomeric polyurethane, 100 percent solids, ASTM D 16, Type V, (Urethane P): As manufactured by the following or equal:
1. GET: Endura-Flex EF-1988.
- M. Concrete floor coatings: As manufactured by one of the following or equal:
1. Carboline: Semstone 140SL.
 2. Devoe: Devran 124.
 3. Dudick: Polymer Alloy 1000.
 4. Tnemec: Tneme-Glaze Series 282.
- N. Waterborne acrylic emulsion: As manufactured by one of the following or equal:
1. S-W: DTM Acrylic B66W1.
 2. Tnemec: Tneme-Cryl Series 6.
- O. Galvanizing Zinc Compound: As manufactured by one of the following or equal:
1. ZRC: Cold Galvanizing Compound.
- 2.4 MIXES
- A. Mix in accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.1 GENERAL PROTECTION

- A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection:
- B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings:
 - 1. Mask off surfaces of items not to be coated or remove items from area.
- C. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and in particular, surfaces within storage and preparation area.
- D. Place cotton waste, cloths, and material which may constitute fire hazard in closed metal containers and remove daily from site.
- E. Remove electrical plates, surface hardware, fittings, and fastenings, prior to application of coating operations. Carefully store, clean, and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.2 GENERAL PREPARATION

- A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Section.
- B. Protect following surfaces from abrasive blasting by masking, or other means:
 - 1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
 - 2. Machined surfaces for sliding contact.
 - 3. Surfaces to be assembled against gaskets.
 - 4. Surfaces of shafting on which sprockets are to fit.
 - 5. Surfaces of shafting on which bearings are to fit.
 - 6. Machined surfaces of bronze trim, including those slide gates.
 - 7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
 - 8. Galvanized items, unless scheduled to be coated.
- C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.
- D. Concrete:
 - 1. Allow new concrete to cure for minimum of 28 days before coating.
 - 2. Clean concrete surfaces of dust, mortar, fins, loose concrete particles, form release materials, oil, and grease. Fill voids so that surface is smooth. Etch or brush off-blast clean in accordance with SSPC SP-7 to provide surface profile equal to 40 to 60-grit sandpaper, or as recommended by coating manufacturer. All concrete surfaces shall be vacuumed clean prior to coating application.
- E. Ferrous metal surfaces:
 - 1. Remove grease and oil in accordance with SSPC SP-1.
 - 2. Remove rust, scale, and welding slag and spatter, and prepare surfaces in accordance with appropriate SSPC standard as specified.
 - 3. Abrasive blast surfaces prior to coating.

- a. When abrasive blasted surfaces rust or discolor before coating, abrasive blast surfaces again to remove rust and discoloration.
 - b. When metal surfaces are exposed because of coating damage, abrasive blast surfaces and feather in to a smooth transition before touching up.
 - c. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC SP-10, unless blasting may damage adjacent surfaces, prohibited or specified otherwise. Where not possible to abrasive blast, power tool clean surfaces in accordance with SSPC SP-3.
 - d. Ferrous metal surfaces to be submerged: Unless specified otherwise, abrasive blast in accordance with SSPC SP-5 to clean and provide roughened surface profile of not less than 2 mils and not more than 4 mils in depth when measured with Elcometer 123, or as recommended by the coating manufacturer.
4. All abrasive blast cleaned surfaces shall be blown down with clean dry air and or vacuumed.
- F. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.
- G. Sherardized, aluminum, copper, and bronze surfaces: Prepare in accordance with coating manufacturer's instructions.
- H. Galvanized surface:
- 1. Degrease or solvent clean (SSPC SP-1) to remove oily residue.
 - 2. Power tool or hand tool clean or whip abrasive blast.
 - 3. Test surface for contaminants using copper sulfate solution.
 - 4. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded physically, such as bolts, nuts, or preformed channels.
- I. Shop primed metal:
- 1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
 - 2. Remove shop primer from metal to be submerged by abrasive blasting in accordance with SSPC SP-10, unless greater degree of surface preparation is required by coating manufacturer's representative.
 - 3. Correct abraded, scratched, or otherwise damaged areas of prime coat by sanding or abrasive blasting to bare metal in accordance with SSPC SP-2, SP 3, or SP-6, as directed by the ENGINEER.
 - 4. When entire shop priming fails or has weathered excessively (more than 25 percent of the item), or when recommended by coating manufacturer's representative, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP-10.
 - 5. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP-10.
 - 6. When prime coat not authorized by ENGINEER is applied, remove unauthorized prime coat by abrasive blasting in accordance with SSPC SP-10.
 - 7. Shop applied bituminous paint or asphalt varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.
- J. Cadmium-plated, zinc-plated, or sherardized fasteners:
- 1. Abrasive blast in same manner as unprotected metal when used in assembly of equipment designated for abrasive blasting.
- K. Abrasive blast components to be attached to surfaces which cannot be abrasive blasted before components are attached.

- L. Grind sharp edges to approximately 1/16-inch radius before abrasive blast cleaning.
- M. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning in accordance with NACE SP0178.
- N. PVC and FRP Surfaces:
 - 1. Prepare surfaces to be coated by light sanding (de-gloss) and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.
- O. Cleaning of previously coated surfaces:
 - 1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces:
 - a. Cleaning agent: Biodegradable non-flammable and containing no volatile organic compounds.
 - b. Manufacturer: The following or equal:
 - 1) Chlor-Rid International, Inc.
 - 2. Steam clean and degrease surfaces to be coated to remove oils and grease, then, if necessary, proceed with abrasive blast cleaning.
 - 3. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, steam cleaning, high-pressure washing, or hand washing as approved by the coating manufacturer's representative and the ENGINEER.
 - 4. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.
 - 5. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions.

3.3 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

- A. Identify equipment, ducting, piping, and conduit as specified in Section 22 05 53 – MECHANICAL IDENTIFICATION and Section 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS.
- B. Remove grilles, covers, and access panels for mechanical and electrical system from location and coat separately.
- C. Prepare and finish coat-primed equipment with color selected by the ENGINEER.
- D. Prepare and prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with prefinished coating.
- E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.
- F. Prepare and coat interior surfaces of air ducts, convactor and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.
- G. Prepare and coat dampers exposed immediately behind louvers, grilles, convactor and baseboard cabinets to match face panels.
- H. Prepare and coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.
- I. Prepare and coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

- J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming and numbering, in accordance with Contract Documents.

3.4 GENERAL APPLICATION REQUIREMENTS

- A. Apply coatings in accordance with manufacturer's instructions.
- B. Coat metal unless specified otherwise:
 - 1. Aboveground piping to be coated shall be empty of contents during application of coatings.
- C. Verify metal surface preparation immediately before applying coating in accordance with SSPC SP COM.
- D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.
- E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.
- F. Prime shop primed metal surfaces. Spot prime exposed metal of shop primed surfaces before applying primer over entire surface.
- G. Multiple coats:
 - 1. Apply minimum number of specified coats.
 - 2. Apply additional coats when necessary to achieve specified thicknesses.
 - 3. Apply coats to thicknesses specified, especially at edges and corners.
 - 4. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.
 - 5. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.
 - 6. Dust coatings between coats.
- H. Coat surfaces without drops, overspray, dry spray, runs, ridges, waves, holidays, laps, or brush marks.
- I. Remove spatter and droppings after completion of coating.
- J. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.
- K. Plural component application: Drums shall be premixed each day. All gauges shall be working order prior to the start of application. Ratio checks shall be completed prior to each application. A spray sample shall be sprayed on plastic sheeting to ensure set time is complete prior to each application. Hardness testing shall be performed after each application.
- L. Spray application:
 - 1. Stripe coat edges, welds, nuts, bolts, difficult to reach areas by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
 - 2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for spray application.
 - 3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
 - 4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.

- M. Drying and recoating:
1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
 2. For submerged service the CONTRACTOR shall provide a letter to the ENGINEER that the lining system is fully cured and ready to be placed into service .
 3. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
 4. Do not allow excessive drying time or exposure which may impair bond between coats.
 5. Recoat epoxies within time limits recommended by coating manufacturer.
 6. When time limits are exceeded, abrasive blast clean and de-gloss clean prior to applying another coat.
 7. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
 8. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
 9. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
 10. Leave no holidays.
 11. Sand and feather in to a smooth transition and recoat and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.
- N. Concrete:
1. Apply first coat (primer) only when surface temperature of concrete is decreasing in order to eliminate effects of off-gassing on coating.

3.5 ALKALI RESISTANT BITUMASTIC

- A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.
- B. Application:
1. Apply in accordance with general application requirements and as follows:
 - a. Apply at least 2 coats, 8 to 14 mils dry film thickness each.

3.6 WAX COATING

- A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.
- B. Application:
1. Apply in accordance with general application requirements and as follows:
 - a. Apply at least 1/32-inch thick coat with 2-inch or shorter bristle brush.
 - b. Thoroughly rub coating into metal surface with canvas covered wood block or canvas glove.

3.7 HIGH SOLIDS EPOXY SYSTEM

- A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements and as follows:
 - a. Abrasive blast ferrous metal surfaces to be submerged at jobsite in accordance with SSPC SP-5 prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-10.

- b. Abrasive blast non-submerged ferrous metal surfaces at jobsite in accordance with SSPC SP-10, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 6.
- c. Abrasive blast clean ductile iron surfaces at jobsite in accordance with SSPC SP-7.

B. Application:

- 1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply minimum 2-coat system with minimum total dry film thickness (DFT) of 12 mils.
 - b. Recoat or apply succeeding epoxy coats within time limits recommended by manufacturer. Prepare surfaces for recoating in accordance with manufacturer's instructions.
 - c. Coat metal to be submerged before installation when necessary, to obtain acceptable finish, and to prevent damage to other surfaces.
 - d. Coat entire surface of support brackets, stem guides, pipe clips, fasteners, and other metal devices bolted to concrete.
 - e. Coat surface of items to be exposed and adjacent 1 inch to be concealed when embedded in concrete or masonry.

3.8 HIGH SOLIDS EPOXY AND POLYURETHANE COATING SYSTEM

A. Preparation:

- 1. Prepare surfaces in accordance with general preparation requirements and as follows:
 - a. Prepare concrete surfaces in accordance with general preparation requirements.
 - b. Touch up shop primed steel and miscellaneous iron.
 - c. Abrasive blast ferrous metal surfaces at jobsite prior to coating. Abrasive blast clean rust and discoloration from surfaces.
 - d. Degrease or solvent clean, whip abrasive blast, power tool, or hand tool clean galvanized metal surfaces.
 - e. Lightly sand (de-gloss) fiberglass and poly vinyl chloride (PVC) pipe to be coated and wipe clean with dry cloths, or solvent clean in accordance with coating manufacturer's instructions.
 - f. Abrasive blast clean ductile iron surfaces.

B. Application:

- 1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply 3 coat system consisting of:
 - 1) Primer: 4 to 5 mils dry film thickness high solids epoxy.
 - 2) Intermediate coat: 4 to 5 mils dry film thickness high solids epoxy.
 - 3) Topcoat: 2.5 to 3.5 mils dry film thickness aliphatic or aliphatic-acrylic polyurethane topcoat.
- 2. Recoat or apply succeeding epoxy coats within 30 days or within time limits recommended by manufacturer, whichever is shorter. Prepare surfaces for recoating in accordance with manufacturer's instructions.

3.9 EPOXY NOVOLAC SYSTEM

A. Preparation:

- 1. Prepare surfaces in accordance with general preparation requirements and as follows:
- 2. Prepare concrete to obtain clean, open pore with exposed aggregate in accordance with manufacturer's instructions.
- 3. Prepare ferrous metal surfaces in accordance with SSPC SP-5, with coating manufacturer's recommended anchor pattern.
- 4. Complete application of prime coat within 6 hours of abrasive blast cleaning. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-5.
- 5. When handling steel, wear gloves to prevent hand printing.

6. Adjust pH of concrete to within 7 to 11 before applying prime coat.

B. Application:

1. Apply coatings in accordance with general application requirements and in accordance with manufacturer's instructions.
2. Continue to monitor dew point. Dew point shall remain 5 degrees above ambient temperature for a minimum of 8 hours after application of coating.

3.10 HIGH TEMPERATURE COATING

A. Preparation:

1. Prepare surfaces in accordance with general preparation requirements and as follows:
 - a. Abrasive blast surface in accordance with SSPC SP-10.

B. Application:

1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply number of coats in accordance with manufacturer's instructions.

3.11 ASPHALT VARNISH

A. Preparation:

1. Prepare surfaces in accordance with general preparation requirements.

B. Application:

1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply minimum 2 coats.

3.12 COAL TAR EPOXY SUBSTITUTE

A. Preparation:

1. Prepare surfaces in accordance with general preparation requirements and in accordance with the coating manufacturer's printed instructions.

B. Application:

1. Apply 2 coats at 6 mils to 8 mils each, for a minimum total DFT of 12 mils.

3.13 VINYL ESTER

A. Preparation:

1. Prepare surfaces in accordance with coating manufacturer's recommendations and as directed and approved by coating manufacturer's representative.

B. Application:

1. Apply prime coat, as required by coating manufacturer, base coat, glass mat, and topcoat to total dry film thickness of 125 mils minimum:
 - a. Final topcoat on floors shall include non-skid surface, applied in accordance with manufacturer's instructions.
2. Perform high voltage holiday detection test in accordance with SP0188-06, over 100 percent of coated surface areas to ensure pinhole free finished coating system.
3. All work shall be accomplished in strict accordance with coating manufacturer's instructions and under direction of coating manufacturer's representative.

3.14 ELASTOMERIC POLYURETHANE (100 PERCENT SOLIDS)

A. Preparation:

1. Prepare surfaces in strict accordance with coating manufacturer's instructions and as directed and approved by coating manufacturer's representative.
- B. Application:
 1. Apply epoxy primer at DFT of 1 to 2 mils, in strict accordance with manufacturer's instructions.
 2. Apply polyurethane coating at minimum total DFT as follows:
 - a. Steel: 60 mils DFT.
 - b. Ductile iron and ductile iron pipe coating and lining: 30 mils DFT.
 - c. Concrete: 120 mils DFT.
 - d. Or as recommended by the coating manufacturer and accepted by the ENGINEER.
- C. For concrete application, provide saw cutting for coating terminations in strict accordance with manufacturer's instructions:
- D. For application to damaged concrete, refer to Section 03_01_03.
- E. Perform high voltage holiday detection test in accordance with SP0188-06, over 100 percent of coated surface areas to ensure pinhole free finished coating system.

3.15 CONCRETE FLOOR COATINGS

- A. Preparation:
 1. Prepare surfaces in accordance with general application requirements and in strict accordance with coating manufacturer's instructions.
- B. Application:
 1. Apply primer if required by coating manufacturer.
 2. Apply 1 or more coats as recommended by coating manufacturer to receive a minimum total dry film thickness of 25 mils, color as selected by OWNER.
- C. Final topcoat shall include non-skid surface, applied in strict accordance with coating manufacturer's instructions.

3.16 WATERBORNE ACRYLIC EMULSION

- A. Preparation:
 1. Remove all oil, grease, dirt, and other foreign material by Solvent Cleaning in accordance with SSPC SP-1.
 2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.
- B. Application:
 1. Apply 2 or more coats to obtain a minimum dry film thickness (DFT) of 5.0 mils.

3.17 FIELD QUALITY CONTROL

- A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.
- B. Control and check dry film thicknesses and integrity of coatings.
- C. Measure dry film thickness with calibrated thickness gauge.

- D. Dry film thicknesses on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-Off Gage or Positector 6000.
- E. Verify coat integrity with low-voltage sponge or high-voltage spark holiday detector, in accordance with SP0188 06. Allow ENGINEER to use detector for additional checking.
- F. Check wet film thickness before coal tar epoxy coating cures on concrete or non-ferrous metal substrates.
- G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing:
 1. Notify ENGINEER 24 hours in advance of each visit by coating manufacturer's representative.
 2. Provide ENGINEER with a written report by coating manufacturer's representative within 48 hours following each visit.

3.18 PROTECTIVE COATINGS SYSTEMS

- A. System No. 1: Submerged Metal - General

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5)	Primer – High Solids Epoxy (Self Priming)	1 coat, 6 MDFT
	Top Coat – High Solids Epoxy	1 coat, 6 MDFT

- B. System No. 2: Submerged Metal - Domestic Sewage

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 5 MDFT
	Top Coat –Coal-Tar Epoxy Substitute	2 coats, 20 MDFTPC

- C. System No. 3: Exposed Metal - Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2.5 MDFT
	Intermediate Coat – High Solids Epoxy	1 coat, 4 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 3 MDFT

- D. System No. 4: Exposed Metal – Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2.5 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 3 MDFT

E. System No. 5: Buried Metal - General:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel Blast (SP 10)	Standard Hot Coal-Tar Enamel -OR- Coal-Tar Epoxy -OR- Tape Coat System	AWWA C203 AWWA C210 AWWA C214
	For Acidic Soil, Brackish Water High Bacteria - Hot Coal-Tar, Double Felt	AWWA C203, App. A, Sec. A1.5
	For Highly Abrasive Soil, Brackish Water - Hot Coal-Tar, Fibrous Glass -OR- Tape Coat System	AWWA C203, App. A, Sec. A1.5 AWWA C214 with Double Outer Wrap

F. System No. 6 High Temperature (150° - 350°):

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT
	Top Coat – High Temperature Coating 150° - 350°	1 coat, 2 MDFT

G. System No. 7 High Temperature (400° - 1000°):

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT

	Top Coat – High Temperature Coating 400° - 1000°	1 coat, 2 MDFT 1 coat, 1.5 MDFT
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H. System No. 8 High Temperature (1000° - 1400°):

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT
	Top Coat – High Temperature Coating up to 1400°	1 coat, 1.5 MDFT

I. System No. 10 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1), followed by Hand Tool (SP 2), or Power Tool (SP 3),	Wash Primer or Coating Manufacturer's Recommendation.	1 coat, 0.4 MDFT
		Remaining coats as required by exposure

J. System No. 11 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1), followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7)	Primer – Organic Zinc Rich	1 coat, 3 MDFT Additional coats as required by exposure.

K. System No. 12 Skid-Resistant Aluminum and FRP:

Surface Prep.	Paint Material	Min. Coats, Cover
Brush-off Blast (SP 7) or Plastic Surface Preparation	High Solids Epoxy (aggregated)	1 coat, 16 MDFT

L. System No. 13 Sliding Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1), followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7)	Wax Coating	1 coat, 31 MDFT

M. System No. 14 Exposed PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
Plastic Surface Preparation	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT
	Waterborne Acrylic Emulsion	1 coat, 3 MDFT

N. System No. 15 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 1	Alkali Resistant Bitumastic or Coal-Tar Epoxy Substitute	1 coat, 18 MDFT

O. System No. 16 Existing Concrete/CMU Repair:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Filler – Per Manufacturer's Recommendations	1 coat, 10 MDFT
	Primer – Per Manufacturer's Recommendations	1 coat, 5 MDFT
	Top Coat – High Solids Epoxy	1 coat, 4 MDFT

P. System No. 17 New Concrete/CMU Exterior (as required by application schedule):

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Filler – Per Manufacturer's Recommendations	1 coat, 10 MDFT
	Intermediate Coat – High Solids Epoxy	1 coat, 4 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 3 MDFT

Q. System No. 18 Concrete/CMU – Interior or Immersion Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Filler – Per Manufacturer's Recommendations	1 coat, 10 MDFT
	Intermediate Coat – High Solids Epoxy	1 coat, 6 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 6 MDFT

R. System No. 19 Concrete/CMU – Immersion Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Per Manufacturer's Recommendations	As required by conditions
	Epoxy Novolac	2 coat, 40 MDFT Minimum or as called for on the Project Drawings.

3.19 SCHEDULE OF ITEMS NOT REQUIRING COATING

1. General: Unless specified otherwise, the following items do not require coating:
2. Items that have received final coat at factory and not listed to receive coating in field.
3. Aluminum, brass, bronze, copper, plastic (except PVC pipe), rubber, stainless steel, chrome, Everdur, or lead.
4. Buried or encased piping or conduit.
5. Exterior concrete.
6. Grease fittings.
7. Fiberglass ducting or tanks in concealed locations.
8. Steel to be encased in concrete or masonry.

3.20 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

- A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces unless specified or otherwise indicated on the Drawings. Coat concrete surfaces and anodized aluminum only when specified or indicated on the Drawings. Color coat all piping as specified in Section 40 23 39, PROCESS PIPING GENERAL.
- B. Following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.
- C. Metal:
 1. System 3 – Exposed Metal – Highly Corrosive
 - a. Above grade piping, wall pipes, and pipe sleeves.
 - b. Structural Steel.
 - c. Pumps and valves

END OF SECTION

SECTION 09 97 26.13 – INTERIOR COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Interior coating systems for concrete sewer manholes and other concrete structures as indicated, specified, or as directed by the Engineer.
- B. Related sections:
 - 1. Section 33 39 13.13 – Pre-Cast Concrete Manholes

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM), latest edition.
 - 1. ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
 - 2. ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coating by Notched Gages
 - 3. ASTM D 4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 - 4. ASTM D 4787 – Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
 - 5. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - 6. ASTM D 695 – Standard Test Method for Compressive Properties of Rigid Plastics
 - 7. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics
 - 8. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- B. Other Standards, latest edition.
 - 1. ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
 - 2. NACE No. 6 / SSPC SP-13 – Surface Preparation of Concrete

1.3 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and Section 01 33 00 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation requirements, and application instructions.
- C. Color Samples: Submit manufacturer's color samples showing full range of standard colors.
- D. Manufacturer's Quality Assurance:
 - 1. Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.
 - 2. Submit a list of at least 5 completed projects of similar size and similar waste stream where coating has been applied. Include for each project:
 - a. Project name and location.
 - b. Name, address, and phone number of owner.
 - c. Name of applicator.

- d. Name of engineer.
- e. Approximate area of coatings applied.
- f. Date of completion.

E. Applicator's Quality Assurance:

1. The applicator must be trained and certified/approved by the coating system manufacturer.
2. Submit a list of at least 5 completed projects of size and complexity similar to this Work where applicator has spray applied 100% solids epoxies. Include for each project:
 - a. Project name and location.
 - b. Name, address, and phone number of owner.
 - c. Name of contractor.
 - d. Name of engineer.
 - e. Name of coating manufacturer and product applied.
 - f. Approximate area of coatings applied.
 - g. Date of completion.
3. Submit certification that each foreman to be utilized on this project has overseen the application of 50,000 square feet of 100% solids epoxy coatings in the last three years, 30,000 square feet of which shall have been applied in manholes. Certification for each foreman shall include the following information for each applicator company for which each foreman worked:
 - a. employees' name;
 - b. project names and descriptions;
 - c. name, address, and phone number of contact person for each applicator company worked for;
 - d. name, address, phone number of contact person for each project owner;
 - e. years experience and amount of coating applied.
4. Submit certification that the "nozzle men" to be utilized on this project each have a minimum of two years experience and have spray applied a minimum of 30,000 square feet of 100% solids epoxy coatings in the last two years, 20,000 square feet of which shall have been applied in manholes. Certification for each "spray man" to be utilized shall include the following information for each applicator company for which each "spray man" worked:
 - a. employees' name;
 - b. project names and descriptions;
 - c. name, address, and phone number of contact person for each applicator company worked for;
 - d. name, address, phone number of contact person for each project owner;
 - e. years experience and amount of coating applied.
5. Submit certification that at least two-thirds of the crew to be utilized on this project has a minimum of two years experience applying 100% solids epoxy coatings. Certification for each crew member to be utilized shall include the following information for each applicator company for which each employee worked:
 - a. employees' name;
 - b. project names and descriptions;
 - c. name, address, and phone number of contact person for each applicator company worked for;
 - d. name, address, phone number of contact person for each project owner;
 - e. primary role(s) and years experience in each role applying 100% solids epoxies.
6. Other, equivalent documentation will be considered for approval at Engineer's discretion.

F. Manufacturer's Field Report: Provide copy of report from manufacturer's representative confirming that the surfaces to which coating is to be applied are in a condition suitable to receive same.

G. Warranty:

1. Material Warranty: A written guarantee of 5 years submitted to the City for the specified project shall be provided by the Manufacturers of the Coatings and Repair Products, if different manufacturers.
2. Workmanship Warranty: A written guarantee of at least 2 years shall be provided by the Applicator against any shortcoming in Workmanship.

1.4 QUALITY ASSURANCE

A. Pre-Installation Conference

1. Pre-Installation Conference: Prior to beginning coating operations, a meeting will be held with Contractor, coating sub-contractor, Engineer, Owner's representative, and coating manufacturer's representative to verify and review the following:
 - a. Project requirements for coating as set out in Contract Documents.
 - b. Manufacturer's product data including application instructions.
 - c. Substrate conditions and procedures for substrate preparation and coating installation. Applicator shall be familiar with the overall condition of structures to be coated prior to the conference.
2. Technical Consultation: The coating manufacturer's representative shall provide technical consultation on coating application.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:

1. Coating or material name.
2. Manufacturer.
3. Color name and number.
4. Batch or lot number.
5. Date of manufacture.
6. Mixing instructions.

B. Storage:

1. Store materials in a clean dry area away from open flame, heat, and strong oxidants. Store materials within temperature range as recommended by manufacturer.
2. Keep containers sealed until ready for use.
3. Do not use materials beyond manufacturer's shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination. Handle materials according to their material safety data sheets.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Coating System:

1. The coating system shall be a spray applied 100% solids epoxy coating which forms a monolithic coating covering all interior surfaces of the structures specified to be coated.
2. The bonding strength of the finished coating shall exceed the point of concrete substrate failure according to ASTM D4541.
3. The coating system shall be designed for hydrostatic loading and shall be continuously bonded to all brick, mortar, concrete, chemical sealant, grout, pipe, and other surfaces inside the manhole.
4. When cured, the system shall form a continuous, tight fitting, hard, impermeable, pinhole-free coating that is suitable for sewer system service and chemically resistant to any

chemicals, bacteria, or vapors normally found in domestic sewage and sewage from the Fayetteville Industrial Park.

5. The coating shall effectively seal the interior surfaces of the manhole and prevent any penetration or leakage of groundwater infiltration.
 6. Acceptable coating manufacturers shall be:
 - a. Raven
 - b. Warren
 - c. Approved Equal
 7. The epoxies shall meet the following minimum requirements:
 - a. Flexural strength according to ASTM D790: 6,000 psi
 - b. Compressive strength according to ASTM D695: 8,000 psi
 - c. Tensile strength according to ASTM D638: 4,000 psi
 - d. Tensile elongation according to ASTM D638: 4%
- B. Repair Materials and Primers:
1. Acceptable patching, filling, repairing, and priming systems shall be as recommended by the coating manufacturer and shall be certified to be compatible with and provide adequate bonding to both the substrate and coating system.
- C. Conductive Underlayment:
1. Acceptable conductive underlayments, as necessary to facilitate high-voltage holiday testing, shall be as recommended by the coating manufacturer and shall be certified by the coating manufacturer to be compatible with and provide adequate bonding to the substrate, any repair or primer materials, and coating system.
- D. Equipment:
1. All equipment for surface cleaning, surface preparation, and coating application shall be approved for use by the coating manufacturer.
 2. Spray equipment for application of the coating system shall be airless.
- E. Non-skid Materials:
1. Non-skid material shall be "8-12" dry sand as manufactured by APAC-Arkansas, Arkhola Division or approved equal.

PART 3 - EXECUTION

3.1 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

- A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.
- B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.2 AREA PREPARATION

- A. All structures to be coated shall be readily accessible to applicator.
- B. Appropriate actions shall be taken to comply with local, state, and federal regulatory and other applicable agencies with regard to environment, health, and safety.
- C. Active flows shall be dammed, plugged, or diverted as required to ensure that the cleaning, preparation, and coating may be performed or applied to the entirety of the surfaces specified to be coated and shall remain dammed, plugged, or diverted until the coating manufacturer's recommended cure time for immersion service has been accomplished.

- D. Surface cleaning, surface preparation, and coating application shall not commence until the concrete substrate has properly cured for a minimum of 28 days.
- E. The temperature of the surface to be coated shall be maintained within the range recommended by the manufacturer. Prior to and during application, care should be taken to avoid exposure of structure to be coated to direct sunlight or other intense heat sources. Application of preparation or coating materials shall not be performed when the concrete surface temperature is rising or in direct sunlight to avoid blistering due to thermal expansion of trapped air or moisture in the substrate.
- F. Applicator shall inspect all surfaces specified to receive a coating prior to surface cleaning and preparation. Applicator shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair or coating materials.

3.3 SURFACE PREPARATION

- A. All contaminants including oil, grease, waxes, form release, curing compounds, efflorescence, sealers, salts, incompatible existing coatings, and other contaminants shall be removed.
- B. A water drop test shall be utilized to test the concrete surface for the presence of hydrophobic contaminants. A droplet of water is placed on the concrete surface and its wetting behavior is observed. If the water droplet flattens and "wets out" the concrete surface, it is likely that the concrete is not contaminated. If the water droplet beads up on the surface like rain on a freshly waxed car, it is likely that the concrete is contaminated.
- C. Suitable surface cleaning methods for removing oils, grease, and other chemicals from the substrate are low pressure detergent/degreaser water cleaning and low pressure hot water cleaning.
- D. Surface preparation shall achieve surfaces that are sound, clean, smooth, even, and free of laitance, fins, protrusions, chemical contaminants, dust, and standing water. Surface preparation shall also result in a concrete surface profile (CSP) as recommended by the coating manufacturer.
- E. Suitable surface preparation methods are abrasive blasting and water jetting. Surface preparation procedures shall be in accordance with ICRI Guideline No. 03732 and NACE No. 6 / SSPC SP-13.
- F. All surfaces shall be inspected during and after surface preparation and prior to application of the coating system. Any evidence of remaining contamination or laitance shall be removed by additional cleaning or surface preparation before proceeding with the application of the coating.
- G. Application of Repair Materials:
 - 1. Areas where structural steel has been exposed or removed shall be repaired as acceptable to the Engineer and surface shall be built out to full-thickness to match adjacent surfaces.
 - 2. All areas where the existing surface is more than 1/2" less than the thickness of the original surface will be built out to full-thickness to match adjacent surfaces.
 - 3. All structural cracks, voids, bug holes, and honeycombs shall be filled and floated with an approved repair material.
 - 4. All bituminous or elastomeric joint sealants or gaskets shall be coated with an approved material.
 - 5. Approved repair materials shall be trowel or spray applied using proper equipment to specified surfaces. Repair materials shall be applied and prepared to provide a surface

with a profile equivalent to the ICRI concrete surface profile (CSP) recommended by the coating manufacturer.

6. Repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds may not be used unless approved by the coating manufacturer for compatibility with the specified system.
7. Application of the repair materials, if not performed by the coating applicator, shall be observed by the applicator's representative to ensure proper finishing for suitability to receive the coating system.

3.4 APPLICATION OF COATING SYSTEM

- A. Prior to application of any coating, the conductivity of the concrete shall be tested for each structure to be coated. The test shall be performed in accordance with ASTM D4787. If the test indicates the concrete provides an insufficient ground, a conductive underlayment shall be applied prior to any coating.
- B. Prior to application of any coating, a moisture test shall be performed on the walls and repaired areas as recommended by the manufacturer.
- C. Application procedures shall conform to the recommendations of the coating manufacturer, including material handling, mixing, environmental controls during application, safety, equipment, pressure settings, and application techniques.
- D. For concrete surfaces that do not require rehabilitation, the coating shall be applied to average and minimum uniform dry film thicknesses as follows or as approved by Engineer:

Product	Average Thickness (mils)	Minimum Thickness (mils)
Raven - 405	100	80

- E. For concrete surfaces that require rehabilitation, the coating shall be applied to average and minimum uniform dry film thicknesses as follows or as approved by Engineer:

Product	Average Thickness (mils)	Minimum Thickness (mils)
Raven - 405	125	100

- F. Do not use mixed coatings exceeding manufacturer's recommended pot life.
- G. The spray applied coating, including any recommended basecoat or primer, shall be applied according to the manufacturer's recommended number of coat applications.
- H. The benches shall be coated to the same average and minimum thicknesses as required for the walls except the benches shall have non-skid materials included in the coating system. The benches shall be made non-skid in accordance with manufacturer recommended procedures and shall have a final texture similar to 10 grit sandpaper.
- I. The elapsed time between succeeding coats shall be as specified by manufacturer.
- J. Any solvents left in the equipment shall be completely removed before applying coating to the designated surfaces.
- K. No application shall be made to frozen surfaces or if freezing is expected to occur inside the structure within a time period detrimental to the uncured coating.

- L. Applied coatings shall be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.5 FIELD QUALITY CONTROL

- A. Contractor's Services:
 - 1. Verify coatings and other materials are as specified.
 - 2. Verify surface preparation and application are as specified.
 - 3. Verify wet film thickness of each coat using wet film gages and total dry film thickness of the coating system by dry film testing as described below.
 - 4. Coating Defects:
 - a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
 - b. Check for holidays on interior surfaces using holiday detector as described in Paragraph 3.6.
 - 5. Report:
 - a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
 - b. Report nonconforming work not corrected.
 - c. Submit copies of report to Engineer and Contractor.
- B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.6 TESTING AND INSPECTION

- A. A wet film thickness gage, conforming to ASTM D4414, shall be used during coating application to ensure a uniform thickness during application.
- B. After the coating system has set hard to the touch it shall be inspected by the Engineer, verifying the following:
 - 1. The coating system's cured thickness. Measurement shall be obtained from a specimen retrieved by the applicator by physically cutting through the coating (by drilling or coring).
 - 2. No groundwater infiltration
 - 3. All pipe connections are open and clear
 - 4. No evident cracks, voids, pinholes, uncured spots, lifts, delamination, blisters, or other type of defects.
 - 5. No "runs" or "sags" not in conformance with the standard set by the mock-ups or that affect the performance of the coating system.
- C. Holiday Testing:
 - 1. Holiday testing shall be performed according to ASTM D 4787 and these specifications. After the elapsed time recommended by the coating manufacturer, the coating shall be inspected with high-voltage holiday detection equipment. An induced holiday shall be made onto the coated concrete surface and serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of minimum specified (not average) film thickness applied but shall be increased if it is insufficient to detect the induced holiday. All detected holidays shall be marked. Holidays shall be repaired by abrading the coating system surface with grit paper or other hand tooling method, completely opening the holiday. After abrading and cleaning, additional coating material shall be hand applied to the repair area. All touch-up/repair procedures shall follow the recommendations of the coating system manufacturer. Repaired areas shall be allowed to cure, as recommended by the manufacturer, before being retested.
- D. Pull-off Testing:

1. Measurement of bond strength of the coating system to the substrate shall be made at a minimum of three locations on each coated structure and along different sections of the structure (i.e. corbel, wall, bench). Bond strength shall be measured in accordance with ASTM D4541, Method E and these specifications. A minimum of three 20mm dollies shall be fixed to the coated surface at locations selected by the Engineer. Test failures shall be documented as failure within the concrete, failure within the coating, or failure at the coating/concrete interface. The following criteria shall be used to evaluate the test results:
 - a. Failure of the dolly adhesive shall require retesting.
 - b. Failure at the coating/concrete interface with less than 20% of substrate adhered to the coating and less than 200 psi pull-off strength shall be deemed coating adhesion failure and the contractor shall remove all coating not meeting minimum requirements, re-perform surface preparation procedures, and recoat the failed surfaces, at no additional cost to the Owner.
 - c. Low pull-off strength values (<250 psi) may require additional testing/evaluation to determine potential adhesion defects at the sole discretion of the Owner.
 - d. The Owner shall further evaluate any areas detected to have inadequate adhesion. Further adhesion testing may be performed to determine the extent of potentially deficient bonded areas and repairs shall be made in accordance with the manufacturer's recommendations.
- E. A final visual inspection shall be made by the Engineer and applicator. Any deficiencies in the finished system shall be marked and repaired by the coating applicator according to the manufacturer's recommendations.

3.7 WARRANTY INSPECTIONS

- A. Inspection of the coated structures shall be performed after the first year of service. Owner will set date for inspections.
- B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.
- C. Coating defects found shall be evaluated by a qualified inspector and the coating manufacturer to determine the cause of the failure and propose repair procedures. Contractor shall coordinate repair of deficiencies in coating systems in accordance with recommended repair procedures, at no additional cost to the Owner.

END OF SECTION

SECTION 09 97 26.23 - EXTERIOR COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Exterior Coating systems for concrete sewer manholes and concrete structures.

1.2 RELATED SECTIONS

- A. Section 33 39 13.13 – Pre-Cast Concrete Manholes

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM), latest edition.

ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coating by Notched Gages

- B. Other Standards, latest edition.

ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

NACE No. 6 / SSPC SP-13 – Surface Preparation of Concrete

1.4 SUBMITTALS

- A. General: Submit listed submittals in accordance with conditions of the Contract and Section 01 33 00 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.
- C. Manufacturer's Quality Assurance:
 - 1. Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.
- D. Applicator's Quality Assurance:
 - 1. Submit certification that the foreman to be utilized on this project has overseen the application of 30,000 square feet of similar coatings in the last three years.
- E. Manufacturer's Field Report: Provide copy of report from manufacturer's representative confirming that the surfaces to which coating is to be applied are in a condition suitable to receive same.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.
 - 2. Able to demonstrate successful performance on comparable projects.
- B. Applicator's Qualifications:

1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.
- C. Pre-Installation Conference: Prior to beginning exterior coating operations, a meeting will be held with Contractor, coating sub-contractor, Engineer, Owner's representative, and coating manufacturer's representative to verify and review the following:
1. Project requirements for coating as set out in Contract Documents.
 2. Manufacturer's product data including application instructions.
 3. Substrate conditions and procedures for substrate preparation and coating installation. Applicator shall be familiar with the overall condition of structures to be coated prior to the conference.
- D. Technical Consultation: The coating manufacturer's representative shall provide technical consultation on coating application.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
1. Coating or material name.
 2. Manufacturer.
 3. Color name and number.
 4. Batch or lot number.
 5. Date of manufacture.
 6. Mixing and thinning instructions.
- B. Storage:
1. Store materials in a clean dry area away from open flame, heat, and strong oxidants. Store materials within temperature range as recommended by manufacturer.
 2. Keep containers sealed until ready for use.
 3. Do not use materials beyond manufacturer's shelf life limits.
- C. Handling: Protect materials during handling and application to prevent damage or contamination. Handle materials according to their material safety data sheets.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Coating System:
1. The coating system shall be designed for hydrostatic loading and shall be continuously bonded to all brick, mortar, concrete, chemical sealant, grout, pipe, and other surfaces outside the manhole.
 2. When cured, the system shall form a continuous, tight fitting, hard, impermeable, pinhole free coating that effectively seals the exterior surfaces of the concrete structures and prevents any infiltration of groundwater through the coating.
 3. Acceptable exterior coating systems shall be:
 - a. Kop Coat – Bitumastic Black Solution
 - b. Tnemec – 46-465 H.B. Tnemecol
 - c. Approved Equal
- B. Repair Materials:
1. Acceptable repair materials shall be as recommended by the coating manufacturer and shall provide adequate bonding to the substrate and coating system.

- C. Equipment:
 - 1. All equipment for surface cleaning, surface preparation, and coating application shall be approved for use by the coating manufacturer.

PART 3 - EXECUTION

3.1 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

- A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.
- B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.2 AREA PREPARATION

- A. All structures to be coated shall be readily accessible to applicator.
- B. Appropriate actions shall be taken to comply with local, state, and federal regulatory and other applicable agencies with regard to environment, health, and safety.
- C. Surface cleaning, surface preparation, and coating application shall not commence until the concrete substrate has properly cured for a minimum of 28 days.
- D. The temperature of the surface to be coated shall be maintained within the range recommended by the manufacturer. Concrete surfaces that have been in direct sunlight must be shaded for 24 hours prior to application of coating materials. Prior to and during application, care should be taken to avoid exposure of structure to be coated to direct sunlight or other intense heat sources. Application of coating materials shall not be performed when the concrete surface temperature is rising or in direct sunlight to avoid blistering due to thermal expansion of trapped air or moisture in the substrate.
- E. Applicator shall inspect all surfaces specified to receive a coating prior to surface cleaning and preparation. Applicator shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair or coating materials.

3.3 SURFACE PREPARATION

- A. All contaminants including oil, grease, waxes, form release, curing compounds, efflorescence, sealers, salts, and other contaminants shall be removed.
- B. A water drop test shall be utilized to test the concrete surface for the presence of hydrophobic contaminants. A droplet of water is placed on the concrete surface and its wetting behavior is observed. If the water droplet flattens and "wets out" the concrete surface, it is likely that the concrete is not contaminated. If the water droplet beads up on the surface like rain on a freshly waxed car, it is likely that the concrete is contaminated.
- C. Suitable surface cleaning methods for removing oils, grease, and other chemicals from the substrate are low pressure detergent/degreaser water cleaning and low pressure hot water cleaning.
- D. Surface preparation shall achieve surfaces that are sound, clean, smooth, even, and free of laitance, fins, protrusions, chemical contaminants, dust, and standing water. Surface preparation shall also result in a surface with a neutral pH and a concrete surface profile (CSP) as recommended by the coating manufacturer.

- E. Suitable surface preparation methods are abrasive blasting and water jetting. Surface preparation procedures shall be in accordance with ICRI Guideline No. 03732 and NACE No. 6 / SSPC SP-13.
- F. All surfaces shall be inspected during and after surface preparation and prior to application of the coating system. Any evidence of remaining contamination or laitance shall be removed by additional cleaning or surface preparation before proceeding with the application of the coating.
- G. Application of Repair Materials:
 - 1. All structural cracks, voids, bugholes, and honeycombs shall be filled and floated with an approved repair material.
 - 2. Approved repair materials shall be trowel or spray applied using proper equipment to specified surfaces. Repair materials shall be applied and prepared to provide a surface with a profile equivalent to the ICRI concrete surface profile (CSP) recommended by the coating manufacturer.
 - 3. Repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds may not be used unless approved by the coating manufacturer for compatibility with the specified system.
 - 4. Application of the repair materials, if not performed by the coating applicator, shall be observed by the applicator's representative to ensure proper finishing for suitability to receive the coating system.

3.4 APPLICATION OF COATING SYSTEM

- A. Exterior coating system shall be applied to a total minimum dry film thickness of 30 mils.
- B. Application procedures shall conform to the recommendations of the coating manufacturer, including material handling, mixing, environmental controls during application, allowable moisture levels, safety, equipment, pressure settings, and application techniques.
- C. Do not use mixed coatings exceeding manufacturer's recommended pot life.
- D. The coating materials must be applied by a certified or approved installer of the coating system.
- E. The spray applied coating, including any recommended basecoat or primer, shall be applied to the manufacturer's recommended average and minimum dry film thicknesses and number of coat applications.
- F. The elapsed time between succeeding coats shall be as specified by manufacturer.
- G. No application shall be made to frozen surfaces or if freezing is expected to occur inside the structure within a time period detrimental to the uncured coating.
- H. Applied coatings shall be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.5 FIELD QUALITY CONTROL

- A. Contractor's Services:
 - 1. Verify coatings and other materials are as specified.
 - 2. Verify surface preparation and applications are as specified.
 - 3. Verify dry mil thickness of each coat and total dry mil thickness of each coating system are as specified using wet film and dry film gauges.
 - 4. Coating Defects:

- a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
- 5. Report:
 - a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
 - b. Report nonconforming work not corrected.
 - c. Submit copies of report to Engineer and Contractor.
- B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating system.

3.6 TESTING AND INSPECTION

- A. A wet film thickness gage, conforming to ASTM D4414, shall be used during coating application to ensure a monolithic coating and uniform thickness during application.

END OF SECTION

DIVISION 22
PLUMBING

SECTION 22 05 29 - PROCESS SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for mechanical system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe positioning systems.
 - 7. Equipment supports.
- B. Related Sections include the following:
 - 1. Section 40 23 39, PROCESS PIPING - GENERAL for pipe guides and anchors.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Pipe positioning systems.
- B. Shop Drawings:
 - 1. Show fabrication and installation details and include calculations for the following:
 - a. Trapeze pipe hangers. Include Product Data for components.
 - b. Metal framing systems. Include Product Data for components.
 - c. Equipment supports.

2. Drawings of piping support system, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

C. Welding certificates.

D. Contract Closeout Submittals: Maintenance information on piping support system.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel and ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

1.7 DESIGN REQUIREMENTS

A. General:

1. Contractor shall be responsible for the design, size, and location of process piping support systems in accordance with the requirements specified herein and in general conformance with the Drawings and the Design Details. The design shall be provided by a company specifically specializing in the design of support systems. The pipe support system design company shall demonstrate that they have at least five years of experience in pipe support design and have successfully completed at least three designs in the previous year. The Contractor shall provide Certification of Compliance with these requirements.
1. Seismic Load: Seismic Design Category B with seismic loads in accordance with the structural notes found on the Drawings.
2. Piping smaller than 30": Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Piping 30" and larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89.

B. Pipe Support Systems:

1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation and capable of supporting combined weight of supported systems, system contents, and test water.
2. Safety Factor: Minimum of 5.
3. Maximum Support Spacing and Minimum Rod Size:
 - a. Steel or Ductile Iron Piping:

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
1-inch & smaller	6 feet	1/4-inch
1-1/2-inch thru	8 feet	1/4-inch

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
2-1/2-inch		
3-inch & 4-inch	10 feet	3/8-inch
6-inch	12 feet	3/8-inch
8-inch	12 feet	1/2-inch
10-inch & 12-inch	14 feet	5/8-inch
14-inch	16 feet	3/4-inch
16-inch & 18-inch	16 feet	7/8-inch
20-inch	18 feet	1-inch
24-inch	18 feet	1-1/4-inch
30-inch & larger	As shown on Drawings	As shown on Drawings

- b. Copper Piping:
Maximum Support Spacing: 2 feet less per size than listed for steel pipe, with 1” and smaller pipe supported every 5 feet.
Minimum Hanger Rod Sizing: Same as listed for steel pipe.
- c. Plastic and Fiberglass Piping:
Maximum support spacing: As recommended by manufacturer for flow temperature in pipe.
Minimum Hanger Rod Sizing: Same as listed for steel pipe.
- d. Stainless Steel Piping:

SST Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
1-inch thru 4-inch	8 feet	1/4-inch
6-inch	8 feet	3/8-inch
8-inch & 10-inch	10 feet	1/2-inch
12-inch	10 feet	1/2-inch
14-inch & 16-inch	12 feet	5/8-inch
18-inch &	14 feet	3/4-inch

SST Pipe Size	Maximum Support/Hanger Spacing	Minimum Rod Size Single Rod Hangers
20-inch		
24-inch	14 feet	7/8-inch

- C. Framing Support System:
1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
 2. Column Members: Size in accordance with Manufacturer's recommended method.
 3. Support Loads: Calculate using weight of pipes filled with water.
 4. Maximum Spans:
 - a. Steel and Ductile Iron Pipe, 3" Diameter and Larger: 10-foot centers, unless otherwise shown.
 - b. Other Pipelines and Special Situations: May require supplementary hangers and supports.
 5. Electrical Conduit Support: Include in design of framing support system.
- D. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
- E. Vertical Sway Bracing: 10-foot maximum centers, or as shown.
- F. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show that they are adequate for additional load, or if they are strengthened to support the additional load.

PART 2 - PRODUCTS

2.1 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.
- B. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.
- C. Materials:
 1. Wetted and Submerged: Stainless steel.
 2. Atmospheric Exposed: Galvanized or painted steel in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.
 3. Corrosive Areas: FRP

2.2 MANUFACTURERS

- A. The following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering products that may be incorporated into the Work include, but are not limited to, Manufacturers specified.

2.3 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Empire Industries, Inc.
 - 3. ERICO/Michigan Hanger Co.
 - 4. Globe Pipe Hanger Products, Inc.
 - 5. Grinnell Corp.
 - 6. GS Metals Corp.
 - 7. National Pipe Hanger Corporation.
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Power-Strut Div.; Tyco International, Ltd.
 - 3. Thomas & Betts Corporation.
 - 4. Tolco Inc.
 - 5. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.

- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. Clevis or Band Hangers: Insert and shield shall cover lower 180° of pipe.
- G. Insert Length: Extend 2" beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - d. MKT Fastening, LLC.
 - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

2.8 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install support systems in accordance with MSS SP 69, Pipe Hangers and Supports-Selection and Application and MSS SP 89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.
- B. Support piping connections to equipment by pipe support and not by the equipment.
- C. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
- D. Support no pipe from the pipe above it.
- E. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
- F. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
- G. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
- H. Install lateral supports for seismic loads at all changes in direction.
- I. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
- J. Repair mounting surfaces to original condition after attachments are made.

3.2 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 °F pipes, NPS 4 to NPS 16, requiring up to 4" of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4" of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6" for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 °F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 °F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
 - J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
 - K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4".
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4" thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool Manufacturer. Install fasteners according to powder-actuated tool Manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to Manufacturer's written instructions.

- G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Section 22 40 00, PLUMBING FIXTURES for plumbing fixtures.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- O. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180°.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12" long and 0.048" thick.
 - b. NPS 4: 12" long and 0.06" thick.
 - c. NPS 5 and NPS 6: 18" long and 0.06" thick.
 - d. NPS 8 to NPS 14: 24" long and 0.075" thick.
 - e. NPS 16 to NPS 24: 24" long and 0.105" thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.5 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2".

3.7 PAINTING

- A. Paint exposed surfaces immediately after erecting hangers and supports as specified in Section 09 90 00, PROTECTIVE PAINTING AND COATINGS.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 22 05 53 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Painted Identification Materials.
 - 2. Equipment Labels.
 - 3. Plastic Pipe Markers.
 - 4. Plastic Tape.
 - 5. Underground-Type Plastic Line Marker.
 - 6. Valve Tags.
 - 7. Valve Schedule Frames.
 - 8. Engraved Plastic-Laminate Signs.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit Manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate the valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- C. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering mechanical identification materials which may be incorporated in the work include; but are not limited to, the following:
 - 1. Allen Systems, Inc.
 - 2. Brady (W.H.) Co.; Signmark Div.
 - 3. Industrial Safety Supply Co., Inc.
 - 4. Seton Name Plate Corp.

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide Manufacturer's standard products of categories and types required for each application as referenced in other sections. Selection is Installer's option where more than a single type is specified for applications but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

- A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 1-1/4" high letters for ductwork and not less than 3/4" high letters for access door signs and similar operational instructions.
- B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, complying with ANSI A13.1 and/or Owner Selection for colors.
- D. See Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

2.4 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 1. Material and Thickness: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets or self-tapping screws
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.5 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide Manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Pressure-Sensitive Type: Provide Manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on un-insulated pipes subjected to fluid temperatures of 125 °F (52 °C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
 1. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360° around pipe at each location, fastened by one of the following methods:
 - a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Laminated or bonded application of pipe marker to pipe (or insulation).
 - d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

2. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - a. Laminated or bonded application of pipe marker to pipe (or insulation).
 - b. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - c. Trapped-to-pipe (or insulation) application of semi-rigid type, with Manufacturer's standard stainless steel bands.
- D. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as shown or specified.
1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
- 2.6 PLASTIC TAPE
- A. General: Provide Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
 - B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
 - C. Color: Comply with ANSI A13.1, except where another color selection is indicated.
- 2.7 UNDERGROUND-TYPE PLASTIC LINE MARKERS
- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
 - B. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.
- 2.8 VALVE TAGS
- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags, with a stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
 1. Provide 1-1/2" diameter tags, except as otherwise indicated.
 2. Provide size and shape as specified or scheduled for each piping system.
 3. Fill tag engraving with black enamel.
 - B. Plastic Laminate Valve Tags: Provide Manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
 1. Provide 1-1/2" sq. black tags with white lettering, except as otherwise indicated.
 2. Provide size, shape and color combination as specified or scheduled for each piping system.
 - C. Valve Tag Fasteners: Provide Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

- D. Access Panel Markers: Provide Manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.9 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.10 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.11 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 2. Stenciled markers, with lettering color complying with ANSI A13.1.
 3. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
 4. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.
 5. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - d. At access doors, manholes and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
 - g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.5 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.6 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
- B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Contracting Officer.
- C. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.7 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.8 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
- B. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION

DIVISION 26
ELECTRICAL

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in the General and Supplementary Conditions.
- B. This project consists of construction of the new building structures, associated facilities, and all related electrical systems as defined in the plans and in these specifications.
- C. The work includes the installation, connection and testing of new electrical equipment, including electrical services, power distribution equipment, lighting equipment, underground electrical work, grounding systems, control systems, conduit and wiring, coordination of traffic flow, temporary power systems, special electrical systems and all appurtenances to construct and demonstrate proper operation of the completed electrical systems.
- D. The Contractor shall be responsible for the coordination of power, communication, and controls for the project.
- E. The electrical plans do not give exact locations, etc., and do not show all the offsets, control lines, pilot lines, and other installation details. Each contractor shall carefully lay out the work at the sites to conform to the job conditions, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide complete operating systems.
- F. The electrical plans show diagrammatically the locations of the various electrical outlets and apparatus and the general method of circuiting and controlling. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, etc., by measurements at the buildings, and in cooperation with other crafts, and in all cases shall be subject to the approval of the Owner and Engineer. The Engineer reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.
- G. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structure of the buildings, which will fit into the several available spaces, and which will ensure complete and satisfactory systems. Each bidder shall be responsible for the proper fitting of the material and apparatus into the buildings.
- H. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the Drawings, the Bidder shall arrange for such space with the Engineer before submitting the bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such changes at the Contractor's expense.
- I. Where wire sizes, conduit and other items of construction are shown or required for a complete installation, but are not adequately identified as to size or material requirements, the materials furnished shall be in accordance with "Code" requirements as though shown in detail on the Drawings.
- J. All equipment shall be leveled and made plumb. Metal junction boxes, equipment enclosures and metal raceways mounted on water or earth-bearing walls shall be separated from walls not less than 1/4 inch by corrosion-resistant spacers. All electrical conduits and items of equipment shall be run or set parallel to walls, floors and other items of construction.

1.2 STANDARDS

- A. The Contractor shall perform work specified in Division 26 in accordance with standards listed below. Where these specifications are more stringent, the most stringent standard shall take precedence. In case of conflict, obtain a decision from the Engineer.
1. Applicable National Fire Protection Association (NFPA) codes, including but not limited to:
 - a. NFPA 70 – National Electrical Code.
 - b. NFPA 70E – Standard for Electrical Safety in the Workplace.
 - c. NFPA 72 - National Fire Alarm Code.
 - d. NFPA 101 – Life Safety Code.
 - e. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
 - f. Internet Website: <http://www.nfpa.org>
 2. Applicable Code of Federal Regulations (CFR) codes, including but not limited to:
 - a. 29 CFR 1910 – Occupational Safety and Health Standards (OSHA).
 - b. 29 CFR 1926 – Safety and Health Regulations for Construction.
 - c. Internet Website: <http://www.gpo.gov/fdsys>
 3. ANSI/IEEE C2 – National Electrical Safety Code.
 4. Applicable Federal, State and Local Fire codes.
 5. Applicable Federal, State and Local Energy Codes.
 6. Applicable Federal, State and Local Building Codes.
 7. Applicable City Electrical Code.
 8. Applicable City Ordinances pertaining to electrical work.
 9. Applicable Federal, State and Local – Environmental, Health and Safety Laws and Regulations.
- B. Contractor shall utilize the most current editions of standards, which are current at time of bid and as recognized by the Authority Having Jurisdiction for the respective standard.

1.3 SUBMITTALS

- A. Submittals shall comply with Section 01 33 00 SUBMITTAL PROCEDURES and the General and Supplementary Conditions.
- B. Submittals shall be furnished by the Contractor for the work involved in sufficient time so that no delay or changes will be caused. Fax copies are not acceptable.
- C. Submittals shall consist of manufacturing information, schematics, wiring diagrams, ladder logic diagrams, instrument loop diagrams, outline drawings, clearances and related information. Shop Drawings shall be so marked as to indicate the EXACT items offered.
- D. Submittals shall bear Contractor's certification that the item complies in all respects with the item originally specified. It is the Contractor's responsibility to procure the proper sizes, quantities, rearrangements, structural modifications or other modifications in order for the substituted item to comply with the established requirements.
- E. The Contractor shall combine each submittal set into one electronic file (pdf format). Group materials submitted by their Specification numbers, but do not submit the entire electrical within one submittal. Provide electronic bookmarks in the pdf to indicate the included equipment types and a title sheet to separate each section.
- F. The Contractor shall submit complete descriptions, illustrations, specification data, etc., of all materials, fittings, devices, fixtures, special systems, etc., as required by the individual sections of this Division.

- G. Submittal of shop drawings, product data and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed.
- H. All submittals shall provide the following information:
 - 1. General Contractor.
 - 2. Sub-Contractor.
 - 3. Distributor and/or Supplier.
 - 4. Sales Agency.
 - 5. Submittals not supplying this information will be rejected.
- I. Shop Drawings: In addition to the above, submit shop drawings for major materials where called for and when requested by the Engineer.
 - 1. Lockout/Tagout Program.
 - 2. Switchboard, motor control centers, panelboards, surge arresters, and safety switches.
 - 3. Motor starters and contactors including custom wiring diagrams for all motors.
 - 4. Lighting fixtures and lamps including light pole foundation requirements.
 - 5. Wire, cable and conduit.
 - 6. Dry type transformers including weight and dimensions.
 - 7. Wiring devices and plates.
 - 8. Dimensioned layout of electrical room drawn to scale, with equipment location shown therein. Clearances shall be in accordance with NEC and local codes.
 - 9. Dimensioned layout of all below grade conduit installations.
 - 10. Grounding system and layout.
 - 11. Lightning protection system layout.
 - 12. Traffic control system layout and schematics.
 - 13. Seismic protection materials and methods for all electrical equipment.
 - 14. Mounting brackets, supports and assembly for walkway mounted equipment including instruments, lighting and control panels

1.4 QUALITY ASSURANCE

- A. Any electrical equipment provided under this Division shall be turned over to the Owner in operating condition. Instruction on further operation and maintenance shall be included in the operating and maintenance instructions.

1.5 PRODUCT LISTING

- A. Prepare listing of major electrical equipment and materials for the project.
- B. Provide all information requested.
- C. Submit this listing as a part of the submittal requirements.
- D. When two or more items of same material or equipment are required they shall be of the same manufacturer when available. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment kits, and similar items used in Work, except as otherwise indicated.
- E. Provide products that are compatible within systems and other connected items.

1.6 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.7 WORK SUPERVISION

- A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a master electrician as defined by the statutes of the State of the work being performed. The supervisor or his appointed alternate possessing at least a master electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.
- B. All master and journeyman electricians shall be licensed in accordance with the statutes of the State of the work being performed. No unlicensed electrical workers shall perform work on this project. Apprentice electricians in a ratio of not more than one apprentice per journeyman electrician will be allowed if the apprentices are licensed and actively participating in an apprentice-ship program recognized and approved by the statutes of the State of the work being performed.

1.8 TELEPHONE WORK

- A. The Contractor shall be responsible for coordinating all telephone work with the servicing utility, Owner and Engineer.

1.9 LOCKOUT / TAGOUT PROGRAM

- A. The Contractor shall provide a complete copy of and electrical energy source Lockout/Tagout Program to the Owner, with copy to the Engineer. The document shall clearly identify the on-site master electricians and their contact information, including office and mobile telephone numbers.
- B. The Lockout/Tagout Program shall comply with Part 1910 - Occupational Safety and Health Standards (OSHA) Subpart S – Electrical, and meet the requirements of 29 CFR 1910.147, The Control of Hazardous Energy (Lockout/Tagout), including requirements listed in 1910.331 through 1910.335.
- C. Implementation of the Lockout/Tagout Program and all other related safety requirements are the sole responsibility of the Contractor.

1.10 SAFETY PROGRAM

- A. The Contractor shall implement an electrical safety program that complies with NFPA 70E and 29 CFR 1926.
- B. Implementation of the Electrical Safety Program, determining and providing proper Personal Protective Equipment (PPE), training and enforcing personnel to wear the prescribed PPE, conducting work area safety inspections (including correcting deficiencies), and all other related safety requirements are the sole responsibility of the Contractor.

1.11 EQUIPMENT CONNECTIONS

- A. General: Provide connections for all equipment installed or modified by this contract, regardless of who furnished the equipment.
- B. Provide all disconnect switches required by Code whether or not shown on the plans.
- C. Contractor shall connect Owner-furnished equipment when specified.

1.12 GENERAL CONDITIONS

- A. The work under this heading is subject to the General and Supplementary Conditions, special conditions for mechanical and electrical work, and the Contractor or subcontractor will be responsible for and be governed by all requirements thereunder as though specifically repeated herein.

1.13 COORDINATION

- A. The Contractor shall coordinate arrangement, mounting and support of all electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at a required slope.
 - 4. So connecting raceways, cables and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. The Contractor shall coordinate electrical equipment to be mounted on vendor supplied walkways with supplier.

1.14 SPECIAL NOTE

- A. The mechanical, structural and process plans and specifications, including the general conditions and all supplements issued thereto, information to bidders, and other pertinent documents issued by the Engineer, are a part of these specifications and the accompanying electrical plans, and shall be complied with in every respect. All the above is included herewith, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of mechanical, process and structural details from the electrical drawings.

1.15 CONTINUATION OF SERVICES

- A. The Contractor shall install any temporary lines and connections required to maintain electric services and safely remove and dispose of them when complete. The Contractor shall supply emergency power whenever any existing electrical service is without power. In general, the existing facility shall remain operational during construction.
- B. Planned outages shall be coordinated two weeks in advance with duration and time of start approved by the Owner. Changeover work which may be required after normal hours or weekends shall not constitute the basis for additional cost to the Owner. When an outage begins, the Contractor shall proceed directly to completion of the work without unscheduled interruptions or delays due to lack of manpower, equipment or tools.
- C. The Contractor shall refer to the sequence of construction and shall provide temporary connections as may be required to complete each phase of construction as may be required. The

Contractor shall submit proposed electrical service plans for each phase of construction to the Owner and Engineer for consideration.

1.16 LAYOUT

- A. The Contractor shall coordinate and establish all bench marks and control lines. The Contractor shall lay out all work. The lay out shall be reviewed by the Engineer and Owner prior to starting any work.

1.17 RELATED WORK SPECIFIED ELSEWHERE

- A. Mechanical Equipment: The Contractor shall rough-in for and make final electrical connections to all motor, panels, fixtures, and equipment furnished under other sections of the specifications, providing all material and equipment required for such final connections, except hereinbefore described. This includes, but is not limited to, control panels and other miscellaneous equipment.
- B. The Contractor shall refer to other sections of these specifications for all information relating to the requirements of all electrical connections to the equipment and shall furnish and install electrical items required for a complete installation, ready for operation.
- C. Roughing-in shall be accomplished from approved shop drawings.
- D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- E. Refer to equipment specifications in other Divisions for rough-in requirements.

1.18 LOCAL CONDITIONS

- A. Inspection of Sites: The bidder shall inspect the site, thoroughly acquaint himself with conditions to be met and work to be accomplished. Failure to comply with this shall not constitute grounds for any additional payments.

1.19 RECORD DOCUMENTS

- A. Refer to the General and Supplementary Conditions for requirements. The following paragraphs supplement the requirements of the General and Supplementary Conditions:
 - 1. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned for column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.
 - 2. The Contractor shall locate all underground and concealed work, identifying all equipment, conduit, circuit numbers, motors, feeders, breakers, switches, and starters. The Contractor will certify accuracy by endorsement. Record drawings shall be correct in every detail, such that the Owner can properly operate, maintain, and repair exposed and concealed work.
 - 3. The Contractor shall store the Record drawings on the site. Drawings shall not be rolled. Make corrections, additions, etc., with pencil, with date and authorization of change.
 - 4. Mark specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.20 OPERATION AND MAINTENANCE DATA

- A. Refer to Section 01 33 00 SUBMITTAL PROCEDURES and Section 01 78 23 OPERATION AND MAINTENANCE DATA for procedures and requirements for preparation and submittal of maintenance manuals.
- B. In addition to the information required by Sections 01 33 00 and 01 78 23, include the following information:
 - 1. Installation manual: Description of function, installation and calibration manuals, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 - 2. Operations manual: Manufacturer's printed operating instructions and procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; summer and winter operating instructions; and all programming and equipment settings.
 - 3. Maintenance manual: Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Service manual: Servicing instructions and lubrication charts and schedules, including the names and telephone numbers of personnel to contact for both routine periodic and warranty service for equipment and materials provided under this Division.
 - 5. Final approved equipment shop drawings, clearly labeled.
 - 6. Final test reports, clearly labeled, including motor certification tests.
 - 7. Final certified calibration sheets for all equipment and instruments.
- C. After approval of the O&M Manuals, the Contractor shall provide three (3) complete electronic copies of all documentation in Adobe PDF file format using a storage media device of the Owner and Engineer's choosing along with 6 hard copies.

1.21 GUARANTEE

- A. The Contractor shall guarantee the work and materials for a period of one (1) year from the date of completion. If there are failures due to faulty material or workmanship, the Contractor shall correct the failure at no cost to the Owner.
- B. Refer to the General and Supplementary Conditions for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
 - 1. Compile and assemble the warranties specified in Division 26, into a separate set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
- D. Upon completion of the installation, the Contractor shall adjust the systems to the satisfaction of the Engineer.
- E. This guarantee shall include the capacity and integrated performance of the component parts of the various systems in accordance with the intent of the specifications. The Contractor shall conduct complete tests required by the Engineer to demonstrate the ability of the various systems.

1.22 CLEANING

- A. Refer to Section 01 77 00 CLOSEOUT PROCEDURES for general requirements for final cleaning.

- B. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps.
- C. The electrical system shall be thoroughly cleaned inside and outside, of all enclosures to remove all debris, dust, concrete splatter, plaster paint and lint.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All materials and equipment used in carrying out these specifications shall be new and have UL listing, or listing by other recognized testing laboratory when such listings are available. Specifications and drawings indicate name, type, or catalog numbers of materials and equipment to be used as standards.

PART 3 - EXECUTION

3.1 SALVAGE

- A. All salvage and equipment removed by the work shall remain the property of the Owner unless directed otherwise by the Owner. Material removed from the project shall be stored on the project site where and as directed. Debris shall be removed from the job site and disposed of by the Contractor.

3.2 DEMOLITION AND DISPOSAL

- A. All conduit, wire, and other electrical appurtenances associated with equipment removed in this project, and no longer in use, shall be removed and stored or disposed of as directed by the Owner. The Contractor shall patch and apply finish to walls, floors, and other structures from which such items are removed to match surrounding colors, textures, or other visual characteristics.

3.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Equipment and materials shall be stored in accordance with the manufacturer's recommendations and instructions.
- D. All equipment, including but not limited to equipment containing coils and/or electronics, shall be stored in a clean, dry, ventilated and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from condensation shall be essential and shall be accomplished by the use of auxiliary heaters as required to raise the temperature to 5-degree C above the ambient temperature. The equipment shall be protected from excessive dust.
- E. In addition, certain electronic equipment that requires cooling based upon its specific storage temperature range shall be stored in an air-conditioned building.
- F. All motors shall be stored in a clean, dry, ventilated and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from

condensation shall be essential and shall be accomplished by the use of auxiliary heaters as required to raise the temperature to 5 degree C above the ambient temperature. The motors shall be protected from excessive dust.

- G. Cables and wiring shall be kept in a dry location out of the sun.
- H. Outdoor storage, even when protected by a tarpaulin, is unacceptable.
- I. Equipment may be rejected if the storage criteria are not followed.

3.4 INSTALLATION

- A. Coordinate electrical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- D. The Contractor shall keep ends of conduits, including those extending through roofs, equipment and fixtures covered or closed with caps or plugs to prevent foreign material from entering during construction.
- E. Coordinate the installation of required supporting devices and sleeves to be set in concrete and other structural components as they are constructed.
- F. Sequence, coordinate, and integrate installations of electrical materials and equipment for maintaining the required operation of the facility. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- G. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- H. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
- I. Install electrical equipment to facilitate 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.
- J. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
- K. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- L. Coordinate installation of electrical equipment on vendor supplied walkways with supplier.

3.5 MATERIALS AND WORKMANSHIP

- A. All materials shall be new and shall be of the latest standard design of a manufacturer regularly engaged in the manufacture of that type of equipment. Materials shall be in good condition and shall be free from dents, scratches or other damage incurred in shipment or installation.

- B. All equipment shall comply with the National Electrical Code, Underwriters Laboratories or other appropriate agency.
- C. Installation shall be made in a neat and workmanlike manner, and all materials shall be installed in accordance with the recommendations of the various manufacturers. The installation shall be subject to the approval of the Owner and Engineer.
- D. Incidental materials required to complete the installation as intended by these Specifications shall be of the type and quality in keeping with specified equipment.

3.6 COORDINATION

- A. Carefully examine specification and drawings to be thoroughly familiar with items which require electrical connections and coordination. (Electrical drawings are diagrammatic and shall not be scaled for exact sizes.)
- B. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interference between work of various contractors shall be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to the Owner. Engineer to be mediating authority in all disputes arising on project.
- C. Equipment shall be installed in accordance with manufacturer's recommendation. Where conflicts occur between contract documents and these recommendations, a ruling shall be requested of the Engineer for decision before proceeding with such work.

3.7 CUTTING AND PATCHING

- A. Repair or replace routine damage caused by cutting in performance of work under this Division.
- B. Correct unnecessary damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.
- C. Holes cut through floor slabs to be sleeved or core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs to be properly sealed, fire proofed and water proofed.
- D. Repairs to be performed with materials which match existing materials and to be installed in accordance with appropriate sections of these specifications.
- E. All cutting and patching work shall be coordinated in advance with the Engineer and Owner prior to any work.

3.8 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

- A. Provide trenching, excavation, and backfilling necessary for performance of work under this Division.

3.9 FOUNDATIONS AND PADS

- A. Foundations and pads required for equipment shall be provided as indicated. Proper size and location of foundations, pads and anchor bolts shall be determined under this Division.
- B. Provide anchors and bases for electrical equipment to withstand lateral forces and accommodate displacements.

3.10 NOISE AND VIBRATION CONTROL

- A. The electrical system as installed shall be free of objectionable noise or vibration. The Contractor shall isolate motors, starters, transformers, equipment, ballasts, etc., as directed or required as to ensure acceptable noise level free from objectionable vibration in all systems.

3.11 TESTS

- A. On completion of work, installation shall be completely operational and entirely free from ground, short circuits, and open circuits. Perform a thorough operational test in presence of the Owner and Engineer. Furnish all labor, materials and instruments for above tests.
- B. Furnish the Engineer, as part of closing file, a copy of such tests including identification of each circuit and readings recorded. Test information to be furnished to the Engineer includes ampere readings of all panels and major circuit breakers, isolation resistance reading of motors and transformers.
- C. Prior to final observation and acceptance test, all electrical systems and equipment shall be in satisfactory operating condition. Including, but not limited to the following:
 - 1. Electrical power and distribution system.
 - 2. Lighting systems.
 - 3. Transformers.
 - 4. Electric motors for all equipment.
 - 5. Telecommunication system.
 - 6. Emergency power system.
 - 7. Special electrical control systems.
- D. After installation of the electrical system and before operating equipment, functional checking shall be conducted in accordance with the manufacturer's recommendations, with the contract drawings and as follows:
 - 1. Functional checking shall include inspection, testing and repair, replacement or adjustments as necessary to ensure compliance with the requirements of the specifications. Tests and inspections shall be recorded on appropriate yellow lined contract and shop drawings, standard test forms and checklists to indicate that wiring and controls are in place in accordance with requirements and to form the basis of record drawings.
 - 2. The functional test procedures shall be signed and dated by the Contractor and presented to the Owner's construction observation personnel prior to operating any equipment.
 - a. Visual Inspection – The electrical system shall be examined as outlined below:
 - 1). Parts of components missing
 - 2). Improper assembly
 - 3). Parts or components not functioning properly
 - 4). Finish not as specified
 - 5). Materials not as specified
 - 6). Connections not tight
 - 7). Mounting and supports loose or unsatisfactory
 - 8). Nameplates missing or inaccurate
 - b. Grounding System Tests
 - 1). Measure the resistance of the counterpoise grounding system by the rate-of-fall of potential method. Record all measurements on an approved standard test form made specifically for the purpose. The resistance of the grounding system to ground shall not exceed NFPA 70 requirements.
 - c. Continuity Tests
 - 1). Each wire and each wire in each cable rated 300 volts and below shall be tested for continuity. Record wire number and pass or fail on checklist for each wire.
 - d. Dielectric Tests

- 1). Each power conductor rated 600 volts and above shall be tested (meggered) for dielectric strength to ground.
- 2). Prior to testing, all components that could be damaged should be disconnected. After testing, the circuit shall still register a resistance value of not less than 1 megohm at 600 volts, dc. This test shall apply between all insulated circuits and external metal parts. Record equipment name, phase or wire number and all observed values for each wire.
- 3). Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning of all circuits. Record equipment or circuit number and pass or fail on function test checklist for each circuit.
- 4). The Contractor shall develop non-conforming material reports for each failure. Repair and report failures all failures to Owner and Engineer.
- 5). The Contractor shall replace defective parts, correct malfunctioning units, make all repairs and retest to demonstrate compliance. The Contractor shall document all actions taken on appropriate non-conforming material report.

3.12 INSPECTION FEES AND PERMITS

- A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.13 IDENTIFICATION OF EQUIPMENT

- A. Properly identify all electrical equipment, including but not limited to the following:
 1. Switchgear, switchboards, motor control centers, and control panels.
 2. Main distribution panel and individual devices within it.
 3. Panelboards and individual devices within it.
 4. Safety switches and disconnects.
 5. Contactors and lighting control center, including all branch circuits.
 6. Individually mounted circuit breakers.
 7. Relays.
 8. Transformers.
 9. Generators and automatic transfer switches.
 10. Any other type of enclosure that includes electrical equipment.

END OF SECTION

SECTION 26 05 14 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles with integral GFCI and associated device plates.
 - 2. Snap switches and wall-box dimmers.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.

1.3 SUBMITTALS

- A. Product Data: for each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Samples: One for each type of device and wall plate specified in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as type are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers:
 - 1. Cooper wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20A: Comply with NEMA WD1, NEMA WD 6 configuration 5-20R, and UL 498.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD1, NEMA WD6, UL498 and UL 943, Class A and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CSI221 (single pole), CSI222 (two pole), CSI223 (three way), CSI224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 12224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole); 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to the following:
 - a. Cooper; 2221PL for 120 V and 277V.
 - b. Hubbell; HPL1221PL for 120 V and 277V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "OFF."

2.5 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 1. Plate-Securing Screws: Stainless steel or unbreakable nylon in damp areas.
 2. Material: 0.035-inch-(1mm-) thick, satin-finished stainless steel.
 3. Provide in-use covers for all exterior installations and interior damp locations.

2.6 FINISHES

A. Color:

1. Wiring Devices: As selected by Owner, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint and other material that may contaminate the raceway system, conductors and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing conductors:
 - a. Cut back and pigtail or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection such as plastic film and smudge covers until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 1. Line voltage: Acceptable range is 105 to 132V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Test straight blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115g).

END OF SECTION

SECTION 26 05 15 - ELECTRIC MOTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes materials, installation and testing of induction motors and applies to motors which are generally provided as part of equipment specified in other sections. The Contractor shall provide motors, accessories and appurtenances complete and operable in accordance with the individual driven equipment specifications.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Complete motor data shall be submitted, including:
 1. Machine name and specification number of driven machine.
 2. Motor manufacturer.
 3. Motor type or model and dimensional drawing, including weight.
 4. Horsepower nominal.
 5. Guaranteed minimum full load efficiency. Also, nominal efficiencies at 1/2 and 3/4 load.
 6. Full load speed.
 7. Full load current at rated horsepower for application voltage.
 8. Service factor, minimum 1.15.
 9. Voltage, phase and frequency rating.
 10. Winding insulation class.
 11. Temperature rise class.
 12. Frame size.
 13. Enclosure.
 14. NEMA design.
 15. Thermal protection or over temperature protection.
 16. Wiring diagram for devices such as temperature switches, space heaters and motor leak detection as applicable.
 17. Bearing data, including recommendation of lubricants.
 18. Inverter duty motor for all motors connected to variable frequency drive controllers. Include minimum speed at which motors may be operated.
 19. Power factor at 1/2, 3/4 and full load.
 20. Complete nameplate data, rating and characteristics.
 21. Mounting arrangement, size and location of conduit entries, including lugs.
 22. Factory test results for each motor.

1.3 QUALITY ASSURANCE

- A. Provide routine (short commercial) test data complying with NEMA MG 1-12.51 and MG 1-23.46.
- B. Test thermally protected motors in accordance with NEMA MG 1 winding temperature and trip current tests.
- C. Comply with NEMA MG 1.
- D. Motors for applications in hazardous locations shall bear the UL label listing its use in accordance with the NEC.

1.4 COORDINATION

- A. Furnish reviewed shop drawings from motor controller manufacturer for coordination and sizing of the controller.
- B. Coordinate supplied motor connection box with conduits sizes indicated in the drawings.
- C. Coordinate motor leads and lugs with wire sizes indicated in the drawings.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Unless otherwise specified or specifically required by the manufacturer of the equipment to be driven, all motors shall be single speed, squirrel cage, a-c induction type motors. Electric motors shall be NEMA Design B constant speed squirrel cage induction motors having normal starting torque with low starting current except for motors controlled by variable speed operation and other special motors. In no case shall starting torque or breakdown torque be less than the value specified in ANSI/NEMA MG 1. In all cases, motors shall be suitable for the indicated starting method.
- B. Stator winding shall be copper.
- C. The maximum motor loading of each motor shall not exceed its nameplate horsepower rating (exclusive of service factor) under any operating condition.
- D. Motors shall be sized to start and accelerate the design loading and operate the full range of driven equipment without exceeding any of the specified design requirements. Motors that fail to meet these requirements shall be replaced at no additional cost to the Owner.
- E. All three phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated without exceeding Class B temperature rise limits stated in ANSI/NEMA MG1-12, 42. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class. Motors to be operated with variable frequency drives shall be provided with insulation systems to withstand 1600 volt spikes, with dV/dt as defined in NEMA MG 1-31.
- F. All motors shall have a minimum service factor of 1.15.
- G. Motors for use in hazardous locations shall have enclosures suitable for the classification of the location. Such motors shall be UL listed and stamped.
- H. Motors larger than 50 HP located outdoors or in non-conditioned areas shall have 120-volt AC space heaters and temperature sensors.
- I. For motors controlled by variable frequency drives, the critical vibration speed of the motor/load combination shall either not fall within the operating range of the drive or such frequencies shall be blocked with the drive critical speed avoidance circuit. All motors connected to variable frequency drives shall be inverter duty rated.
- J. Unless otherwise specified, motors shall have no-load sound power levels not to exceed the values specified in NEMA MG 1-12.53.3.
- K. Premium Efficiency Motors:

1. Motors with a nameplate rating of 1 horsepower and larger shall be premium efficiency type motors as determined by the testing set forth in ANSI/IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators, Method B. Motors shall be stamped with the efficiency on the nameplate with the caption “NEMA Nominal Efficiency.”
2. Efficiency index, nominal efficiency and minimum efficiency shall be defined in accordance with ANSI/NEMA MG1-12.59 – Efficiency Levels of Energy Efficient Polyphase Squirrel-Cage Induction Motors. All three values are required to be indicated in the submittal.

2.2 MOTOR BEARINGS

- A. All motors greater than 2 horsepower shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.
- B. Motors less than 2 horsepower shall be provided with sealed, permanently lubricated ball bearings.
- C. Horizontal motors over 2 horsepower shall be shielded open-type bearing installed with labyrinth sealed end bells with pipe plugs. Bearings shall be regreasable and have provisions for purging old grease.
- D. Vertical motors over 2 horsepower shall be provided with relubricatable ball, spherical, roller or plate type trust bearings. Lubrication shall be per manufacturer’s recommendation for smooth operation and long life of the bearing. Drains shall be provided to prevent over lubrication.

2.3 MOTOR THERMAL PROTECTION

- A. All single phase motors shall have integral thermal overload protection or shall be current limited.
- B. Winding thermostats shall be provided in accordance with NEMA MG-1. Thermostats shall be snap action, bi-metallic, temperature actuated type switches and shall be provided with a normally closed contact. Thermostats shall be precalibrated by the manufacturer and shall be series connected.

2.4 ACCESSORIES

- A. All vertical motors and horizontal motors 3 horsepower and larger shall have split-type conduit boxes with a gasketed moisture seal between the conduit box and motor frame. Motors less than 3 horsepower shall have the manufacturer’s standard conduit boxes. Motors other than open drip-proof shall be gasketed.
- B. All motors weighing 250 pounds or greater shall have suitable lifting eyes for installation and removal.
- C. Motor grounding lugs shall be provided and shall be suitable for terminating ground wires.
- D. All motors shall be fitted with permanent stainless steel nameplates indelibly stamped or engraved with NEMA Standard motor data.
- E. Refer to equipment specifications for special requirements such as space heaters or motor winding thermal protection.

PART 3 - EXECUTION

3.1 STORAGE

- A. Protect motors from exposure to elements for which they are not designed. Install and energize temporary electrical service to motors with electrical heaters.
- B. Store motors in an air-conditioned, ventilated or protected environment similar to or better than the destination environment.

3.2 INSTALLATION

- A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment.
- B. Connections, switches, controls, disconnects and other items shall be provided in accordance with the plans and specifications for each motor.
- C. The Contractor shall coordinate conduit sizes indicated in the drawings with the supplied motor connection box. The Contractor shall be responsible for providing larger connection boxes as may be required.

3.3 FIELD TESTING

- A. Perform insulation resistance tests in accordance with NEMA MG-1. Test voltage shall be 1000 VAC plus twice the rated voltage of motor.
- B. Inspect the physical and mechanical conditions of each motor installation including any deviations from the nameplate, drawings, specifications and manufacturer's written guidelines. Verify expected rated voltage, phase and frequency for each motor installation. Confirm the presence of and correct application of lubrications for each motor along with proper securing and torque settings for bolted installations of each motor.
- C. Check for proper phase and ground connections for each motor are connected. For multi-voltage motors, verify that motors are connected properly for the supplied voltage.
- D. Verify that space heaters, where provided, are functional.
- E. Test the motor for proper rotation prior to connection to the driven equipment. Measure and record running current and evaluate the current relative to the load conditions and nameplate full-load amps.
- F. Simulate operating conditions for each motor to demonstrate proper operation of interlocks and control features.
- G. Record operating current in each phase for each motor ½ horsepower and larger. Motors exceeding motor nameplates values shall be repaired or replaced.
- H. For motors 50 horsepower and larger or when a discernible abnormal vibration is detectible, a vibration test shall be completed. Vibration shall not exceed 0.25 in./sec. For horizontal motors, the N-S and E-W vibrations shall be measured at the top and bottom of the front and rear bearing housing. For vertical motors, the N-S and E-W vibrations shall be measured at the upper and lower bearing housing.
- I. All testing shall be witnessed by the Engineer and Owner.

1. Motor and Motor Protection Tests for motors – In addition to other testing start and stop each motor a minimum of 3 times and perform a run test for vibration, heat, and to document motor protection. The Contractor shall document the settings of the motor overcurrent protection, overload relay and similar data on the provided form – MOTOR TEST REPORT.
2. The Contractor shall develop non-conforming material reports for each failure and repair or report failures.
3. The Contractor shall replace defective parts, correct malfunctioning units, make all repairs and retest to demonstrate compliance. The Contractor shall document action taken on appropriate non-conforming material report.

3.4 MOTOR TEST REPORT

- A. The following form is provided for the motor certification specified herein. Master blank forms are available on request.

END OF SECTION

PROJECT NAME

MOTOR TEST REPORT

Each electric motor shall be tested for proper operation. Follow manufacturer's testing recommendations and procedures.

1. Name and Horsepower of Motor Tested: _____

2. Overcurrent Protection: _____

3. Overload Protection: _____

4. Visual Inspection Checklist:

- Momentarily Bump Motor Shaft for Proper Rotation
- Motor Frame Bolts
- Shaft Coupling
- Lubricants
- Other Comments:

5. Megger motor from wire in motor control center or control panel and record results:

$\phi A-\phi B$ _____ $\phi B-\phi C$ _____ $\phi C-\phi A$ _____

$\phi A-G$ _____ $\phi B-G$ _____ $\phi C-G$ _____

6. Record full load voltage and current:

V_{ab} _____ V_{an} _____ I_a _____

V_{bc} _____ V_{bn} _____ I_b _____

V_{ca} _____ V_{cn} _____ I_c _____

7. Motor Nameplate FLA: _____

Running Amps: _____

P.F. _____

8. Comments:

Signature Required: _____

Company: _____

Date: _____

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Division 26 Section.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene monomer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association (NETA) or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70. No aluminum on project.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW and RHH-RHW-USE.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper, stranded.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type RHH-RHW-USE single conductors in raceway.

B. Exposed Feeders: Type RHH-RHW-USE, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type RHH-RHW-USE, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type RHH-RHW-USE single conductors in raceway.

E. Feeders in Cable Tray: Type RHH-RHW-USE, single conductors in raceway for larger than 4/0 AWG; Otherwise Type TC tray cable.

F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW, single conductors in raceway.
- I. Variable Frequency Drive Branch Circuits: Shielded cable, size adjusted for published ampacity of cable.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. Cable splicing, in general, will not be allowed. Where applicable, all wiring connections to be made using terminal block type connections. Wire nut use will be permitted only where allowed by the Owner and Engineer.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. Megger Test of individual conductors to ground after installation.
 2. Visual observation of conductor at accessible locations.
- B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test the following for compliance with requirements.
 - a. All panel feeders.
 - b. All motor feeders.
 - c. All control wires for continuity.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For grounding to include the following in emergency, operation and maintenance manuals.
 - 1. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on ANSI/NETA MTS.
 - a. Test shall be to determine if ground resistance or impedance values remain within specified maximums and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare copper Conductors:
 - 1. Solid Conductors: ASTM B3
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Conductor: No. 4 AWG, stranded conductor or per NFPA 70.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
 - 1. Bury at least 30 inches below grade.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with ANSI/IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole and Handhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

- D. Pad-Mounted Equipment: Install four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with utility transformers by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment and components.
- E. Metal Poles Supporting Outdoor Lighting fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.
- C. Ground rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit from building's main service equipment, or grounding bus, to main metal water service entrance to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column and indicated item, extending around the perimeter of building.
 1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches from building foundation at a depth not less than 30 inches below finished grade.
- J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 5. Substations and Pad-Mounted Equipment: 5 ohms.
 6. Manhole and Handhole Grounds: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section 26 05 43, "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.2 DEFINITIONS

- A. LFMC: Liquidtight flexible metal conduit.
- B. LFNC: Liquidtight flexible nonmetallic conduit.
- C. GRS: Galvanized Rigid Steel Conduit.
- D. RNC: Rigid nonmetallic conduit.
- E. EMT: Electrical Metallic Tubing.

1.3 SUBMITTALS

- A. Product Data: for surface raceways, wireways and fittings, hinged-cover enclosures and cabinets.
- B. Custom enclosures and cabinets.
- C. Source quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflec Inc.
 - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 5. Electri-Flex Co.
 - 6. Manhattan/CDT/Cole-Flex.
 - 7. Maverick Tube Corporation.
 - 8. O-Z Gedney; a unit of General Signal.

- 9. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. PVC-Coated Steel Conduit: PVC-coated.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
 - 3. Comply with ETL Verified PVC-001.
- D. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corporation
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. RACO; a Hubbell Company
 - 12. Thomas & Betts Corporation.
- B. RNC: NEMA TC2, Type EPC-40-PVC, unless otherwise indicated.
- C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell company.
 - 8. Scott Fetzer Co.; Adalet Division.
 - 9. Spring City Electrical Manufacturing Company.
 - 10. Stahlin Non-Metallic Enclosures.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The)
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. subsidiary.
- B. Sheet Metal Outlet and Device boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device boxes: NEMA FB 1, Type FD, with gasketed cover.

- D. Small Sheet Metal Pull and Junction boxes: NEMA OS 1.
- E. Cast-Metal Access, Pull and Junction boxes: NEMA FB 1.
- F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch for conditioned spaces only, unless otherwise indicated.
- G. Hinged-Cover Enclosures: NEMA 250, Type 4 Stainless steel, with continuous-hinge cover with latches for outdoor, process buildings, above and below grade structures and damp locations, unless otherwise indicated.

2.4 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A, 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052-or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with Engineer.

2.5 SLEEVE SEALS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Advance Products & systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Stainless steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: apply raceway products as specified below, unless otherwise indicated:
 1. Exposed: PVC-Coated Rigid Steel
 2. Concealed: PVC-Coated Rigid Steel.
 3. Underground, Single Run: RNC, Schedule 40 in concrete encasement.
 4. Underground, Grouped: RNC, Schedule 40 in concrete encasement.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): PVC-Coated LFMC.
- B. Indoors:
 1. Exposed: PVC-Coated Rigid Steel or as noted in the Drawings.

2. Concealed: PVC-Coated Rigid Steel or as noted in the Drawings.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid or Motor-Driven Equipment): PVC-Coated LFMC.
 4. Damp or Wet Locations: PVC-coated Rigid Steel or as noted in the Drawings.
- C. Minimum Raceway Size: ¾-inch trade size; 1-inch trade size for below grade installation.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material.
- 3.2 INSTALLATION
- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Raceways Embedded in Slabs:
1. Run conduit larger than 1 inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Do not install conduits in such a manner as to compromise the structural integrity of walls, roofs, ceilings or floor. Where necessary, provide additional supporting members to support conduit runs. Below grade conduits 1 1/2" and larger shall be routed 24" below the concrete floor slabs.
 4. Comply with Chapter 6 of ACI 318.
 5. Change from nonmetallic conduit to Galvanized Rigid Steel or PVC-Coated Rigid Steel Conduit before rising above the floor.
- H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

- K. Install raceway sealing fittings at suitable, approved and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.

- L. Expansion-Joint Fittings: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg. F, and that has straight-run length that exceeds 25 feet.
 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces: connected with the Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
 3. Install each expansion-joint fitting with position, mounting and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

- M. Flexible conduit connections: Use maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement, and for transformers and motors.
 1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

- N. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application Engineer.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Size pipe sleeves to provide ¼-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint.

- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with fire-stop materials.
- J. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 26 05 33.13 - PVC COATED CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes PVC-coated raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Raceway and Boxes for Electrical Systems".

1.2 SUBMITTALS

- A. Product Data: for surface raceways, wireways and fittings, hinged-cover enclosures and cabinets.
- B. Custom enclosures and cabinets.
- C. Source quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. All the conduit, fittings, and supporting products shall be provided by the same manufacturer to ensure that a five-year product warrantee is achieved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:
 - 1. Perma-Cote
 - 2. Plasti-Bond
 - 3. KorKap
 - 4. Calbond
 - 5. Ocal

2.2 MATERIALS

- A. PVC-coated, Galvanized Rigid Conduit (GRC), and fittings shall meet all the performance standards specified herein and such performance standards shall require verification by a nationally recognized testing agency including American Society for Testing and Materials (ASTM) and Underwriter Laboratories (UL).
- B. The PVC coated galvanized rigid conduit shall be UL Listed. The PVC coating shall have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit.

Ferrous fittings for general service locations shall be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating shall be UL listed. All conduits and fittings must be new, unused material. Applicable UL standards shall include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.

- C. The PVC coated galvanized rigid conduit shall be Electrical Testing Laboratory (ETL) Verified PVC-001 or Underwriter Laboratories (UL) 6 for safety.
- D. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.
- E. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
- F. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.
- G. Form 8 Condulets, 1/2" through 2" diameters, shall have a v-seal tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available. Form 8 Condulets shall be supplied with plastic encapsulated stainless steel cover screws.
- H. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.
- I. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).
- J. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
- K. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
- L. Independent certified test results shall be available to confirm coating adhesion under the following conditions:
 - 1. Conduit and conduit exposure to 150°F (65°C) and 95% relative humidity with a minimum mean time to failure of 30 days (ASTM D1151).
 - 2. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
 - 3. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
 - 4. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.
- M. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U bolts will be supplied with plastic encapsulated nuts that cover the exposed portions of the threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be vigorously followed.
- B. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's Installation Manual. To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit.
- C. Installer certification, before installation, is required.
- D. Clamps, bolts, angles, pipe straps, struts, rods, nuts and other supporting products for PVC-coated conduits shall be PVC-coated or stainless steel.
- E. The Contractor shall use equipment specifically designed for PVC-coated conduit when cutting, clamping, reaming, threading, bending, assembling or performing other installation procedures. PVC-coating shall be protected.
- F. Touch-up compound for PVC-coated conduit shall not be allowed for areas larger than one inch squared except for conduit rethreading. All conduits with damaged coatings larger than one inch squared shall be removed and replaced at no cost to owner.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
 - 2. Handholes and boxes.

1.2 DEFINITIONS

- A. RNC: Rigid nonmetallic conduit.
- B. SCTE: Society of Cable Telecommunications Engineers.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Accessories for manholes, handholes, boxes.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details/
 - 3. Step details.
 - 4. Grounding details.
 - 5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 6. Joint details.
- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts and pulling-in lifting irons.
- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
- E. Product Certificates: for concrete and steel used in precast concrete handholes, as required by ASTM C858.
- F. Source quality-control test reports.
- G. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.

- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- C. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions and surface features. Revise locations and elevations from those indicated a required to suit field conditions and to ensure that duct runs drain to manholes and handholes and as approved by Engineer.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel conduit: Galvanized. Comply with ANSI C80.1.
- B. PVC-Coated Steel Conduit: Comply with ANSI C80.
- C. RNC: NEMA TC2, type EPPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Available Manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. Oldcastle Precast Group.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosure are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive cover-securing bolts.

3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
4. Frame and cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: comply with SCTE 77.
 1. Color: Gray.
 2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC" or as noted.
 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin and reinforced with steel or fiberglass or a combination of the two.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
 - a. Amorcast Products Company.
 - b. Quazite
 - c. Carson Industries LLC.

- d. CDR Systems Corporation.
- e. NewBasis.

2.4 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
 - 1. Bilco Company (The).
 - 2. Campbell Foundry Company.
 - 3. Carder Concrete Products
 - 4. Christy Concrete Products.
 - 5. East Jordan Iron Works, Inc.
 - 6. Elmhurst-Chicago Stone Co.
 - 7. McKinley Iron Works, Inc.
 - 8. Neenah Foundry Company.
 - 9. NewBasis.
 - 10. Oldcastle Precast Group.
 - 11. Osburn Associates, Inc.
 - 12. Pennsylvania Insert Corporation.
 - 13. Riverton Concrete Products; a division of Cretex companies, Inc.
 - 14. Strongwell Corporation; Lenoir City Division.
 - 15. Underground Devices, Inc.
 - 16. Utility Concrete Products, LLC.
 - 17. Utility Vault Co.
 - 18. Wausau Tile, Inc.

- B. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation and workable at temperatures as low as 35 degrees F. Capable of withstanding temperature of 300 degrees F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

- C. Cover Hooks: Heavy duty, designed for lifts 60 Lb and greater.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in red blended mix concrete-encased duct bank, unless otherwise indicated. Transition to above ground shall be PVC-coated steel conduit.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3.3 EARTHWORK

- A. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

- B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, timing, seeding, sodding, sprigging and mulching.
- C. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 36 inches, both horizontally and vertically unless otherwise indicated. All below grade elbows and bends to be galvanized.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10- feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall or Floor Penetrations: Make a transition from underground duct to PVC coated steel conduit unless otherwise indicated, at least 10 feet outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Extend concrete encasement beyond structural footings into the building directly below the electrical equipment.
- F. Sealing: Provide temporary closures at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling cord: Install 100-lbf-test nylon cord in ducts, including spares.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C 891, unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level 12" bed of crushed stone or gravel graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
 - 1. Install handholes with bottom below the frost line.
 - 2. Handhole covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
 - 3. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms as required for installation and support of cables and conductors and as indicated.
- D. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading form and pour a concrete ring encircling and in contact with, enclosure and with top surface screeded to top of box cover frame.
 - 1. Concrete: 3000 psi, 28-day strength, with a troweled finish.
 - 2. Dimensions: 12 inches wide by 12 inches deep.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports.
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for conductors and communication and control cable.
 - 2. Warning labels and signs.
 - 3. Instruction signs.
 - 4. Equipment identification labels.
 - 5. Miscellaneous identification products.
- B. Related sections:
 - 1. DIVISION 26

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with NFPA 70E
- D. Comply with 29 CFR 1910.145.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION – AND CONTROL-CABLE IDENTIFICATION MATERIALS.

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WARNING LABEL AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145 and NFPA 70E.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door or other access to equipment unless otherwise indicated.
- C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend and size required for application. ¼ inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- D. Sample warning label and sign shall include, but are not limited to the following legends:
 - 1. Multiple Power source Warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
 - 3. WARNING – ARC FLASH AND SHOCK HAZARD –APPROPRIATE PPE REQUIRED.

2.3 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sized.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark gray background. Minimum letter height shall be 3/8 inch.
- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS.

- A. Cable ties: fungus-inert, self-extinguishing, 1-piece, self-locking, type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb minimum.
 - 3. Temperature Range: Minus 40 to plus 185 degrees F.
 - 4. Color: Black, except where used for color-coding.
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Outlet Boxes for Receptacles: Identify branch circuit by panel name and circuit number.

- B. Power-Circuit Conductor Identification: of secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
- D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 - 1. Identify conductors, cables and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker type designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- E. Warning Labels for Indoor Cabinets, Boxes and Enclosures for Power and Lighting: comply with 29 CFR 1910.145 and apply metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover or other access.
 - 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to the following:
 - a. Power transfer switches
 - b. Controls with external control power connections.
 - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- F. Instruction Signs:
 - 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 - 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.
- G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with ½-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Motor-control centers.
 - f. Disconnect switches.

- g. Enclosed circuit breakers.
- h. Motor starters.
- i. Push-bottom stations.
- j. Power transfer equipment.
- k. Contactors.
- l. Remote-controlled switches and control devices.
- m. Power-generating units.
- n. Voice and data cable terminal equipment.
- o. Terminals, racks and patch panels for voice and data communications and for signal and control functions.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - 1. Color shall be factory applied or, for sized larger than No. 6 AWG if authorities having jurisdiction permit, field applied.
 - 2. Colors for 480/277-V Circuits:
 - a. Phase A: Brown
 - b. Phase B: Orange
 - c. Phase C: Yellow
 - 3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

END OF SECTION

SECTION 26 67 05 - COMMUNICATION CABLE AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Requirements specified in Division 26 Sections apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Section includes the following wiring system components:
 - 1. Communication cable.

1.3 SYSTEM DESCRIPTION

- A. Ethernet cabling.
- B. Instrumentation cable.

1.4 SUBMITTALS

- A. Procedures for submittals.
 - 1. Product Data: Provide for each material or equipment item specified.
 - 2. Shop Drawings:
 - a. Point-to-point wiring diagrams for cables installed under this Section.
 - b. Detailed plan views and elevations of telecommunications spaces showing termination equipment, and cable paths.
 - c. Minimum Scale for Details: 1/4 inch.
 - 3. Termination Schedule: Indicate the following.
 - a. Cable identification number.
 - b. Room location.
 - 4. Assurance/Control Submittals:
 - a. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
 - b. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.
- B. Procedures for closeout submittals. Deliver prior to Final Acceptance.
 - 1. Certification: Comprehensive test results for category 6, and fiber optic certification of cable plant per specifications of TIA/EIA 568A. Test results must be provided on 8.5 X 11 inch sheets of paper, and furnished in electronic PDF format.
 - 2. Project Record Documents: Accurately record the following:
 - a. Cable pulling schedules, in printed form and on CD-R data disks.
 - b. Labeling shall conform to the ANSI/TIA/EIA-606 guidelines.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing Products specified with minimum 5 years documented experience.
 - 2. Installer: Company specializing in the installation of category 6, and fiber optic structured wiring systems with minimum 5 years documented experience. Contractor shall have a minimum of one person on job site at all times with documented formal training in the installation of category 6, and fiber optic cabling systems if fiber optic cabling is required.

- B. Regulatory Requirements:
 1. Conform to requirements of NFPA 70.
 2. Products: Listed and classified by Underwriter's Laboratories Incorporated as suitable for the purpose specified and indicated.

- C. Pre-Installation Meetings:
 1. Convene a pre-installation meeting one week prior to commencing Work of this Section.
 2. Require attendance of parties directly affecting Work of this Section.
 3. Review conditions of operations, procedures and coordination with related work.
 4. Agenda:
 - a. Tour, inspect, and discuss conditions relating to communications cable.
 - b. Review exact location of each item within building construction, casework, and fixtures and their requirements.
 - c. Review required submittals, both completed and yet to be completed.
 - d. Review Drawings and Specifications.
 - e. Review and finalize construction schedule and verify availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays.
 - f. Review cable routing and support.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle, store, and protect products.
- B. Deliver in accordance with NEMA WC 26.

1.7 REFERENCES

- A. Telecommunication Industry Association (TIA), Electronic Industries Association (EIA):
 1. TIA/EIA-568-A - Commercial Building Telecommunications Cabling Standard
 2. TIA/EIA-569 - Commercial Building Standard for Telecommunications Pathways
 3. TIA/EIA-606 - Administration Standard for the Telecommunications Wiring Standard
 4. TIA/EIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications

- B. National Electrical Manufacturer's Association (NEMA):
 1. NEMA WC 26 - Wire and Cable Packaging.

- C. National Fire Protection Association (NFPA):
 1. NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 PATCH CORDS

- A. Subject to compliance with project requirements, manufacturer's offering products which may be incorporated in the Work include the following:
 1. AMP Incorporated.
 2. Interlink Technologies.
 3. Lucent Technologies.
 4. NORDX/CDT, Incorporated.
 5. Siemon Company.
 6. Or Equal.

- B. Conductors: Straight through type 4 twisted pair - 24 AWG, stranded copper.
 1. Terminated with male 8-pin modular plugs.

2. Complies with individual characteristics established in TIA for category 6a cable performance specification.

2.2 INSTRUMENTATION CABLE

- A. Subject to compliance with project requirements, manufacturer's offering products which may be incorporated in the work include:
 1. Belden
 2. Approved equal.
- B. Conductors: For all 4-20mA signals, use 20 AWG stranded tinned copper, two pair minimum, wet location rated.
 1. Individually shielded with shield drain wire.
 2. Insulation to be polyethylene PE or PVC.
 3. Outer jacket to be polyvinyl chloride PVC.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Report in writing to the Engineer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
- C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 INSTALLATION

- A. Cross electrical cables with communications cable at 90 degrees only.
- B. Run communication cables and power cables in separate conduits.
- C. Comply with cable manufacturers minimum bend radius requirements.
 1. Do not stretch, stress, tightly coil, bend or crimp cables.
 2. Replace cables that are severely stressed during installation at no additional cost to Owner.
- D. Furnish and install machine generated labels.
 1. Communications Cables:
 - a. Display cable identification number in black uppercase lettering on permanent adhesive white label stock covered with water resistant sealer.
 - b. Place labels on each end of cable, maximum 6 inches from cable termination.

3.3 CONSTRUCTION

- A. Interface with Other Work:
 1. Provide information to affected trades regarding requirements and responsibilities for preparation of Work of a particular trade for installation of Work installed under this Section.

3.4 FIELD QUALITY CONTROL

- A. Field testing and inspection.
- B. Inspect installation of cables and equipment during and at completion of installation.
- C. Perform end-to-end tests of each cable as follows:
 - 1. Pair/conductor for proper pinouts and continuity.
 - 2. Ground fault.
 - 3. Proper termination, shorts, and crossed pairs.
 - 4. Channel attenuation per ANSI/TIA/EIA-568-A, Annex E or later.
 - 5. Channel bi-directional worst case near end cross talk (NEXT) at frequencies up to 100 MHz, per ANSI/TIA/EIA-568-A, Annex E or later.
 - 6. Measured effective cable run length.

END OF SECTION

SECTION 26 90 00 – GENERAL INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. The work to be included under this section shall consist of furnishing all materials, labor, equipment, tools, supplies, and incidentals necessary for the installation and coordinate testing of all instrumentation, control, and SCADA systems.
- B. Related Sections:
 - 1. 26 90 10 - Process & Analytical Instruments

1.2 REFERENCES

- A. Definitions: Symbols, Definitions, and Abbreviations: All symbols, definitions, and engineering unit abbreviations utilized shall conform to IEEE 100-84, S50.1, and S51.1, where applicable.
 - 1. SCADA – Supervisory Control and Data Acquisition
 - 2. HMI – Human Machine Interface (Graphical Screens, Text Displays)
 - 3. OIT – Operator Interface Terminal
 - 4. PLC – Programmable Logic Controller
 - 5. I/O – Input/Output
 - 6. VFD – Variable Frequency Drive
 - 7. SSRVS – Solid State Reduced Voltage Starter (“Soft Starter”)
 - 8. RTU – Remote Telemetry Unit
 - 9. MTU – Master Telemetry Unit
 - 10. MCC – Motor Control Center
 - 11. Operating Program – Operating system, SCADA or other core software
 - 12. Integrated Operating Platform – System of installed, connected, and configured hardware, operating programs, and networking equipment.
 - 13. PLC and HMI Programming – Software configuration of operating programs to implement plant control strategies

1.3 PATENTS

- A. If the Manufacturer is required or desires to use any design, device, material, or process covered by letter, patent, or copyright, the Manufacturer shall provide for such use by suitable legal agreement with the patentee or owner, and the prices bid hereunder shall, without exception, indemnify and save the Owner and Engineer from any and all claims for infringement by reason of the use of any such patented design, device, material, or process, or any trademark or copyright used in connection with any equipment to be furnished hereunder.

1.4 SCOPE

- A. The scope of the instrumentation, control, and SCADA system for this project includes:
 - 1. Process Control: Furnishing, installing, and configuring existing Telemetry control panels and OITs to control the process equipment as detailed on the Drawings and in the Specifications. PLC panels in this project is listed below:
 - a. Existing Telemetry Control Panel

All instruments, PLC I/Os, terminal blocks, relays, and wires shall be furnished by the Contractor with the exception of items furnished as part of an equipment package. The Contractor shall be responsible for coordinating installation and commissioning of the required site control system. Coordination shall include equipment suppliers and subcontractors required to implement a complete and functional system as described herein.

2. With the exception of items furnished under this contract as part of an equipment package, PLC and HMI programming shall be by an application programmer selected and compensated by the Owner under separate contract.

1.5 SUBMITTALS

- A. Refer to Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 1. Instrument Installation Details.
 2. Instrument Specification Sheets: See Specification 26 90 10 – Process and Analytical Instruments.
 3. Certified Calibration Sheets.
 4. Complete and detailed instruction manuals on each item furnished including but not limited to all devices and instruments. Information to be contained in the instruction manuals shall include but not be limited to drawings, dimensions, manufacturer's recommendations, ratings, performance charts, power requirements, schematics, maintenance requirements and procedures, calibration recommendations and procedures, repair instructions, complete and recommended spare parts lists and related information.
 5. Proposed tagging and attachment materials and methods.
- C. Shop Drawings shall be submitted for approval by the Engineer.
 1. The Contractor shall submit to the Engineer, for approval, Shop Drawings of the equipment to be installed to meet the Specifications. The Drawings shall be supported by notes or written directions as required to fully define the installation. The submission shall be made as soon as feasible after award of the Contract and, in any event, shall be submitted and approval obtained before installation of the equipment.
 2. The information required on the Shop Drawings shall include, but is not necessarily limited to, the following:
 - a. Full and complete specifications covering the equipment proposed to be furnished.
 - b. Detail Drawings showing plan, network connections and elevation dimensions of the equipment proposed to be furnished.
 - c. Guarantees of performance of the equipment proposed to be furnished.
 - d. Nearest location of factory maintenance and service facilities that will be available to service the equipment offered.
 - e. To scale plans, sections and elevations detailing entire installation. Include mounting hardware, brackets, assemblies and other devices as required for a complete installation.
 3. Control panels:
 - a. Panel and sub-panel layout
 - b. Point-to-Point Wiring Diagrams
 - c. Interconnection drawings
 - d. System hardware
- D. Third Party Certification documents shall be submitted for approval by the Engineer:
 1. Credentials of technicians doing the inspection and testing
 2. Written certification as detailed under Third Party Certification in this specification section
- E. Contract Closeout Submittals:
 1. Project Record Documents
 2. Operating and Maintenance Data
 3. Warranty
 4. Final as-built copies of documented PLC and OIT programs for vendor supplied equipment packages, on electronic media, suitable for future troubleshooting or modifications by others.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection: Delivery, storage, and handling shall be in accordance with Manufacturers' recommendation and the requirements of General Conditions and other sections herein.

1.7 PROJECT AND SITE CONDITIONS

- A. Environmental Requirements: Instrumentation and control elements may be installed outdoors exposed to sun, rain and excessive humidity and shall be capable of continuous operation without significant reduction of their operating life under the following ambient conditions:

Temperature	-25 °C to 80 °C
Pressure	650 mm Hg to 800 mm Hg
Relative Humidity	20% to 100% condensing
Vibration Frequency:	10 - 2000 Hz.
Vibration Position	1.5 mm peak-to-peak
Vibration Acceleration	10 G.

- B. Where the ratings of individual components cannot meet the requirements, provide suitable means of physical protection. Suitable physical protection shall consist of an assembly which meets the requirements listed, while limiting the ambient conditions at the non-conforming component to 90% of the component's rating (Example: A component rated for vibration at only 5 G. acceleration would be required to be combined with vibration isolation to limit the acceleration of the component to 4.5 G. when subjected to ambient acceleration of 10 G. from 10 - 2000 Hz.).
- C. Operating Environmental Conditions: All instruments and control devices provided shall be rated for continuous operation in their installed operating environment and shall be capable of continuous operation at the operating conditions without significant reduction of their operating life.
- D. All controlling devices shall be NEMA or IEC rated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. All meters, instruments, control units, and other components shall be the most recent field proven models marketed by their respective manufacturers at the time of the submittal of the shop drawings unless otherwise specified to match existing equipment.

- B. Analog measurements and control signals shall be electrical and shall vary in direct linear proportion to the variable being measured. All analog signals whether inputs or outputs shall be 4-20mA DC unless otherwise noted. The analog input signals shall maintain loop integrity with the installation of properly sized resistors across the input terminals.
- C. All of the elements, instruments, accessories, and assemblies shall be installed in accordance with the manufacturer's installation instructions, and as detailed on the Drawings. Shielded instrumentation cables shall be used for all analog signals from the instruments to the programmable logic controller panels. Separate conduits shall be used for instrument power, instrument signals, and fiber optic cables.
- D. All instruments installed outdoors shall include a stainless steel sunshade.
- E. All digital outputs shall be isolated from the field equipment through an interposing relay. The relays shall be mounted inside the cabinet housing the associated programmable logic controller as shown on Drawings.
- F. The Contractor shall make the necessary power connections and signal connections from the field devices (i.e. instruments, control valves, etc.) to the programmable logic controllers.
- G. The Contractor shall configure and verify proper operation of the Integrated Operating Platform, included but not limited to the following requirements:
 1. The computer workstations, SCADA servers, PLCs, OITs, ethernet switches, surge protection devices, uninterruptible power supplies, and other incidental equipment shall be configured and installed as shown on the Drawings and as specified herein.
 2. All networked devices shall be configured for proper communication via the topology and protocol shown on the Drawings or specified herein.
 3. Verify that all system devices power up, function and properly communicate prior to commencing any startup or testing procedures as described herein.

3.2 TESTING AND INSTALLATION REQUIREMENTS

- A. Testing and Installation Requirements: The Contractor shall be required to coordinate the following services during construction related to the testing and installation of the instrumentation and control system. The complete system testing shall include all PLCs, computer systems, SCADA software and hardware, network devices, remote telemetry devices, interconnecting cables, and other peripheral devices required for a complete and functional system. The testing of the system shall occur in three stages: a Control Panel Readiness Test, a Site Acceptance Test, and a Final Acceptance Test.
- B. Control Panel Readiness Test
 1. The Contractor shall conduct a Control Panel Readiness Test for each control panel at a facility located within fifty miles of the project construction site. The test shall include the Engineer and Contractor. The Owner may also attend this test. The Contractor shall coordinate with the Engineer and Owner to schedule this test a minimum of thirty (30) days in advance.
 2. The Contractor shall assemble all hardware components within the specified enclosures, including the instruments, PLCs, OITs, network components and other required items. This assembly shall be complete and considered suitable for field installation.
 3. For the Control Panel Readiness Test, the Contractor shall demonstrate that each control panel is suitable for field installation by powering up each item and testing for proper network connections. In addition, the Contractor shall test each PLC input and output for proper operation from each field connection point within each control panel. The Contractor shall be responsible for all measurement and testing components required to complete the Control Panel Readiness Test.

4. The Contractor shall be responsible for connecting test instruments to each PLC and OIT and verifying proper operation of each input and output. The Contractor shall provide test screens for the OITs and test programming for each PLC. All wire and terminal numbers will be checked for conformance with the submittal drawings during this Readiness Test.
 5. Each analog I/O point shall be checked for proper operation from each field connection point in the control enclosure and confirmation of each item shall be properly displayed on each associated OIT as applicable. The Contractor shall be prepared to simulate several inputs and outputs in order to fully confirm the proper operation of each analog I/O.
 6. After the Engineer (and Owner if in attendance) are satisfied that the system is fabricated as intended, the Contractor will then be authorized to ship the system to the project site for installation.
- C. Third Party Certification: Prior to the Site Acceptance Test, the Contractor shall furnish to the Engineer written certification from a third party that all system components, panels, communications, control wiring, device configurations, instrument calibrations, motor controllers, and variable frequency controllers and associated integration have been installed in conformance with the Contract Documents.
1. Said certification shall include energization and testing for correct hardware integration of all system components, including PLC remote I/O assemblies, and reliable communications between components with correct protocols.
 2. Analog input and output channels shall be verified at 0 percent, 25 percent, 50 percent, 75 percent, and 100% of span.
 3. Personnel performing the third party certification shall have International Society of Automation (ISA) Certified Control Systems Technicians (CCST) or equivalent credentials as approved by the Engineer or Owner.
 4. A written Third Party Certification that all aforementioned systems are installed and operational in conformance with the Contract Documents shall be submitted to the Engineer.
- D. Site Acceptance Test
1. Upon the Engineer's written approval of the Third Party Certification, the Site Acceptance Test may be scheduled and executed.
 2. Coordination with Engineer and Owner: The Contractor shall coordinate with the Engineer and Owner to schedule this test a minimum of thirty (30) days in advance.
 3. The Contractor shall conduct a Site Acceptance Test at the Owner's facility following system installation and prior to startup. The test shall include complete in-service testing of all system components, panels, communications, and OITs to ensure conformance with the Contract Documents. The Engineer and Owner may decide to witness these tests.
 4. The Contractor shall ensure that components having adjustable features are set carefully for the specific conditions and applications of this installation and that the components and systems are within the specified limits of accuracy. Defective elements which cannot achieve proper calibration or accuracy, either individually or within the system or subsystem, shall be replaced.
 5. Test Conditions: Where feasible, system testing and commissioning shall include the use of air or water to establish service conditions that simulate, to the greatest extent practical, normal final control element operating ranges and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady-state operating conditions to verify that proper and stable control is achieved.
 6. Failure to Complete Site Acceptance Test: If the Site Acceptance Test is not completed due to installation errors, the Contractor shall repeat the Third Party Certification process and resubmit certification to the Engineer at no additional cost to the Owner. After Engineer approval of the new Third Party Certification submittal, the Site Acceptance Test shall be repeated. The cycle of Third Party Certification and Site Acceptance

Testing shall be repeated at no cost to the Owner until all systems work correctly as determined by the Owner and Engineer.

E. Final Acceptance Test:

1. The Contractor shall conduct a 10-day Final Acceptance test of the completed installation. The test shall start after the Engineer has received marked record (as-built) drawings from the Contractor and when directed by the Owner/Engineer. The Contractor's personnel shall be readily available to address issues onsite during the acceptance test.
2. The system shall operate with 100% reliability during the test period. Failure shall be defined as the inability to control or indicate status of specified inputs or outputs or any specified function of the control systems as described herein caused by defective hardware or software furnished in this project. Failure of hardware or software shall require repair or remedy of the defect to the satisfaction of the Engineer within a two hour period. If the problem cannot be repaired in this time, the test shall be aborted and restarted after the problem is corrected and when directed by the Owner/Engineer. Restarting and satisfactory completion of the test shall be conducted at no additional cost to the Owner.
3. The Contractor shall complete the Operations and Maintenance Manuals including all updated documentation of programmable devices to the satisfaction of the Engineer.
4. The Contractor will be allowed two attempts at successfully completing the Final Acceptance Test. After that time, the Contractor will become responsible to reimburse the Owner for liquidated damages. Successful completion of the Final Acceptance Test will be required prior to Substantial Completion.

3.3 TRAINING, STARTUP ASSISTANCE, & WARRANTY

A. Training: The Contractor shall provide training for the purpose of familiarizing Owner's personnel with the instrumentation and control system. All training shall be as scheduled by the Owner. The training shall be scheduled a minimum of thirty (30) days in advance of when it is to be given. Proposed training materials, including a detailed training agenda itemizing relative emphasis on various topics of each course, shall be submitted to the Owner and Engineer at least fourteen (14) days in advance of when the training is to begin. The course content shall include, but not be limited to, a description of system philosophy, all major hardware components utilized in the system and hardware maintenance practices.

B. Startup Assistance

1. The Contractor shall be responsible for furnishing a qualified technical representative who shall supervise the installation of equipment and/or install equipment, and who shall test, adjust, field calibrate, and fully commission all flow metering equipment, instrumentation equipment, control equipment, and accessories specified herein and required as integral components of the complete systems. The commissioning will be deemed to be complete only after all systems are found to be performing satisfactorily following the final balancing of plant operation. The guarantee period, during which all defective materials shall be replaced and all faulty workmanship will be corrected at no cost to the Owner, shall begin with the date on which the commissioning is judged to be complete.

C. Service:

1. Manufacturers shall provide as part of the equipment cost sufficient days of service by a factory-trained service engineer specifically trained on the type equipment herein specified to assist the Contractor during installation and start-up. The service time shall be sufficient to place the units in satisfactory service and instruct the Owner's personnel in proper operation and maintenance of the equipment.
2. A minimum of three (3) days service Engineer time shall be provided.

- D. Maintenance Instruction:
 - 1. Operating and maintenance instructions, along with a separate parts list, shall be furnished in three (3) copies to the Owner. Operating instructions shall also incorporate a functional description of the system, including the system schematics which reflect "as-built" modifications. Maintenance requirements particular to the system shall be clearly defined, along with calibration and test procedures.

- E. Warranty:
 - 1. All equipment and workmanship furnished under this contract shall be guaranteed to be free of defects in materials and workmanship for a period of two (2) years from and after the date of final acceptance of the work by the Owner, and any such defects which appear within the stipulated guaranty period shall be repaired, replaced or made good without charge. This guarantee shall include the capacity and integrated performance of the component's parts.

END OF SECTION

SECTION 26 90 10 – PROCESS AND ANALYTICAL INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. The work to be included under this section of the Specifications shall consist of furnishing all materials, labor, equipment, tools, supplies, and incidentals for installation of all instrumentation equipment. The work shall include every item of construction necessary for a complete and acceptable installation as shown on the Drawings and as specified herein.
- B. Related Sections:
 - 1. 26 90 00 - General Instrumentation and Control

1.2 REFERENCES

- A. ISA S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves
- B. ISA S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments
- C. ISA S51.1 - Process Instrumentation Terminology
- D. ISA S51.1; Sec. 5 - Test Procedures
- E. Definitions: Symbols, Definitions, and Abbreviations: All symbols, definitions, and engineering unit abbreviations utilized shall conform to IEEE 100-84, S50.1, and S51.1, where applicable.
 - 1. SCADA – Supervisory Control and Data Acquisition
 - 2. HMI – Human Machine Interface
 - 3. VFD – Variable Frequency Drive
 - 4. PLC – Programmable Logic Controller
 - 5. SSRVS – Solid State Reduced Voltage Starter (“Soft Starter”)
 - 6. I/O – Input/Output
 - 7. OIT – Operator Interface Terminal
 - 8. RTU – Remote Telemetry Unit
 - 9. MTU – Master Telemetry Unit
 - 10. N.O. – Normally Open
 - 11. N.C. – Normally Closed

1.3 SCOPE

- A. This section of the Specifications covers the instrumentation equipment. The major items of instrumentation equipment to be furnished and installed shall include the following:
 - 1. Level Transmitters

1.4 SYSTEM REQUIREMENTS

- A. Design Requirements:
 - 1. Provide analog field instruments with transmitters which condition the signal to output a 4-20 mA signal linear to the measured variable.
 - 2. Similar instruments shall be by the same Manufacturer to the extent practical.
- B. Performance Requirements:
 - 1. Accuracy:

- a. Accuracy shall be as defined in ISA S51.1 and ISA S51.1, Sec. 5. Provide a complete and operating instrument installation with measurement accuracy determined by adding the accuracy of the element and the transmitter and any wiring to the field terminal enclosure of 0.75% of calibrated span or better, unless specified otherwise below, at any environmental condition specified.
2. Ranges:
 - a. The expected range of each instrument shall be as directed by the Owner and Engineer. Expected ranges shall correspond to actual field conditions.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Furnish instruments specified in the instrument specification sheets at the end of this section. Instruments for services not listed shall be equal in quality, performance, and environmental and functional characteristics as instruments listed and shall be approved in writing by the Owner.

2.2 INSTRUMENT ACCESSORIES

- A. Instrument and Control Device Tags: Each field mounted field device shall be identified by its unique tag number as it appears on the original P&I diagrams and the Instrument Loop Diagram. The tag number shall be stamped on a 1" x 2" stainless steel tag permanently attached to the instrument by braided stainless steel wire which has been sealed by an approved method such that the wire must be cut or the seal broken to remove the tag. The tag number shall not be stamped on the nameplate of the instrument. This requirement shall be documented on the Instrumentation Specification Sheet.
- B. Sunshades: Furnish stainless steel sunshades for all outdoor instruments not shaded by adjacent or integral equipment.
- C. Process Tubing: Stainless Steel, ASTM A 269, TP316, seamless, annealed, 1/2" x 0.065" W.T. minimum.
- D. Pneumatic Supply Tubing: Stainless Steel, ASTM A 269, TP316, seamless, annealed, 1/2" x 0.065" W.T., 3/8" x 0.049" W.T. and 1/4" x 0.035" W.T. minimum.
- E. Fittings: 316 Stainless Steel ferrule type, SWAGELOCK or equal.
- F. Pipe Stand Type Supports for Instrumentation: Pipe stands shall be stainless steel using welded fabrications with 2" schedule 40 pipe, 2" square tube x 0.188" thick, 3/8 zinc/cadmium plated hardware, 1/2" expansion anchors, 12 gauge mounting channel and 1/4" thick stainless steel plate as a minimums. Supply u-bolts or cable mounts as necessary. Acceptable alternatives include engineered pipe stand systems such as O'Brien Saddlepak.
- G. Enclosures for outdoor locations: Furnish and install NEMA 4X enclosures. All outdoor enclosures with instrumentation accessible in enclosure door shall have a stainless steel sunshade.

2.3 CALIBRATION

- A. Order instruments factory calibrated to the range indicated with calibration sheets indicating certification of traceability to National Institute of Standards and Technology (NIST). Instruments shall be ranged as directed by Engineer.

2.4 FABRICATION

- A. Materials of Construction: Provide 316 Stainless Steel for wetted and other parts unless otherwise specified.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Installation
 - 1. Install sensing elements at the point of measurement and route sensing line or cable to the transmitter. Install the transmitters 4'-6" above grade or platform in an easily accessible location adjacent to the sensor location. Mount on pipe stanchion or steel support designed for the purpose individually or grouped with other transmitters. Furnish and install surge protector Phoenix Contact PipeTrab 2818122 or equal in each 4-20 mA current loop, adjacent to each respective instrument. Route signal cable in conduit from transmitter to terminal cabinet or control panel for termination to test terminals. Steel supports shall be in accordance with this Section, and all other sections and specification requirements. Process connections for instrumentation shall be in accordance with piping sections and all other specification requirements. Provide block valves at taps for pressure or sampling sensor lines. Provide plugged tees at taps suitable for rodding or blowing out taps. Make pipe taps with weld-o-let type fittings or equal. Install block valves suitable for the service and rated as the pipe at each tap, generally use NPT threaded ball valves. Use materials rated for the service and transition to tubing for sensor runs. Use 1/2" OD 316 SS tubing or as shown on the Drawing details.
- B. Flow Instruments: Mount magnetic flowmeters according to manufacturer's instructions with any reducers necessary. Install grounding rings and ground magnetic flowmeters according to manufacturer's instructions.
- C. Pressure Instruments: Make pressure taps in top of pipe for gas service and side of pipe for liquid or steam service.
- D. Pressure Gauges: Use 1/2" NPT pipe and ball or needle valve for pressure gauge taps. Mount gauges vertically; provide 90° fitting, seal, snubber or siphon tube as required. Where 90° fitting is required, install a tee-fitting with plug.
- E. Differential pressure and level transmitters: Use 1/2" tubing and ball or needle valves for pressure taps. Slope tubing runs 1" per foot to drain the sensing line to the pipe where the transmitter is higher than the tap and to drain the line to the transmitter where the transmitter is lower than the tap. At the transmitter connection provide a valve manifold that can block, bleed, vent, purge and provide calibration ports to the transmitter. For gas service transmitters, route 1/2" tubing straight up from the tap for a minimum of 12" to a high point in the line, then with a minimum slope of 1" per foot to the transmitter connection. Provide an automatic condensate drain at the transmitter.
- F. Temperature instruments: Generally mount thermocouple assemblies in the side of the pipe at a minimum angle of 15° up from horizontal and route thermocouple or RTD cable to the transmitter in conduit. Do not mount thermocouples absolutely horizontal or at angles below horizontal. Provide adequate clearance for removal of head assembly and extraction of sensor.
- G. pH elements: For pH elements mounted in sample lines, mount according to Manufacturer's instructions in an insertion assembly which permits removal of the element while the process line is pressurized. Mount with the element vertical and in a trap to keep electrodes hydrated. Arrange taps and sensor lines to keep flow velocity at sensor below 10 ft. / sec.

1. Mount all instrumentation according to manufacturer's instructions except as specified.
- H. Tubing and Fittings:
1. Install tubing and fittings in a neat, orderly and functional manner; level and plumb except as required, noted on approved drawings, or specified. Make offsets required for fittings or equipment level in the horizontal plane to prevent high or low spots.
- I. Conduit and fittings:
1. Install conduit as required. Provide a cast body tee fitting at the instrument connections at the low point of all conduit runs below the instrument with a drain fitting for condensate. Make connections from instrument to tee with liquid-tight flexible conduit and use sealing compound inside the conduit and shrink-fit tubing over the outside of the connection to prevent entry of water into the instrument. Heat trace and insulate all liquid filled lines and the sensing body of all instruments connected to liquid service in exterior locations.
- J. Calibration: Calibrate each and every instrument connected to the work of this contract in its range, whether furnished under this contract, owner-furnished or existing and fill out a signed and dated five point calibration sheet and install an initialed and dated calibration sticker. Notify the Owner in writing immediately of any instrument which will not calibrate. Instruments that do not calibrate will require the on-site services of a factory authorized representative at no cost to the Owner.

INSTRUMENT SPECIFICATION SHEETS:

INSTRUMENT SPECIFICATION SHEET

LEVEL TRANSMITTERS

Accuracy	±0.1% of full scale	
Operating Temperature	-4 °F to 204 °F	
Output	4-20mA	
Power Supply	120VAC	
Enclosure	IP68	
Features	Wastewater Approval	
Housing	316L SS coupling suitable for use in hazardous locations	
Suppliers	Siemens Echomax XPS 15 with Hydroranger 200HMI	
Instrument Tag	Application	Measurement Range
LT01	Wet Well No.1	0 – 50 ft
LT02	Wet Well No.2	0 – 50 ft

END OF SECTION

DIVISION 31
EARTHWORK

SECTION 31 11 00 - SITE PREPARATION

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 inches caliper to a depth of 12 inches below subgrade.
- D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.
- E. Stripping: Removal of topsoil remaining after applicable scalping is completed.
- F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.2 SUBMITTALS

- A. Shop Drawings: Drawings clearly showing clearing, grubbing, and stripping limits.

1.3 QUALITY ASSURANCE

- A. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.4 SCHEDULING AND SEQUENCING

- A. Prepare site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 5 acres.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or site improvements within limits shown or specified.
- B. Do not injure or deface vegetation that is not designated for removal.

3.2 LIMITS

- A. As follows, but not to extend beyond Project limits.
 - 1. Excavation, including trenches, 5 feet beyond top of cut slopes or shored walls.
 - 2. Fill:
 - a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
 - b. Stripping and Scalping: 2 feet beyond toe of permanent fill.
 - 3. Structures: 15 feet outside of new structures.

4. Roadways: Clearing, grubbing, scalping, and stripping 15 feet from centerline.
5. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.3 CLEARING

- A. Clear areas within limits shown or specified.
- B. Fell trees so that they fall away from facilities and vegetation not designated for removal.
- C. Cut stumps not designated for grubbing to within 6 inches of ground surface.
- D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.4 GRUBBING

- A. Grub areas within limits shown or specified.

3.5 SCALPING

- A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.
- B. Scalp areas within limits shown or specified.

3.6 STRIPPING

- A. Do not remove topsoil until after scalping is completed.
- B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.
- C. Stockpile strippings, meeting requirements for topsoil, separately from other excavated material.

3.7 TOPSOIL

- A. Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

3.8 DISPOSAL

- A. Clearing and Grubbing Debris:
 1. Dispose of debris
 2. Burning of debris will not be allowed.
 3. Woody debris may be chipped. Chips may be sold to CONTRACTOR'S benefit or used for landscaping as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Maximum dimensions of chipped material used shall be 1/4-inch by 2 inch. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
 4. Limit disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.
- B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 22 13 - SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work and testing required for preparing subgrade.
- B. Related sections:
 - 1. Section 02 41 00 – Demolition.
 - 2. Section 31 11 00 – Site Preparation.
 - 3. Section 31 23 16 – Excavation.
 - 4. Section 31 23 23.13 – Fill and Backfill.

1.2 REFERENCE STANDARDS

- A. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³)
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)

1.3 DEFINITIONS

- A. Optimum Moisture Content: As defined in Section 31 23 23.13, FILL AND BACKFILL.
- B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
- C. Relative Compaction: As defined in Section 31 23 23.13, FILL AND BACKFILL.
- D. Relative Density: As defined in Section 31 23 23.13, FILL AND BACKFILL.
- E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.
- F. Standard Specifications: The latest edition, including supplements of the Texas Department of Transportation (ODOT) Standard Specifications for Highway Construction.

1.4 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Sections 02 41 00, DEMOLITION; 31 11 00, SITE PREPARATION; and 31 23 16, EXCAVATION, prior to preparation.

1.5 QUALITY ASSURANCE

- A. Notify Engineer when subgrade is ready for compaction or whenever compaction is resumed after a period of extended inactivity.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. Do not use sections of prepared ground surface as haul roads. Protect prepared from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.

3.2 MOISTURE CONDITIONING

- A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
- B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.3 TESTING

- A. Test roll subgrade as specified in Standard Specifications to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

3.4 CORRECTION

- A. Soft or Loose Subgrade:
 - 1. Adjust moisture content and recompact, or
 - 2. Over excavate as specified in Section 31 23 16, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 31 23 23.13, FILL AND BACKFILL

END OF SECTION

SECTION 31 22 19 - GRADING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Removal and storage of topsoil.
 - 2. Rough grading the site for site structures, building pads, and drive and parking isles.
 - 3. Finish grading for planting.
- B. Related sections:
 - 1. Section 31 23 16 – Excavation.
 - 2. Section 31 23 16.13 – Trenching for Site Utilities.
 - 3. Section 31 23 23.13 – Fill and Backfill.

1.2 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Texas Highway Department standards.
 - 1. Maintain one copy on site.

1.4 PROJECT CONDITIONS

- A. Protect above – and below – grade utilities that remain.
- B. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.
- C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving and curbs from grading equipment and vehicular traffic.

PART 2 - PRODUCTS

2.1 MATERIALS.

- A. Topsoil: Shall be soil suitable for sustaining grass and vegetation and shall not have any particles larger than $\frac{3}{4}$ " in diameter and shall be free of any trash, debris, or deleterious material.
- B. Other Fill Materials: See Section 31 23 23.13, FILL AND BACKFILL.

PART 3 - EXECUTIONS

3.1 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.

- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect utilities that remain from damage.
- D. Notify utility company to remove and relocate utilities.

3.3 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
- D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform work by hand and cut roots with sharp axe.
- F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.4 SOIL REMOVAL

- A. Stockpile excavated topsoil on site.
- B. Stockpile excavated subsoil on site.
- C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.5 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of ½ inch in size. Remove soil contaminated with petroleum products.
- C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.
- D. Place topsoil in areas where seeding are indicated.
- E. Place topsoil to the following compacted thicknesses:
 - 1. Areas to be Seeded with Grass: 6 inches.
 - 2. Areas to be Sodded: 4 inches.
 - 3. Shrub Beds: 18 inches.
 - 4. Flower Beds: 12 inches
 - 5. Planter Boxes: To within 3 inches of box rim.
- F. Place topsoil during dry weather.
- G. Remove roots, weeds, rocks, and foreign material while spreading.
- H. Near plants spread topsoil manually to prevent damage.

- I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- J. Lightly compact placed topsoil.

3.6 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.
- B. Top Surface of Finish Grade: Plus or minus ½ inch.

3.7 FIELD QUALITY CONTROL

- A. See Section 31 23 23.13, FILL AND BACKFILL for compaction density testing.

3.8 CLEANING AND PROTECTION

- A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 23 16 - EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work and materials associated with excavation.
- B. Related sections:
 - 1. Section 01 50 00 – Temporary Facilities and Controls.
 - 2. Section 02 41 00 – Demolition.
 - 3. Section 31 11 00 – Site Preparation.
 - 4. Section 31 23 19 – Dewatering.
 - 5. Section 31 50 00 – Excavation Support Systems.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Excavation Plan, Detailing:
 - a. Methods and sequencing of excavation.
 - b. Proposed locations of stockpiled excavated material.
 - c. Proposed and spoil disposal sites.
 - d. Numbers, types, and sizes of equipment proposed to perform excavations.

1.3 QUALITY ASSURANCE

- A. Provide adequate survey control to avoid unauthorized overexcavation.

1.4 WEATHER LIMITATIONS

- A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.
- B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.5 SEQUENCING AND SCHEDULING

- A. Demolition: Complete applicable Work specified in Section 02 41 00, DEMOLITION, prior to excavating.
- B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 11 00, SITE PREPARATION, prior to excavating.
- C. Dewatering: Conform to applicable requirements of Section 31 23 19, DEWATERING, prior to initiating excavation.
- D. Excavation Support: Install and maintain, as specified in Section 31 50 00, EXCAVATION SUPPORT SYSTEMS, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1-foot except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
- B. Do not over excavate without written authorization of Engineer.
- C. Remove or protect obstructions as shown and as specified in Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS.

3.2 UNCLASSIFIED EXCAVATION

- A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 TRENCH WIDTH

- A. Minimum Width of Trenches:
 - 1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
 - a. Less than 4-inch Outside Diameter or Width: 18 inches.
 - b. Greater than 4-inch and up to 18-inch Outside Diameter or Width: 12 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
 - c. Greater than 18-inch Diameter or Width: 24-inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
 - 2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
 - 3. Increase trench widths by thicknesses of sheeting.
- B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.4 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

- A. Semicircular, trapezoidal, or 90-degree-V.
- B. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

3.5 STOCKPILING EXCAVATED MATERIAL

- A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
- B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
- C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

- D. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
- E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.6 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill,
- B. Dispose of debris resulting from removal of underground facilities as specified in Section 02 41 00, DEMOLITION, for demolition debris.
- C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 11 00, SITE PREPARATION, for clearing and grubbing debris.

3.7 EXCAVATION SAFETY

- A. Conform to all applicable federal, state, and local regulations.

3.8 SUBGRADE PREPARATION

- A. The excavation for all structures and facilities shall be in dewatered, firm, undisturbed earth. If, in the Engineer's opinion, the has been disturbed, corrective measures may include:
 - 1. Scarification and recompaction to 95 percent relative compaction or,
 - 2. Overexcavation and replacement with compacted granular fill.
- B. If the source of disturbance is determined to be the result of the actions, or inactions of the Contractor, (for example, inadequate dewatering, disturbance by excavating or hauling equipment) the cost of additional subgrade preparation will be at the Contractor's expense.

END OF SECTION

SECTION 31 23 16.13 - TRENCHING FOR SITE UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Backfilling and compacting for utilities outside the building to utility main connections.

1.2 RELATED SECTIONS

- A. Section 31 22 19, GRADING.
- B. Section 31 23 16, EXCAVATION.
- C. Section 31 23 23.13, FILL AND BACKFILL.
- D. Section 31 23 23.16, TRENCH BACKFILL.

1.3 DEFINITIONS

- A. Subgrade Elevations: 4 inches below finish grade elevations indicated on drawings, unless otherwise indicated.
- B. Finish Grade Elevations: 4 inches above subgrade elevations indicated on drawings, unless otherwise indicated.

1.4 SUBMITTALS

- A. See Section 01 33 00, SUBMITTAL PROCEDURES, for submittal procedures.
- B. Compaction Density Test Reports.

1.5 PROJECT CONDITIONS

- A. Provide sufficient quantities of fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.
- B. Verify that survey bench marks and intended elevations for the work are as indicated.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

- A. As specified in Section 31 23 23.16, TRENCH BACKFILL.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Notify utility company to remove and relocate utilities.

- D. See Section 31 22 19, GRADING, for additional requirements.

3.2 TRENCHING

- A. Notify Owner's Representative of unexpected subsurface conditions and discontinue affected Work in areas until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove excavated material that is unsuitable for re-use from site.
- G. Remove excess excavated material from site.

3.3 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.4 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum lime for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Store grade away from building minimum 2 inches in 10 ft. unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- F. Correct areas that are over-excavated.
 - 1. Thrust bearing surfaces: Fill with concrete.
 - 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- G. Compaction Density Unless Otherwise Specified or Indicated.
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. All other locations: 95 percent of maximum dry density.
- H. Reshape and re-compact fills subjected to vehicular traffic.

3.5 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping, Conduits, and Duct Bank:
 - 1. Bedding: Use general fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

- B. At Pipe Culverts:
 - 1. Bedding: use general fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.6 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL

- A. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D6938, or ASTM D3017.

- B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASSTM D698 ("Standard Proctor"), ASTM D1557 ("Modified Proctor"), or AASHTO T180.

- C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

- D. Frequency of Tests; each lift.

3.8 CLEAN-UP

- A. Leave unused materials in a neat compact stockpile.

- B. Remove unused stockpiled material, leave area in a clean and neat condition. Grade stockpile areas to prevent standing surface water.

- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 31 23 16.16 – TRENCHING FOR WATER AND SEWER LINES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes excavation required for the construction of water and sewer pipes and appurtenances.
- B. Related sections:
 - 1. Section 31 23 23.16 – Trench Backfill
 - 2. Section 31 23 23.16 – Testing Sanitary Sewer Systems
 - 3. Section 33 39 13.13 – Pre-Cast Concrete Manholes
 - 4. Section 33 34 13 – Ductile Iron Force Main Pipe and Fittings
 - 5. Section 33 41 16 – Ductile Iron Gravity Sewer Pipe and Fittings
 - 6. Section 33 41 19 – Pipe Laying

1.2 GENERAL

- A. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Provide and install trench bracing and shoring that conforms to the requirements of 29 CFR Part 1926 Subpart P of the OSHA Standards. Bracing shall be so arranged as not to place any strain on portions of completed work until the construction has proceeded far enough to provide ample strength.
- C. Overexcavation, whether by Contractor's negligence or at direction of the Engineer, shall be repaired to required lines and grades.
- D. Trenches shall be dug to the alignment and depth required and shall not advance more than 100 feet ahead of the completed pipe, unless otherwise permitted by the Engineer.

1.3 UTILITIES

- A. Contractor shall call "TEXAS ONE CALL" two working days before starting excavation.
- B. The location and/or elevation of existing utilities as shown on these plans is based on records of the various utility companies and, where possible, measurements taken in the field. The information is not to be relied upon as being exact or complete. The Contractor must call each utility owner at least two working days before any excavation to request exact field location of utilities.
- C. Protect utilities encountered during excavation.
- D. Do not interrupt service in utilities encountered during excavation without approval of the utility owner.
- E. If utilities are damaged or utility service is interrupted by work under this section, the utility owner has the first right to repair. If public health or safety is at risk, Contractor shall take appropriate prudent action to repair damage and service interruption. Costs of utility protection and repair shall be at no additional cost to the Owner.

- F. If existing utilities are found to interfere with the permanent facility being constructed, notify the Engineer for instructions. Do not proceed with permanent relocation of utilities without written instructions from the Engineer.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

- A. Shall be as specified in Section 31 23 23.16, TRENCH BACKFILL

PART 3 - EXECUTION

3.1 GENERAL

- A. Notify property residents two working days prior to beginning excavation on property.
- B. Excavated materials not suitable for backfill or embankment shall not be incorporated into the project but shall be disposed of by Contractor.
- C. Excavate with caution so that structures and underground conduits can be protected.
- D. Excavate every type of material encountered to the lines and elevations necessary to complete the project.
- E. Reroute surface water before excavating and protect excavated trench from entrance of surface water.
- F. In general, the sheeting and bracing shall be removed as the trench or excavation is backfilled, and in such a manner as to avoid the caving in of the bank or disturbance of adjacent areas or structures. The voids left by the withdrawal of sheeting shall be backfilled the same as trench excavations.
- G. Provide "before and after" color photographs of lawns and gardens to Engineer.
- H. Comply with Section 33 41 19, PIPE LAYING.

3.2 TRENCH DEPTH

- A. Excavate to the elevation necessary to provide the depth of bedding material under the barrel of the pipe, noted on the plans or in these specifications, whichever is greater.
- B. All over-excavation up to 2 feet shall be backfilled with bedding material in 6-inch layers and tamped to a bearing capacity equal to the adjacent undisturbed earth. Over excavation greater than 2 feet will require excavation operation to stop until an engineered backfill is determined. Over excavation shall not proceed until approved by Engineer. Contractor shall bear all expense involved if he fails to obtain prior approval from the Engineer.

3.3 TRENCH WIDTH

- A. Excavate to the width shown in detail drawings. Specified width dimensions must be maintained from trench bottom to an elevation 12 inches above barrel of pipe. Over-width excavation will require excavation operation to stop until additional earth loads can be compared to strength of pipe. Costs of unauthorized deviation from the specified width will be borne by the Contractor.

3.4 TRENCH LENGTH

- A. Excavate to a maximum distance of 100 feet from the pipe jointing operation. Longer distances will be considered when conditions warrant.

3.5 EXCAVATION IN ROCK

- A. When rock is encountered, excavate to an elevation 6 inches below the pipe and to the trench width as shown in the details at no additional cost to Owner.

3.6 EXCAVATION IN UNSUITABLE SOIL

- A. Where, in the judgment of the Engineer, the planned bottom of trench is found to be unstable, excavation shall stop until an engineered subgrade stabilization method is determined.

3.7 EXCAVATION IN WET CONDITIONS

- A. Where the planned bottom of trench contains water or the trench bottom is soft from excess water, excavation depth shall increase a minimum of 6 inches or as directed by the Engineer.

3.8 EXCAVATION IN UNFORESEEN STRUCTURE

- A. Preserve unforeseen structures encountered in excavation.
- B. Advise the Engineer when unforeseen structure interferes with planned work. Engineer will determine if plan will change or if structure will be abandoned.

3.9 UNAUTHORIZED EXCAVATION

- A. Unauthorized excavation is removal of materials beyond specified elevations or dimensions without the Engineer or Owner's specific prior approval.

3.10 UNSUITABLE AND EXCESS EXCAVATED MATERIAL:

- A. Excavated material not suitable for backfill and excess excavated material shall be disposed of by Contractor in a manner approved by the Engineer and applicable governmental regulations.

3.11 EXCAVATION DEWATERING:

- A. Wellpointing or deep wells, where required to keep the excavation dry and the subgrade stable, shall be installed when the excavation extends to within two (2) feet of the water table, except as herein provided, and shall be in continuous operation until backfill is completed to this level.
- B. When construction equipment is to be operated in an area that has been excavated, and wellpointing or deep wells are required to keep the excavation dry and the subgrade stable, the wellpointing or deep wells shall be installed when the excavation extends to within five (5) feet of the water table.
- C. There shall be sufficient pumping equipment, in good working order, readily available at all times to remove any water that accumulates in excavations to the extent that a stable subgrade is obtained.
- D. Where the excavation crosses natural drainage channels, the work shall be conducted in such a manner that unnecessary damage or delays in the prosecution of the work will be prevented.

- E. Trench dewatering shall discharge to an approved location in conformance with the Stormwater Pollution Prevention Plan.
- F. Wellpoint dewatering for the sewer line construction will not be mandatory where a properly stabilized subgrade can be obtained by use of granular bedding. If granular bedding is utilized by the Contractor for stabilization of the trench bottom in lieu of wellpointing, such bedding material will not be measured for separate payment but will be considered subsidiary to the pipe installation.
- G. Where dewatering might be necessary to properly install the sewer line, such as at drainage channel crossings and tunnel or boring locations, the Contractor shall submit his proposal for this dewatering to the Owner for approval.
- H. Dewatering operations shall continue until pipe has been backfilled and a sufficient cover depth has been reached to prevent flotation of pipe.

END OF SECTION

SECTION 31 23 16.20 - ROCK EXCAVATION

PART 1 GENERAL

The following applies to all trenched construction including, but not limited to, water mains, sanitary sewer mains, gas mains, and other pipelines.

1.1 DESCRIPTION OF WORK

- A. Furnish all labor, material and equipment to excavate rock and dispose of rock as specified herein.
- B. REQUIREMENTS OF REGULATORY AGENCIES
 - 1. Observe all municipal ordinances and State and Federal laws relating to the transportation, storage, handling and use of explosives.
 - 2. Blasters shall be duly licensed and shall have their license on the work site at all time during blasting activities.

1.2 DEFINITION

- A. At sites of utility relocation projects, rock excavation is hereby defined as material that cannot be removed with the normal excavation equipment used on the project. It is further defined as material requiring drilling and/or blasting prior to its removal from the trench site. The following do not qualify for rock excavation: (1) soft or disintegrated rock that can be removed with a hand pick, power-operated excavator, or shovel; (2) loose, broken, or previously-blasted rock or broken stone in rock fills or elsewhere; and (3) rock which has fallen into the excavation from outside of the minimum limits of measurement allowed.

1.3 EXECUTION

- A. Excavate rock to the lines and grades indicated on the drawings. Dispose of excavated material not suitable for backfill in a location approved by the Owner.
- B. In rock, excavations shall be carried six inches (6") below the bottom of the pipe. Loose earth or gravel not larger than three fourths of an inch (3/4") in size shall be used for backfill, tamped thoroughly, and rounded to receive pipe as above.
- C. Excavate rock in structure excavations to 6" below the bottom of the foundation.

1.4 MEASUREMENT AND PAYMENT

- A. The contractor shall notify the owner when rock measurements can be performed. If backfill commences before measurement is made, the contractor will not be paid for that portion of the rock removed. Maximum measurement for rock excavation in pipe trenches shall be to six (6) inches below bottom of pipe with the width of trench at 2' 0" plus the interior diameter of pipe, regardless of the excess width excavated. Maximum measurement for precast and cast-in-place structures shall be structure width plus four (4) feet; structure length plus four (4) feet; and base of structure. Payment shall be the price bid per cubic yard and is to include aggregate fill to bring the ditch to plan grade.

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work required to dewater excavations.
- B. Related sections:
 - 1. Section 01 50 00 – Temporary Facilities and Controls.

1.2 WATER CONTROL PLAN

- A. As a minimum, include:
 - 1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
 - 2. Drawings showing locations, dimensions, and relationships of elements of dewatering system.
- B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and control surface and subsurface water during periods when necessary to properly accomplish Work.

3.2 SURFACE WATER CONTROL

- A. See Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS.
- B. Remove surface runoff controls when no longer needed.

3.3 DEWATERING SYSTEMS

- A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.
- B. Design and Operate Dewatering Systems:
 - 1. To prevent loss of ground as water is removed.
 - 2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
 - 3. To relieve artesian pressures and resultant uplift of excavation bottom.
 - 4. Prevent softening, loosening or otherwise disturbing the excavation subgrade.
- C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

- D. Provide supplemental ditches and sumps only as necessary to collect water from local seeps.

3.4 DISPOSAL OF WATER

- A. Obtain discharge permit for water disposal from authorities having jurisdiction.
- B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.
- C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.
- D. The discharge of ground water into treatment facilities will not be permitted unless specifically authorized by the Owner. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency. If Owner allows groundwater discharge into facilities.

3.5 PROTECTION OF PROPERTY

- A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.
- B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, sheeting bracing, underpinning, or compaction grouting.

3.6 REMEDIATION OF GROUNDWATER AFTER DEPLETION

- A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to the well owner prior to beginning Work or as satisfactory to each well owner.

END OF SECTION

SECTION 31 23 23.13 - FILL AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work and materials required for fill and backfill for all excavations other than trench type excavations.
- B. Related sections:
 - 1. Section 02 41 00 – Demolition.
 - 2. Section 03 30 00 – Cast-In-Place Concrete.
 - 3. Section 31 11 00 – Site Preparation.
 - 4. Section 31 22 13 – Subgrade Preparation.
 - 5. Section 31 23 16 – Excavation.
 - 6. Section 31 23 23.16 – Trench Backfill.
 - 7. Division 32

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM C117, Standard Test Method for Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. ASTM D75, Standard Practice for Sampling Aggregates.
 - d. ASTM D698, Standard Test Methods for Laboratory Characteristics of Soil Using Modified Effort (12,400 ft-lbf/ft³).
 - e. ASTM D1556, Standard Test Method for Density of Soil in Place by the Sand Cone Method.
 - f. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
 - g. ASTM D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - h. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - i. ASTM D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.3 DEFINITIONS

- A. Relative Compaction:
 - 1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
 - 2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.
- B. Optimum Moisture Content:
 - 1. Determined in accordance with ASTM D698 specified to maximum dry density for relative compaction.
 - 2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

- C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.
 - D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and preparation.
 - E. Completed Course: A course or layer that is ready for next layer or next phase of Work.
 - F. Lift: Loose (uncompacted) layer of material.
 - G. Geosynthetics: Geotextiles, geogrids, or geomembranes.
 - H. Well-Graded:
 - 1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
 - 2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 - 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
 - I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
 - 1. 1-foot outside outermost edge at base of foundations or slabs.
 - 2. 1-foot outside outermost edge at surface of roadways or shoulder.
 - 3. 0.5-foot outside exterior at spring line of pipes or culverts.
 - J. Borrow Material: Material from required excavations or from designated borrow areas on or near site.
 - K. Selected Backfill Material/Earthfill: Materials available onsite that Engineer determines to be suitable for specific use.
 - L. Imported Material: Materials obtained from sources suitable for specified use.
 - M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.
 - N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.
 - O. Standard Specification: The latest edition, including supplements of the [Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.
- 1.4 SUBMITTALS
- A. Quality Control Submittals:
 - 1. Catalog and manufacturer's data sheets for compaction equipment.
 - 2. Certified test results from independent testing agency.
- 1.5 QUALITY ASSURANCE
- A. Notify Engineer when:
 - 1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.

2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.6 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Sections 02 41 00, DEMOLITION; 31 11 00, SITE PREPARATION; 31 23 16, EXCAVATION; and 31 22 13, SUBGRADE PREPARATION, prior to placing fill or backfill.
- B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Obtain acceptance of concrete work and attained strength prior to placing backfill.
- C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 22 13, SUBGRADE PREPARATION.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

- A. Gradation Tests: It will be the Contractor's responsibility to conduct testing as necessary to locate acceptable sources of imported material.

2.2 EARTHFILL

- A. Excavated material from required excavations, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

2.3 GRANULAR FILL

- A. Type A, Grade 3 or better crushed limestone base material meeting all the requirements of Item 247 of the Texas Department of Transportation Standard Specifications.

2.4 WATER FOR MOISTURE CONDITIONING

- A. Free of hazardous or toxic contaminants, or contaminants deleterious to proper compaction.

2.5 BASE COURSE ROCK

- A. As specified in Division 32.

2.6 FOUNDATION STABILIZATION ROCK

- A. Crushed rock or pit run rock.
- B. Uniformly graded from coarse to fine.
- C. Free from excessive dirt and other organic material.
- D. Maximum 2-1/2 inches particle size.

PART 3 - EXECUTION

3.1 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.
- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 31 23 23.16, TRENCH BACKFILL.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.16, TRENCH BACKFILL, before resuming filling or backfilling specified in this section.
- F. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.
- H. Fill and backfill materials shall be conditioned to a water content that is within 2 percentage points (plus or minus) of the optimum required for compaction as determined by ASTM D698.

3.2 BACKFILL UNDER AND AROUND STRUCTURES

- A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D698, Method C.
- B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 6-inch maximum thickness and compact each lift to minimum of 90 percent relative density.
- C. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D698, Method C.

3.3 FILL

- A. Outside Influence Areas Beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
1. Allow for 6-inch thickness of topsoil where required.
 2. Maximum 9-inch thick lifts.
 3. Place and compact fill across full width of embankment.
 4. Compact to minimum 95 percent relative compaction as determined in accordance with ASTM D698, Method C.
 5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.4 SITE TESTING

- A. Gradation:
1. One sample from each 400 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
 2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
 3. Remove material placed in Work that does not meet Specification requirements.
- B. In-Place Density Tests: In accordance with ASTM. During placement of materials, test as follows:
1. One test per every other lift per 200 lineal feet of roadway or trench.
 2. A minimum of two tests on granular fill beneath structures.
 3. A minimum of two test per 300 cubic yards during backfilling of walls.
- C. Testing shall be the Contractor's responsibility and conducted by persons experienced in such work.

3.5 GRANULAR BASE, SUBBASE, AND SURFACING

- A. Place and Compact as specified in DIVISION 32.

3.6 REPLACING OVEREXCAVATED MATERIAL,

- A. Replace excavation carried below grade lines shown or established by Engineer as follows:
1. Beneath Footings: Concrete of strength equal to that of respective footing.
 2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
 3. Beneath Slabs-On-Grade: Granular fill.
 4. Trenches:
 - a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.16, TRENCH BACKFILL.
 - b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.16, TRENCH BACKFILL.
 5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
 - a. Flat to Moderate Steep Slopes (3: 1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
 - b. Steep Slopes (Steeper than 3: 1):
 - 1) Correct overexcavation by transitioning between areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.

- 2) Backfilling overexcavated areas is prohibited unless, in opinion, backfill will remain stable, and overexcavated material is replaced as compacted earth fill.

END OF SECTION

SECTION 31 23 23.16 - TRENCH BACKFILL

PART 1 - GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI): 253.1, Safety Color Code.
 2. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.
 3. American Society for Testing and Materials (ASTM):
 - a. ASTM D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - b. ASTM C94, Specification for Ready-Mixed Concrete.
 - c. ASTM C117, Standard Test Method for Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - d. ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - e. ASTM C150, Standard Specification for Portland Cement.
 - f. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - g. ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.
 - h. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/cubic ft).
 - i. ASTM D1140, Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
 - j. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf).
 - k. ASTM D3776, Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
 - l. ASTM D3786, Standard Test Method for Bursting Strength of Textile Fabrics: Diaphragm Bursting Strength Tester Method.
 - m. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - n. ASTM D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - o. ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - p. ASTM D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - q. ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - r. ASTM D4991, Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.
 - s. ASTM D5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

1.2 DEFINITIONS

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- C. Imported Material: Material obtained by the Contractor from source(s) offsite.
- D. Lift: Loose (uncompacted) layer of material.

- E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.
- F. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.
- G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- H. Relative Density: As defined by ASTM D4253 and ASTM D4254.
- I. Selected Backfill Material: Material available that the Engineer determines to be suitable for a specific use.
- J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.3 SUBMITTALS

- A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.
- B. Samples:
 - 1. Trench stabilization material.
 - 2. Bedding and pipe zone material.
 - 3. Granular drain.
 - 4. Granular backfill.
 - 5. Earth backfill.
 - 6. Sand(s).
 - 7. Geotextile.
- C. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.
- D. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.
- E. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 - PRODUCTS

2.1 MARKING TAPE

- A. Plastic:
 - 1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
 - 2. Thickness: Minimum 4 mils.
 - 3. Width: 12 inches.
 - 4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.

5. Manufacturers and Products:
 - a. Reef Industries; Terra Tape.
 - b. Allen; Markline.

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
2. Thickness: Minimum 5 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
6. Manufacturers and Products:
 - a. Reef Industries; Terra Tape Sentry Line.
 - b. Allen; Detectatape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color ^a	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Water, irrigation, and slurry lines
^a As specified in ANSI Z53.1, Safety Color Code.	

2.2 TRENCH STABILIZATION MATERIAL

- A. Clean, hard, durable 3-inch minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.
- B. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.
 1. Duct Banks: 3/4-inch maximum particle size.
 2. PVC Irrigation System Piping, and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
 3. Pipe Under 18 Inches Diameter: 3/4-inch maximum particle size, except 1/4-inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 inches diameter.

4. Pipe Greater than 18 Inches Diameter: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe. 3/4-inch maximum particle size for PVC, FRP, or HDPE Pipe.
5. Perforated Pipe: Granular drain material.
6. Conduit and Direct-Buried Cable:
 - a. Sand, clean or clean to silty, less than 12 percent passing the No. 200 sieve.
 - b. Individual Particles: Free of sharp edges.
 - c. Maximum Size Particle: Pass a No. 4 sieve.
 - d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.4 EARTH FILL

- A. As specified in Section 31 23 23.13, FILL AND BACKFILL.

2.5 CONTROLLED LOW STRENGTH FILL

- A. Select and proportion ingredients to obtain compressive strength between 50 and 150 psi at 28 days in accordance with ASTM D4832.
- B. Materials:
 1. Cement: ASTM C150, Type I or II.
 2. Aggregate: ASTM C33, Size 7.
 3. Fly Ash (if used): ASTM C618, Class C.
 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.6 CONCRETE BACKFILL

- A. Provide as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.7 TOPSOIL

- A. Topsoil removed and stockpiled from onsite excavation.

2.8 SOURCE QUALITY CONTROL

- A. Perform gradation analysis in accordance with ASTM C136 for:
 1. Earth backfill, including specified class(es).
 2. Trench stabilization material.
 3. Bedding and pipe zone material.
- B. Certify Laboratory Performance of Mix Designs:
 1. Controlled low strength fill.
 2. Concrete.

PART 3 - EXECUTION

3.1 TRENCH PREPARATION

- A. Water Control: Conform to Section 31 23 19, DEWATERING.
 1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
 2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.

3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.2 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If it is encountered that it may require removal to prevent pipe settlement, notify Engineer. Engineer will determine the depth of overexcavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

A. Furnish imported bedding material where, in the opinion of the Engineer, excavated material unsuitable for bedding or insufficient in quantity.

B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness:

1. Pipe, 15-inch and Smaller: 4 inches.
2. Pipe, 18-inch to 36 inch: 6 inches.
3. Pipe, 42-inch and Larger: 12 inches.
4. Conduit: 3 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches above top of pipe, unless shown otherwise.

2. Conduit: 3 inches above top of conduit, unless shown otherwise.
 3. Direct-Buried Cable: 3 inches above top of cable, unless shown otherwise.
 4. Duct Bank: 3 inches above top of duct bank, unless shown otherwise.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
1. Pipes 10 Inches and Smaller Diameter: First lift less than or equal to pipe-diameter.
 2. Pipes Over 10 Inches Diameter: Maximum 6-inch lifts.
- D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.
- E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.
- F. Do not use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of all buried piping, at depth of 2 feet. Coordinate with piping installation drawings.
1. Metallic Marking Tape: Install with nonmetallic piping
 2. Plastic Marking Tape: Install with metallic piping.

3.7 BACKFILL ABOVE PIPE ZONE

- A. General:
1. Process excavated material to meet specified gradation requirements.
 2. Adjust moisture content as necessary to obtain specified compaction.
 3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
 4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
 5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
 6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.
- B. Select Excavated Backfill:
1. Place in lifts not exceeding 9-inch thickness.
 2. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.
- C. Excavated Backfill: Backfill trench above the pipe zone with granular backfill in lifts not exceeding 8 inches. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.
- D. Concrete Backfill:
1. Place above bedding.

2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
3. Do not allow dirt or foreign material to become mixed with concrete during placement.
4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

E. Controlled Low Strength Fill:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.8 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 6 inches of backfilled trench.
- B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.9 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.
- D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, ASPHALT CONCRETE PAVEMENT.
- E. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill, will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 23 23.19 – TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes materials and work required for placing bedding and backfilling of water and sewer pipelines and appurtenances.
- B. Related sections:
 - 1. Section 31 23 16.16 – Trenching for Water and Sewer Lines
 - 2. Section 32 12 16 – Asphalt Concrete Pavement
 - 3. Section 33 39 13.13 – Pre-Cast Concrete Manholes
 - 4. Section 33 41 16 – Ductile Iron Gravity Sewer Pipe and Fittings
 - 5. Section 33 41 19 – Pipe Laying

1.2 GENERAL

- A. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.3 DEFINITIONS

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material: Granular material which is used as fill material in the pipe zone of the trench.
- C. Backfill Material: Material used to fill pipe trench from the upper surface of the pipe zone to existing grade or bottom of proposed pavement section.
- D. Imported Material: Material obtained by the Contractor from source(s) offsite.
- E. Lift: Loose (uncompacted) layer of material.
- F. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe or bedding material.
- G. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.
- H. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698, Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- I. Relative Density: As defined by ASTM D4253 and ASTM D4254.
- J. Selected Backfill Material: Material available that the Engineer determines to be suitable for a specific use.
- K. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any

numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.4 SUBMITTALS

- A. Quality Control Submittals
 - 1. Catalog and manufacturer's data sheets for compaction equipment.
 - 2. Certified test results from independent testing agency.
 - 3. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.

1.5 QUALITY ASSURANCE

- A. Notify Engineer when:
 - 1. Soft or loose subgrade materials are encountered wherever pipe bedding is to be placed.
 - 2. Fill material appears to be deviating from Specifications.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Backfill materials shall be obtained from excavated materials or approved borrow sources.
- B. Backfill material shall be free of trash, debris, cinders, organic matter or other deleterious materials.
- C. All backfill materials shall be subject to the Engineer's approval.

2.2 TRENCH STABILIZATION MATERIAL

- A. Clean, hard, durable 3-inch minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.
- B. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Pipe bedding shall be in accordance with ASTM D2321, Class IA, manufactured aggregates, open-graded, clean, non-plastic. The gradation shall be as follows:

ASTM D2321, Class IA	
Sieve Size	Percent Passing
1 ½ in.	100
No. 4	≤10%
No. 200	<5%

- C. Alternative bedding materials may be considered at the discretion of the Engineer. Alternate bedding materials shall be crushed rock classified as GP as specified in ASTM D2487 with 15% sand or less, a maximum of 25% passing 3/8-inch sieve, and a maximum of 5% fines.

2.4 TRENCH BACKFILL - GENERAL

- A. Excavated material from required excavations, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

2.5 TRENCH BACKFILL – GRANULAR

- A. Granular backfill shall be placed under all existing or proposed driving surfaces and/or as specified on the Plans.
- B. Granular backfill shall be Type A, Grade 3 or better crushed limestone base material meeting all the requirements of Item 247 of the Texas Department of Transportation Standard Specifications.

2.6 TOPSOIL

- A. Topsoil removed and stockpiled from onsite excavation.
- B. Should the Contractor dispose of existing topsoil the Contractor shall acquire and place topsoil to a minimum 6-inch depth at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 GENERAL

- A. All bedding material shall be placed in accordance with Section 31 23 16.16, TRENCHING FOR WATER AND SEWER LINES and Section 33 41 19, PIPE LAYING.
- B. Process excavated material to meet specified gradation requirements.
- C. Adjust moisture content as necessary to obtain specified compaction.
- D. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
- E. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
- F. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
- G. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

3.2 TRENCH BACKFILL-GENERAL

- A. Trench backfill shall be placed in in lift not exceeding 9-inch thickness.
- B. Each lift shall be mechanically compacted to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

3.3 TRENCH BACKFILL-GRANULAR

- A. Granular backfill shall be used under all existing or proposed driving surfaces and at locations specified on the Plans.

- B. Granular backfill shall be placed in lifts not exceeding 8-inch thickness.
- C. Each lift shall be mechanically compacted to 95 percent relative compaction prior to placing succeeding lifts.

3.4 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 6 inches of backfilled trench.
- B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.5 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.
- D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, ASPHALT CONCRETE PAVEMENT.
- E. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.6 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work required to install and remove excavation support systems.
- B. Related sections:
 - 1. Section 31 23 23.13 – Fill and Backfill

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Excavation support plan.
 - 2. Movement monitoring plan.
- B. Quality Control Submittals: Movement measurement and data and reduced results indicating movement trends.

1.3 QUALITY ASSURANCE

- A. Provide surveys to monitor movements of critical facilities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Design, provide, and maintain shoring, sheeting, and bracing as necessary and where shown to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.
- B. Minimum areas for shoring, sheeting and bracing are shown on the Drawings. It will be the Contractor's responsibility to determine if areas will require excavation slope retention to protect existing structures and facilities from damage resulting from the Contractor's excavation or excavation methods.
- C. The Contractor will also be responsible for providing shoring, sheeting and bracing of excavations as needed for worker safety and as may be required by federal, state, and local regulations.

3.2 EXCAVATION SUPPORT PLAN

- A. Prepare excavation support plan addressing following topics:
 - 1. Details of shoring, bracing, sloping, or other provisions for worker protection of existing structures or facilities.
 - 2. Design assumptions and calculations.
 - 3. Methods and sequencing of installing excavation support.
 - 4. Proposed locations of stockpiled excavated material.
 - 5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.

3.3 MOVEMENT MONITORING PLAN

- A. Prepare movement monitoring plan addressing following topics:
 - 1. Survey control.
 - 2. Locations of monitoring points (at least one every 50 feet).
 - 3. Plots of data trends.
 - 4. Interval between surveys (not to exceed 5 working days).
- B. Movement monitoring shall be done on every existing structure that is adjacent to the Contractor's excavations.
- C. Results of movement monitoring will be delivered for the Engineer at least once a week.

3.4 REMOVAL OF EXCAVATION SUPPORT

- A. Do not begin to remove excavation support until it can be removed without damage to existing facilities, completed Work, or adjacent property.
- B. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities. Maintain soil wall support as excavation is backfilled.
- C. Fill voids immediately with approved backfill compacted to density specified in Section 31 23 23.13, FILL AND BACKFILL.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

SECTION 32 12 16 - ASPHALT CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Providing and placing Asphalt Concrete Hot Mix (ACHM).
- B. Related sections:
 - 1. Section 31 22 13 – Subgrade Preparation.

1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM D2950 – Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
 - b. ASTM D2041 – Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - c. ASTM E699 – Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components.

1.3 DEFINITIONS

- A. Combined Aggregate: All mineral constituents of an asphalt concrete mix, including mineral filler and separately sized aggregates.
- B. Standard Specifications: The latest edition, including supplements of the Texas Department of Transportation Standard Specifications for Highway Construction.

1.4 SUBMITTALS

- A. Shop Drawings: Job-mix formula for pavements.
- B. Quality Control Submittals:
 - 1. Manufacturer's Certificate of Compliance for the following materials:
 - a. Aggregate: Gradation.
 - b. Asphalt for Binder: Type and grade.
 - c. Tack Coat: Type and grade of asphalt.
 - d. Mixes: Job-mix formula approved by the Materials Engineer for the State of Texas dated no earlier than January, 2018.
 - 2. Manufacturer's Certificate of Proper Installation.
 - 3. Statement of qualification for independent testing laboratory.
 - 4. Test Results:
 - a. For Each Trial Batch of the Mix Design:
 - Aggregate gradation.
 - Asphalt content.
 - Stability number.
 - Percent air voids.
 - Percent voids in mineral aggregate.
 - Density.

- Retained strength.
- b. Asphalt cement for binder.
- c. Field density.

1.5 QUALIFICATIONS

- A. Independent Testing Laboratory: In accordance with ASTM E699.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Temperature:
 - 1. Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F, air temperature is lower than 40 degrees F, or application surface is wet.
 - 2. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

PART 2 - PRODUCTS

2.1 AGGREGATE

- A. As specified in Section 340.2 of Standard Specification for Dense Graded Hot Mix Asphalt; however, reclaimed material will not be acceptable.

2.2 MINERAL FILLER

- A. As specified in Section 340.2 of Standard Specifications.

2.3 TACK COAT

- A. Emulsified asphalt, CSS-1H, SS-1H or PG-58 minimum conforming to Section 340.2 of Standard Specifications.

2.4 BLOTTER MATERIAL

- A. As specified in Section 340 of Standard Specifications.

2.5 ASPHALT CONCRETE MIXTURE

- A. Surface Course: As specified in Section 300.2 of Standard Specifications.
- B. Base Course: As specified in Section 300.2 of Standard Specifications.

2.6 ASPHALT CEMENT

- A. Surface Course: As specified in Section 300.2 of Standard Specifications.
- B. Base Course: As specified in Section 300.2 of Standard Specifications.

2.7 SOURCE QUALITY CONTROL

- A. Tests: Furnish services of independent testing laboratory to conduct tests.
 - 1. Job-Mix Formula for Pavements:
 - a. Define gradation for each of the aggregate constituent used in mixture and establish exact proportion of each constituent to produce a gradation of aggregate within specified limits.
 - b. Bulk specific gravity for each aggregate constituent.
 - c. Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
 - d. Properties as stated in Standard Specifications, Section 340, for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
 - e. Percent of asphalt lost due to absorption by aggregate.
 - f. After each job-mix formula is established, the combined aggregate grading of respective mixture furnished to the Project shall meet tolerances specified in Section 340 of Standard Specifications.

PART 3 - EXECUTION

3.1 GENERAL

- A. Application Equipment: In accordance with Section 320 of Standard Specifications.
- B. Roadways: Construct to lines, grades, and cross-sections shown.
- C. Traffic Control: Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt. Maintain at least one-way traffic at all times.
- D. Traffic Control: Contractor shall be solely responsible for traffic control and for meeting all federal, state, and local requirements for such.

3.2 CONTROL OF LINE AND GRADE

- A. Provide and maintain intermediate control of the underlying base to meet finish surface grades and minimum thickness.

3.3 SURFACE PREPARATION FOR ASPHALT OVER EXISTING GRAVEL ROAD

- A. Blade or otherwise work existing surface as necessary to achieve a smooth and thoroughly compacted surface.
- B. Surface Depressions: Fill with base course, and thoroughly compact.

3.4 TACK COAT

- A. Do not apply more tack coat than necessary for the day's paving operation.
- B. Application: Apply tack coat uniformly to clean dry surfaces. Avoid overlapping of applications. Touch up missed or lightly coated surfaces and remove excess tack coat.

- C. Application Rate: Minimum 0.05-gallon to maximum 0.15-gallon of asphalt (residual if diluted emulsified asphalt) per square yard of surface area. Apply at rate, within range specified, sufficient to assure good bonding, but not too heavy that surplus asphalt flushes into asphalt concrete being placed.

3.5 ASPHALT CONCRETE PAVEMENT PLACEMENT

- A. Lay asphalt concrete over prepared base in a single lift to a total compacted thickness as shown on Plans.
- B. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

3.6 CONNECTIONS WITH EXISTING FACILITIES

- A. Where asphalt concrete pavement connects to an existing roadway surface, bridge, railway crossing, or other facility, modify existing roadway profile to produce a smooth riding connection to existing facility.
- B. Modifying Existing Surfaces: Sawcut existing paved surfaces to provide meet lines and surfaces. Allow for sufficient depth of removal to reinstall a minimum thickness of 1-inch of asphalt concrete.
 - 1. Meet Lines: Lines straight and edges vertical.
 - 2. Edges of Meet Line Cuts: Paint with tack coat prior to placing pavement.
 - 3. Sealing Meet Line: After placement of pavement, by painting with liquid asphalt or emulsified asphalt, cover immediately with clean, dry sand.
- C. Paint edges of contact surfaces (curbs, manhole frames), before laying pavement, with tack coat or paving asphalt cement to provide watertight joints. Do not stain adjacent surfaces not intended to be coated.

3.7 JOINTS

- A. Offset edge of each layer a minimum of 6 inches so joints shall not be directly over those in underlying layer.
- B. Offset longitudinal joints in roadway pavements, so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
- C. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.

3.8 PATCHING

- A. Patch Thickness: 3 inches or thickness of adjacent asphalt concrete, whichever is greater.
- B. Preparation:
 - 1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
 - 2. Prepare patch as specified in Section 31 22 13, SUBGRADE PREPARATION.
- C. Construction:
 - 1. Place asphalt concrete mix across full width of patch in layers of equal thickness.

2. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.
3. Finished surface of patch shall be flush with adjacent surface and match grade, slope, and crown of adjacent surface.

D. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
2. Begin rolling top course at edge of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 the width of roller. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

E. Surface Smoothness of Replaced Pavement: New pavement shall not deviate more than plus 1/4-inch or minus 0 inches when a straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.9 COMPACTION

- A. Roll until roller marks are eliminated and a density of 92 percent of measured maximum density determined in accordance with ASTM D2041 and ASTM D2950 is obtained.

3.10 JOINT COMPACTION

- A. Place top or wearing layer as continuously as possible.
- B. Pass roller over unprotected end of freshly laid mixture only when laying of layer is discontinued long enough to permit mixture to become chilled.
- C. Cut back previously compacted mixture when Work is resumed to produce a slightly beveled edge for full thickness of layer.
- D. Cut away waste material and lay new mix against fresh cut.

3.11 TOLERANCES

- A. Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
- B. Tolerance Measurements:
1. Completed Surface of Top or Wearing Layer: Uniform texture, smooth, and uniform to crown and grade.
 2. Completed surface shall not vary more than 1/8-inch from lower edge of 10-foot straightedge placed on surface parallel to centerline.
 3. Transverse slope of completed surface shall not vary more than 1/4-inch in 10 feet from the rate of transverse slope shown.
 4. Finished grade shall not vary more than 0.02 feet.
- C. Correct deviations in excess of specified tolerances by addition of asphalt concrete mixture to low places or removal of material from high places.

- D. Wearing surface may be removed and replaced to achieve a satisfactory finish surface, if surface of completed pavement deviates by more than twice the specified tolerances.

3.12 FIELD QUALITY CONTROL

- A. General: Provide services of independent testing laboratory to conduct tests.

END OF SECTION

SECTION 32 91 19 - SODDING, SEEDING, FERTILIZING, AND MULCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Sodding.
 - 2. Fertilizer.
 - 3. Mulch.
 - 4. Seed.
 - 5. Preparation.
 - 6. Maintenance.
- B. Related Sections:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 31 23 23.13 – Fill and Backfill
- C. Alternate Methods and Products:
 - 1. Alternate methods from those specified will be considered for use, provided that in the Engineer's opinion the end product will be equal to or exceed that which would result from the specified methods and products.

1.2 DEFINITIONS

- A. Weeds:
 - 1. Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wold Garlic, Perennial Sorrel, and Brome Grass.

1.3 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.4 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.5 MAINTENANCE DATA

- A. Submit maintenance data for continuing Owner maintenance.
- B. Include maintenance instruction, cutting method, maximum grass height, types, application frequency, and recommended coverage of fertilizer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
- B. Deliver fertilizer in water proof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 - PRODUCTS

2.1 AGRICULTURAL LIMESTONE

- A. Shall be agricultural limestone with not less than 90 percent passing the No. 4 sieve and containing not less than 40 percent calcium carbonate equivalent. Lime shall be applied at the rate recommended by soil test.

2.2 FERTILIZER

- A. Shall be a standard commercial product which when applied at the proper rate will supply the equivalent quantity of total nitrogen, available phosphoric acid and soluble potash specified. Fertilizer shall be delivered to the site in bags or other suitable containers, each fully labeled, conforming to applicable state fertilizer laws, and bearing the name, trade name or trademark, and warranty of the producer.
- B. Requirements per acre:
 - 1. Six hundred pounds of 17-17-17 grade fertilizer or equivalent.

2.3 MULCH

- A. Shall be vegetative mulch consisting of cereal straw from stalks of oats, rye, wheat or barley. Straw shall be free of prohibited weed seeds as stated in State Seed Law and shall be relatively free of all other noxious and undesirable seeds. Straw shall be clean and bright, relatively free of foreign material and be dry enough to be spread properly.

2.4 SEED

- A. Seed shall be a mixture with the specified minimum purity and germination requirements, as follows:

<u>Seed Type</u>	<u>% Mix (By Wt.)</u>	<u>Purity %</u>	<u>Germination %</u>
Kentucky K-31 Fescue	52	97	85
Creeping Red Fescue	18	85	80
Rye Grass	8	98	85
Rye Grain	22	-	-

Variation in the above mix to suit local conditions or time of year may be required.

- B. Seed shall be labeled in accordance with USDA regulations. Care shall be taken during transportation to avoid segregation of seed mixtures.
- C. Seed shall be sown at a rate of 217 pounds of seed mix per acre for drill seeding. Seed mixture shall be thoroughly mixed prior to application.

2.5 SODDING

- A. Sodding shall consist of furnishing, and placing sod at all locations shown on the Plans, where directed by the Engineer, and in conformity with these Specifications. Sod shall consist of a live, dense, well-rooted growth of permanent grasses, free of weeds and weedy grasses. All sod shall be cleanly cut in strips having a reasonably uniform thickness of not less than 1 inch, a reasonable uniform width of not less than 8 inches, and a length not less than 12 inches. Sod shall be Kentucky 31 Fescue, Bluegrass, or Bermuda grass. It shall be the obligation of the Contractor to secure a satisfactory growth of grass before final acceptance of the project.

PART 3 - EXECUTION

3.1 GENERAL

- A. The application of fertilizer, seed, and mulch shall follow each other in successive sequence as closely as possible. Seeding shall be accomplished in the first of the following two periods after completion of earthwork.
 - February 15 to May 1st
 - September 1st to October 1st
- B. Seeding outside the specified seeding periods may be permitted at the Engineer's option, provided the Contractor is willing to make appropriate modifications to his seeding operations, and will guarantee the crop.

3.2 INSPECTION

- A. Contractor must request that Engineer inspect site grading, clean-up and surface preparation to determine if site is ready for the seeding, fertilizing and mulching operations.
- B. Upon Engineer's approval operations may begin.

3.3 SURFACE PREPARATION

- A. Immediately in advance of fertilizing, the surface to be seeded shall be repaired, if necessary, to eliminate all damage from erosion or construction operations. The surface shall then be loosened and thoroughly pulverized by discing, harrowing and raking or other approved methods, to such an extent that it is free from sod, stones, clods, or roots. All growth of vegetation that will seriously interfere with planting operations shall be removed and disposed of as directed. The final surface shall be smooth and uniform, and left in such a condition as to prevent formation of low places and pockets.

3.4 FERTILIZING

- A. Fertilizer and lime shall be dressed evenly over the areas to be seeded using approved mechanical type spreading equipment.
- B. Fertilizer and lime after spreading shall be immediately incorporated into the soil to a depth of approximately 2 inches, by chisel, spike tooth harrow, or other approved methods.

3.5 SEEDING METHODS

- A. General methods:
 - 1. The Contractor shall employ a satisfactory method of sowing by use of either approved mechanical hand seeders or mechanical power-driven drills. When delays in operation carry the work beyond the specified planting seasons, or when conditions are such that by reason of drought, high winds, excessive moisture, or other factors, satisfactory results are not likely to be obtained, seeding shall stop. It will be resumed only where the desired results are probable or when approved alternate procedures have been adopted.
- B. Broadcast seeding:
 - 1. When broadcast seeding is utilized, the seed shall be uniformly broadcast by mechanical hand seeder, in two directions at right-angles to each other and at 1/2 of the specified rate per acre in each direction. After the seed is broadcast it shall be covered by an approved method to a depth of 1/3 inch to 3/4 inch. Broadcast seeding shall not be done in windy weather.

- C. Drill seeding:
 - 1. When drilling is utilized, it shall be done with approved equipment best suited to perform the work under prevailing conditions. The seed shall be uniformly drilled to a depth of one-third (1/3) inch to three-fourths (3/4) inch at the rate per acre specified. Drill seeding may be required in windy weather.
- D. Prior to start of seeding, the Contractor shall demonstrate that the application of seed is being made at the specified rate. A final check of the total quantity of seed used shall be made against the area seeded. If the check shows that the Contractor has not applied seed at the specified rate, he shall uniformly distribute seed at a rate calculated to meet the shortage.
- E. The Contractor shall maintain the seeded areas until all fertilizing, seeding and mulching is complete and the work accepted by the Engineer. Areas damaged from the Contractor's own operations shall be repaired at his expense. After acceptance of the work the Contractor will not be held responsible for erosion due to weather, or conditions not due to the Contractor's own operations or negligence. The Contractor is not required to guarantee a crop, if seeding is done during the specified seeding periods.

3.6 MULCHING

- A. Immediately after seeding, the Contractor shall apply vegetative mulch at a rate between 1-1/2 and 2-1/2 tons per acre to all seeded areas. Quantity of mulch shall be adjusted within the above limits, as directed by the Engineer, to the particular area or slope being mulched. Total application of mulch for the project shall average approximately 2 tons per acre. Mulch shall be applied by mechanical mulch spreaders equipped to eject by means of a constant air stream controlled quantities of the vegetative mulch.
- B. Mulch shall be embedded by a disc type roller having flat serrated discs spaced not more than 10 inches apart, with cleaning scrapers for each disc.
- C. Where indicated, or in areas of the project where soil conditions are not suitable for satisfactory crimping, asphalt emulsion shall be applied with the mulching operation. The normal rate of application shall be 100 gallons per ton of straw; however, this rate may be varied as directed by the Engineer to suit the particular area or slope conditions.
- D. All mulch shall be distributed evenly over the areas to be mulched within 24 hours after the seeding operation. Following the mulching operation, suitable precautions shall be taken to prohibit traffic over mulched areas. Displaced mulch shall be replaced immediately, including repair of the underlying seed bed, if damaged as well.

3.7 MAINTENANCE

- A. The Contractor shall maintain all seeded areas until the grass is properly established (not less than 90 days) until satisfactory development. Maintenance shall be continued until final acceptance of the work.
- B. Maintenance of seeded areas shall include protecting, watering, mowing, fertilizing, and such other work as may be necessary to establish a permanent lawn. The Contractor shall reseed those seeded areas in which a satisfactory growth is not obtained, and shall refill any areas which become eroded prior to final acceptance of the work.
- C. Paved areas shall be kept clean while maintenance operations are in progress.

3.8 REPLACEMENT

- A. The Contractor shall replace all trees, shrubs, and flowers damaged by construction activities in the areas designated on the construction plans. The replacement trees and shrubs shall be equal in size to the damaged or removed specimen.

END OF SECTION

DIVISION 33
UTILITIES

SECTION 33 31 23 – TESTING SANITARY SEWER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the Work necessary to test gravity sewer pipe, force main pipe, manholes and appurtenances.
- B. Related sections:
 - 1. Section 33 39 13.13 – Pre-Cast Concrete Manholes
 - 2. Section 33 34 13 – Ductile Iron Force Main Pipe and Fittings
 - 3. Section 33 41 16 – Ductile Iron Gravity Sewer Pipe and Fittings

1.2 GENERAL

- A. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. The contractor is responsible for supplying all equipment required to conduct testing and all testing shall be conducted by the Contractor.
- B. All testing shall be conducted in the presence of the Engineer.

3.2 GRAVITY SEWER TESTING

- A. The Contractor shall have the option of verifying water tightness by either air testing or water testing. The Engineer shall have the option to require testing by both methods to verify marginal results.
- B. Gravity Sewers – Air Testing:
 - 1. After gravity sanitary sewer and service pipe have been laid, all newly laid sewer main pipe shall be subject to an air pressure test to determine watertightness from air loss.
 - 2. Test Equipment:
 - a. All necessary equipment to perform the air test in accordance with this specification shall be provided by the Contractor. The test gauge shall have incremental divisions of 0.10 psi and have an accuracy of at least plus or minus 0.04 psi. In no case shall a test gauge be used which has incremental divisions of greater than 0.25 psi. The gauge shall be of sufficient size to determine accuracy.
 - 3. Procedure:
 - a. As each section of sewer is completed between manholes, each section shall be air tested. When practical, house connections in each section shall be completed. Air test shall be low-pressure air test based on the principal of air-pressure loss per time period. Contractor shall prepare a log of testing and submit this to the Engineer as each section is completed and tested. All tests shall be accomplished in the presence of the Engineer.

- b. The test section of the sewer line is plugged at each end. One of the plugs used at the manhole must be tapped and equipped for air inlet connection for filling the line from the air compressor.
- c. All service laterals, stubs and fittings into the sewer test section shall be properly capped or plugged, and carefully braced against the internal pressure to prevent air leakage by slippage and blowouts.
- d. Connect air hose to tapped plug selected for the air inlet. Then connect the other end of the air hose to the portable air control equipment which consists of valves and pressure gauge used.
 - 1) To control air entry rate to the sewer test section, and
 - 2) To monitor the air pressure in the pipe line.
 More specifically, the air control equipment includes a shutoff valve, pressure regulating valve, pressure reduction valve and a monitoring pressure gauge having a pressure range from 0-5 psi. The gauge shall have minimum divisions of 0.10 psi and an accuracy of 0.04 psi.
- e. Connect another air hose between the air compressor (or other source of compressed air) and the air control equipment. This completes the test equipment set-up. Test operations may commence.
- f. Supply air to the test section slowly, filling the pipe line until a constant pressure of 4.0 psig is maintained. The air pressure must be regulated to prevent the pressure inside the pipe from exceeding 5.0 psig.
- g. When constant pressure of 4.0 psig is reached, throttle the air supply to maintain the internal pressure between 3.5 to 4.0 psig for at least 5 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall. If leakage is detected at any cap or plug, release the pressure in the line and tighten all leaky caps and plugs.
Then start the test operation again by supplying air. When it is necessary to bleed off the air to tighten or repair a faulty plug, a new five-minute interval must be allowed after the pipeline has been refilled.
- h. After the stabilization period, adjust the air pressure to 3.5 psig and shutoff or disconnect the air supply. Observe the gauge until the air pressure reaches 3.5 psig. At 3.5 psig commence timing with a stop watch which is allowed to run until the line pressure drops to 2.5 psig at which time the stop watch is stopped. The time required, as shown on the stop watch for a pressure loss of 1.0 psig, is used to compute the air loss.
- i. If the time in minutes and seconds for the air pressure to drop from 3.5 to 2.5 psig is greater than that shown in the table for the designated pipe size, the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued at that time.
- j. If the time in minutes and seconds for the 1.0 psig drop is less than that shown on the table for the designated pipe size, the section of pipe shall not have passed the test; therefore, adequate repairs must be made and the line retested.
- k. Pipe sizes with their respective recommended minimum times, in minutes and seconds, for acceptance by the air test method are as shown below.

Minimum Time For A 1.0 psig Pressure Drop (Min:Secs)										
Distance Between Manholes	Nominal Diameter (inches)									
	8	10	12	15	18	21	24	30	36	42
100'	7:33	9:26	11:20	14:10	17:00	19:50	22:47	35:37	51:17	69:48
150'	7:33	9:26	11:20	14:10	17:00	26:11	34:11	53:25	76:55	104:42
200'	7:33	9:26	11:23	17:48	25:38	34:54	45:34	71:13	102:34	139:37
250'	7:33	9:53	14:14	22:15	32:03	43:38	56:58	89:02	128:12	174:30
300'	7:35	11:52	17:05	26:42	38:27	52:21	68:22	106:50	153:50	209:24
350'	8:51	13:51	19:56	31:09	44:52	61:08	79:46	124:38	179:29	244:19
400'	10:07	15:49	22:47	35:36	51:17	69:48	91:10	142:26	205:07	279:13
450'	11:23	17:48	25:38	40:04	57:41	78:32	102:33	160:15	230:46	314:07
500'	12:39	19:47	28:29	44:31	64:06	87:15	113:57	178:03	256:24	349:01

Times for distances not listed in the table can be obtained by calculating the straight-line ratio between distances given.

- l. For testing of long sections or sections of larger diameter pipes, or both, a timed-pressure drop of 0.5 psig may be used in lieu of a 1.0 psig timed-pressure drop as approved by the Owner or Engineer. If a 0.5 psig pressure drop is used, the appropriate required test time shall be exactly one-half the values shown in the table above.
 - m. An air pressure correction is required when the prevailing ground water is above the sewer line being tested. Under this condition, the air test pressure must be increased 0.433 psi for each foot the ground water level is above the invert of the pipe.
 - n. Height of ground water above sewer pipe shall be determined by a method approved by the Engineer.
 - o. Any leaks in the system shall be repaired immediately upon discovery. Costs for repairing faulty work, including excavating and re-backfilling and for making tests, shall be paid for by the Contractor.
4. Safety Precautions:
- a. The low pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, a line is over pressurized or plugs are installed improperly. It is extremely important that the various plugs be installed to prevent the sudden expulsion of a poorly inflated plug. As an example of the hazard, a force of 250 pounds is exerted on an 8 inch plug by an internal pressure of 5 psi. Observe the following safety precautions.
 - 1) No one shall be allowed in the manholes during the test or when a plugged pipe is under pressure.
 - 2) Gauges, air piping manifolds, and valves shall be located at the top of the ground.
 - 3) Install and brace all plugs securely.
 - 4) Do not over pressurize the lines.
- C. Gravity Sewers – Water Testing:
- 1. Water testing will be by either the infiltration method or by the exfiltration method if approved by the Engineer. Testing for water-tightness shall be made by the Contractor in the presence of the Engineer. The Contractor shall provide all equipment, plugs, bulkheads, fittings, water, etc. needed for the testing. The water used for testing shall be paid for by the Contractor.
 - 2. The Engineer shall have the right to direct that either the infiltration or the exfiltration water testing be performed based on groundwater conditions at the time.

3. The tests and measurements of the infiltration method shall be as approved by the Engineer. In all cases, the pipeline shall not leak under exterior ground water pressure in excess of 100 gallons per inch of nominal pipe diameter per mile of pipe per 24 hours. Leaks causing any sewer to fail such test shall be repaired until infiltration meets the allowable limit.
4. If, in the opinion of the Engineer, the ground water table at the time of testing is too low to produce dependable infiltration measurement results, the Contractor shall perform the exfiltration method test. The allowable limit shall be as given above including any manholes in the section(s) being tested. Water required for exfiltration test shall be obtained at the Contractor's expense.
5. Where the exfiltration test method is used, the following shall apply:
 - a. The downstream end of the pipe section being tested shall be plugged and the plug shall be braced and blocked securely. No one shall be allowed to enter a manhole where a plugged pipe is under pressure. Any other pipe entrances to the upstream manhole shall likewise be securely plugged.
 - b. Only water from a source approved by the Engineer shall be used to perform the test. Waste water shall not be used to perform exfiltration testing.
 - c. Water shall be added through the upstream manhole of the line section being tested to a depth of 2.0 feet above the inside top of the outgoing pipe (or 2.0' above the ground water level - see d. below). The water shall be maintained at this level for 24 hours prior to beginning the exfiltration test measurement.
 - d. There shall be a minimum of 2.0' positive head above the inside top of the pipe at the high end of the section being tested. This means, if the ground water in the trench is at (or above) the top of the pipe, then the manhole shall be filled to a point at least 2.0' above the ground water level.
 - e. The test shall be conducted for two hours. The leakage shall be determined by the calculated change in total volume of water used in the test.

3.3 PIPE DEFLECTION TESTING

- A. General
 1. All PVC, FRP, and Ductile Iron gravity sewer lines shall be mandrel tested in accordance with these specifications prior to acceptance.
- B. Allowable Deflection:
 1. The maximum allowable pipe deflection shall not exceed 5 percent of the inside diameter.
- C. Mandrel:
 1. The mandrel shall be hand-pulled by the Contractor through all PVC, FRP, and Ductile Iron gravity sewer lines no earlier than 30 days after the trench has been completely backfilled. Any sections of the sewer not passing the mandrel shall be uncovered and the Contractor shall rebed, reround, or replace the sewer to the satisfaction of the Engineer. Any repaired section shall be retested after a sufficient time has elapsed to ensure that trench settlement has stopped. This retest time shall be totally dependent upon method of repair. If the trench has been opened, the retest shall have the same requirements as the original installation. If the pipe has been rerounded, retest shall not occur sooner than seven days after rerounding.
 2. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. The contact length of the mandrel's arms shall equal or exceed the nominal diameter of the sewer to be inspected. Critical mandrel dimensions shall carry a tolerance of plus or minus 0.01 inch. The mandrel and all necessary equipment for the mandrel test shall be provided by the Contractor.
 3. The Owner reserves the right to mandrel test any PVC, FRP, or Ductile Iron sewer pipe before acceptance, and also prior to expiration of the first year of operation. If a previously

accepted line fails a mandrel test performed during the first year of operation, the defects must be corrected at the Contractor's expense.

3.4 INSPECTION OF SERVICE LINES

- A. All building sewer lines shall be installed and tested in accordance with all state, regional, and local plumbing codes.
- B. All building sewer installations shall be inspected and approved by an authorized local governing agency inspector.
- C. Backfill may only be placed on the completed portions of a building sewer following inspection. No approval certificate shall be issued until all portions of a building sewer from the main connection to the building foundation have been inspected and approved by an authorized inspector. At the time of inspection, the pipe should be in place in the trench and "safed-up", but the top half of the pipe barrel exposed. No approval will be given for building sewers all or a portion of which are covered at the time of inspection.
- D. All building sewers are subject to testing to insure water tightness. All tests must be performed in the presence of the Engineer. Tests may be either by:
 - 1. Water Loss Test Procedure; or,
 - 2. Low Pressure Air Loss Procedure.
- E. If, in the opinion of the Engineer, the line in question is properly installed and free from open joints and breaks, building sewers constructed entirely of cast iron soil pipe may be connected to the sewer without testing.
- F. Water Loss Test Procedure
 - 1. Plug the section of line to be tested at the lower end and fill section with water so that at least four (4) feet of head is obtained.
 - 2. The maximum acceptable water loss while so filled is not more than 100 gallons per twenty-four hours per inch of pipe diameter per mile of pipe. This is approximately 3/16 gallon for a one hundred (100) foot long section of four (4) inch pipe tested thirty minutes.
- G. Low Pressure Air Loss Procedure
 - 1. Plug securely both ends of the line to be tested.
 - 2. Charge the line with air to a pressure of 4.5 psig.
 - 3. Allow at least five minutes for the temperature in the pipe to stabilize.
 - 4. Measure the time required for a one (1.0) psi drop in pressure.
 - 5. The minimum time for a one psi loss is $28.5 \times d$ seconds where d = the nominal diameter in inches of the pipe being tested.

3.5 MANHOLE TESTING

- A. Testing, Observations and Guarantee Period:
 - 1. The testing required shall be performed by the Contractor at all manholes and documented to the satisfaction of the Engineer.
 - 2. Testing shall not be performed on a specific manhole until all work has been completed for that specific manhole.
 - 3. Any manholes that are observed to be leaking by the Engineer shall be subject to additional repairs and retested by the Contractor at no additional cost to the Owner.
- B. Inflow Testing:
 - 1. All rehabilitated manholes and new manholes shall be dye tested. Manholes shall be dye water tested in the presence of the Engineer. The dye test shall consist of applying a

concentrated dye solution around the manhole frame. Dyed water shall be applied for at least ten (10) minutes.

2. Manholes observed to be actively leaking will have failed the test and will not be acceptable. Manholes failing the test will require additional rehabilitation by the Contractor at no additional compensation. The manhole shall then be retested as described above until a successful test is made.

C. Vacuum Testing:

1. All new and rehabilitated manholes shall be vacuum tested by the Contractor in the presence of the Engineer for sources of infiltration. Testing will be made during high groundwater conditions, wherever possible.
2. Manholes shall be tested after installation with all connections (existing and/or proposed) in place. Drop-connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond drop-connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. Plate type test heads that rest on top of the frame are also acceptable. A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off. With the valve closed, the level of vacuum shall be read after the required test time. If the drop in the level is less than 1-inch of mercury (final vacuum greater than 9 inches of mercury), the manhole will have passed the vacuum test. After a successful test, the temporary plugs will be removed. The required test time is determined from the table below.

Minimum Time Required for a Vacuum Drop of 1" H _g (10"H _g - 9"H _g) (min:sec)				
Depth of Manhole (ft.)	Manhole Inside Diameter (inches)			
	48"	60"	72"	96"
8'	:20	:26	:32	:45
10'	:25	:33	:40	1:00
12'	:30	:39	:48	1:07
14'	:35	:46	:57	1:18
16'	:40	:52	1:05	1:29
18'	:45	:59	1:13	1:40
20'	:50	1:05	1:21	1:52
22'	:55	1:12	1:29	2:03
24'	:60	1:19	1:37	2:14
26'	1:05	1:25	1:45	2:25
28'	1:10	1:32	1:53	2:36
30'	1:15	1:38	1:01	2:47
Add for each Additional 2'	:05	:07	:08	:11

3. Manhole vacuum levels observed to drop greater than 1-inch of mercury (Final vacuum less than 9 inches of mercury) will have failed the test and will require additional rehabilitation. The Contractor shall make the necessary repairs at no additional compensation for only those work items completed by the Contractor. The manhole shall then be retested as described above until a successful test is made.

3.6 PRESSURE TEST FOR FORCE MAINS

- A. Perform hydrostatic leakage tests for force mains by filling the force main with water and increasing the pressure to a testing pressure of 150% of the working pressure with a minimum of 100 psi.
- B. The duration of the leakage test shall be two hours or as specified by the Engineer.
- C. The force main will not be accepted until the actual leakage is equal to or less than the allowable. In addition, all obvious leaks shall be repaired.
- D. The allowable leakage rate per hour for ductile iron, PVC, FRP or concrete pipe shall be calculated by the following formula:

$$L = \frac{ND \times P^{.5}}{7400}$$

L = Allowable Leakage (gallons per hour)

N = Number of Joints in Pipeline Tested

D = Nominal Diameter (inches)

P = Test Pressure (psi)

3.7 SYSTEM COORDINATION

- A. Maintain existing sewer flow through new connecting manholes until new sewer is approved by Engineer.
- B. Reshape manhole bottom to divert sewer flow into new sewer after new sewer is approved by Engineer.
- C. Locate sewer services before completing the first manhole downstream from the sewer service.

END OF SECTION

SECTION 33 34 13 - DUCTILE IRON FORCE MAIN PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the Work necessary to completely furnish and install Ductile Iron force main pipe and fittings.
- B. Related sections:
 - 1. Section 31 23 16.16 – Trenching for Water and Sewer Lines.
 - 2. Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines.
 - 3. Section 33 31 23 – Testing Sanitary Sewer Systems.
 - 4. Section 33 39 13.13 – Pre-Cast Concrete Manholes.
 - 5. Section 33 41 19 – Pipe Laying.

1.2 GENERAL

- A. Like items of ductile iron pipe provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, and manufacturer's services.
- B. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- C. All pipe shall be circular and shall be of the sizes shown on the Plans and/or listed in the Unit Price Schedule. All pipe shall be new. Used pipe is prohibited.
- D. At the discretion of the Engineer, all pipe line and materials are subject to inspection and approval at the plant of the manufacturer.
- E. All materials shall equal or exceed the standards specified herein.
- F. During the process of unloading, all pipe materials shall be inspected by the Contractor and any damaged pipe set aside.
- G. After pipe lines are laid, the Contractor shall test for defects and leakage as specified in Section 33 31 23, TESTING SANITARY SEWER SYSTEMS of these specifications.
- H. Inspection of pipe at the manufacturer's plant, at the point of delivery, on the job site, or in place shall not relieve the Contractor of his responsibility and the material may be subject to rejection until final acceptance of the completed project.

1.3 SUBMITTALS

- A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.
- B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:
 - 1. Quality Control Submittals:
 - a. Pipe size, class, and thickness.
 - b. Special shipping, storage and protection, and handling instructions.
 - c. Test procedures.

- d. Test results, reports, and certifications.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Ductile iron force main pipe shall be provided to conform to materials of construction as specified herein.
- B. All force mains shall be installed with tracer wire as specified in Section 33 41 19, PIPE LAYING.
- C. Weights and Marking:
 - 1. Weights of pipe and fittings shall conform strictly to the requirements of ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe. Weights shall be plainly and conspicuously painted in white on the outside of each joint of pipe and each fitting after the exterior coating has hardened.
- D. Certification:
 - 1. The Contractor shall upon request furnish the Engineer with certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable ANSI Specifications for each.

2.2 DUCTILE IRON FORCE MAIN PIPE

- A. All pipe and pipe fittings furnished for underground sewer piping shall have either push-on or mechanical type joints.
- B. Flanged DIP and DI fittings shall be used only as indicated on the Plans. Flanged pipe and pipe fittings shall conform to ANSI/AWWA C115/21.15, Class 250 psi. Flanged drilling shall conform to ANSI B16.1, Class 125 flange.
- C. All DIP, 4-inch through 36-inch, shall conform to the requirements of ANSI/AWWA C150/A21.50 (Thickness Design of Ductile-Iron Pipe) and ANSI/AWWA C151/A21.51 (Ductile Iron, Centrifugally-Cast for Water).
- D. Ductile iron pipe for force mains shall have a minimum Pressure Class of 350.
- E. Standard laying lengths shall be 20 feet \pm 1 inch, unless otherwise specified.

2.3 FITTINGS FOR DUCTILE IRON FORCE MAIN

- A. All fittings over 3-inches shall be ductile iron, mechanical joint fittings and shall conform to the requirements of AWWA C153. All fittings shall have a minimum pressure rating of 350 pounds per square inch and shall be lightweight (compact) fittings unless otherwise shown on the Plans.
- B. All fittings shall be furnished with gaskets. MJ fittings shall also be furnished with bolts, nuts, and iron glands. All plugs, caps, tees, and bends deflecting 22-1/2° or more shall be provided with reaction backing.
- C. All casting and mating surfaces shall be smooth and of a workmanlike quality, free from cracks, holes, scale, shrinkage, distortion, grooves, scratches, and other defects. Fittings and other castings may be rejected if found to be unacceptable by the Engineer in accordance with these Specifications.

- D. Joints shall be mechanical joint, shall conform to AWWA C111, and shall be furnished with Mega-lug type retainer glands and gaskets.
- E. Special fittings shall be in accordance with the pipe manufacturer's recommendations and as approved by the Engineer.
- F. All fittings and appurtenances placed on sanitary sewer lines shall meet with the requirements of the type of pipe used and shall be installed in accordance with the manufacturer's recommendations and as approved by the Engineer.
- G. Connections between different kinds of pipe shall be detailed on the Plans and provide self-cleansing sanitary flow and watertight joints and connections.
- H. All fittings shall be fusion-bonded epoxy coated inside and outside in accordance with ANSI/AWWA C116/A21.16.
- I. All valves and fittings (including in-line valves) shall have Megalug style retainer glands or approved equal. Valves, bends, reducers and other hardware near bends shall be positively bolted, all-threaded, or mechanically joined to each other. Bolted includes single and double flanged adapters (such as Foster Adapters or Swivel Adapters) which provide a solid bolted or mechanical joint type connection.

2.4 DUCTILE IRON PIPE JOINTS

- A. Joints shall be mechanical joints (MJ) or push-on type joints which conform to ANSI/AWWA C111/A21.11 (Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings), unless otherwise specified.
- B. Joints shall have the same pressure rating of the pipe or fittings of which they are a part.
- C. All pipe joints other than those specified herein shall be made in strict accordance with the manufacturer's recommendations and as approved.
- D. All joints shall be made watertight in accordance with the latest applicable AWWA and ASTM standards.

2.5 GASKETS FOR DUCTILE IRON JOINTS AND FITTINGS

- A. Gaskets shall be made of vulcanized styrene butadiene rubber (SBR).
- B. Gaskets shall be marked for nominal pipe size, manufacturer, and year of manufacture.
- C. Gaskets shall comply with the requirements of AWWA C111 (Rubber-Gasket joints for Ductile Iron Pressure Pipe and Fittings).

2.6 DUCTILE IRON JOINT AND FITTING LUBRICANT

- A. Lubricant shall be provided by the pipe manufacturer and applied as per the manufacturer's recommendations in accordance with ANSI/AWWA C111/A21.11 (Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings).
- B. Lubricant shall be non-toxic, not support the growth of bacteria and have no deteriorating effects on the gasket or pipe material.
- C. Lubricant containers shall be appropriately identified and labeled with the manufacturer's name.

- D. Each lubricant container shall have printed instructions for usage and joint assembly.

2.7 COATINGS

A. Interior Coatings

1. All ductile iron pipe for force mains shall receive the following interior lining treatment:
 - a. Epoxy Lining
 - 1) All DIP and DI fittings shall be lined with a high-build, multi-component amine-cured novalac epoxy lining, containing at least 20% ceramic quartz pigment, by volume.
 - 2) The lining system shall be Protecto 401 Ceramic Epoxy as manufactured by Vulcan Painters, Inc.
 - 3) The lining Applicator shall have a successful history of applying linings to the interior of DIP.
 - b. Condition of Ductile Iron Prior to Surface Preparation
 - 1) All DIP and DI fittings shall have a high-build protective lining on the interior. All DIP and DI fittings shall be delivered to the application facility without any lining on the interior surface. As removal of old linings may not be possible, the intent of this Specification is that the entire interior of DIP and DI fittings shall not have been lined with any substance prior to the application of the lining specified herein.
 - c. Surface Preparation
 - 1) Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, and other substances. Any areas where oil, grease, or another substance is detected and can be removed by solvent shall be solvent-cleaned using the guidelines outlined in SSPC-SP-1 (Solvent Cleaning).
 - 2) After the surface has been made free of grease, oil, and other substances, all areas to receive the protective compounds shall be abrasive blasted with sand or grit abrasive media.
 - 3) The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, and other sources of roughness shall be removed from the surface. If rust reappears before coating, the affected areas must be reblasted.
 - d. Lining
 - 1) Within eight (8) hours after surface preparation, the interior of the pipe shall receive approximately 40 mils dry film thickness of the protective lining.
 - 2) Lining shall not occur if the substrate or ambient temperature is below 40° F.
 - 3) The surface shall be dry and dustfree before lining.
 - 4) The linings shall not be used on the face of any flanged pipe or fitting, unless otherwise specified.
 - 5) All fittings shall be lined with approximately 40 mils of the protective lining. The 40 mils system shall not be applied in the gasket grooves.
 - e. Coating Gasket and End Spigots
 - 1) Due to the tolerances involved, the gasket area and exterior spigot end, up to six (6) inches back from the end of the spigot end, must be coated with 6 mils nominal, 10 mils maximum Protecto Joint Compound, or approved equal.
 - 2) This coating shall be applied by brush to ensure coverage. Care shall be taken so the coating is smooth, without excess buildup in the gasket groove or on the spigot end.
 - 3) All materials for the gasket groove and spigot end shall be applied after the application of the lining.
 - f. Number of Coats
 - 1) The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied

above the dry thickness per coat recommended by the lining manufacturer in printed literature. The time between coats shall never exceed that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely recoatable without roughening of the surface.

- g. Touchup and Repair
 - 1) Protecto Joint Compound, or approved equal, shall be used for touchup or repair. Procedures for touchup and repair shall be in accordance with manufacturer's recommendations.
- h. Inspection and Certification
 - 1) Inspection
 - a) All DIP and DI fitting linings shall be checked for thickness using a magnetic film thickness gage. The thickness testing shall be as set forth in SSPC-PA-2 (Measurement of Dry Coating Thickness with Magnetic Gages).
 - b) The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects shall be repaired prior to shipment.
 - c) Each pipe joint and fitting shall be marked with the date of application of the lining system and the numerical sequence of application on that date.
 - 2) Certification
 - a) The pipe or fitting manufacturer shall supply a certificate attesting that the Applicator met the requirements of these Specifications, the material used was as specified, and the material was applied as required.

B. Exterior Coatings

- 1. All ductile iron pipe shall have an exterior coating as set forth below.
 - a. Factory Primed Pipe
 - 1) Unless otherwise shown on the Plans, all exposed pipe and fittings within the limits of structure walls or exposed pipe and fittings located aboveground shall be delivered to the job site factory-blasted, cleaned, and primed with one (1) coat of Tnemec Series N140 Pota-Pox Plus, or approved equal compatible paint system.
 - b. Bituminous Coating
 - 1) All pipe and fittings indicated for buried service shall have a petroleum asphaltic coating approximately one (1) mil thick factory-applied to the outside of all pipe and fittings. The finished coating shall be continuous, smooth, neither brittle when exposed to the cold nor sticky when exposed to the sun, and shall be strongly adherent to the pipe or fitting. The bituminous coating shall not be applied to the first six (6) inches of the exterior of the spigot ends.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipe and fittings shall be installed in accordance with these specifications and the Plans.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.
- B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

- C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.3 FIELD QUALITY CONTROL

- A. Contractor shall visually inspect all pipe and fittings upon delivery and set aside and damaged or flawed materials and shall not install any damaged or flawed material.
- B. Contractor shall test for defects and leakage as specified in Section 33 31 23, TESTING SANITARY SEWER SYSTEMS.

3.4 INSTALLATION

- A. Installation shall be as specified in Section 33 41 19, PIPE LAYING.
- B. Pipe trenching shall be as specified in Section 31 23 16.16, TRENCHING FOR WATER AND SEWER LINES.
- C. Pipe bedding and backfill shall be as specified in Section 31 23 23.19, TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES.
- D. Pipe connections to concrete manholes and other concrete structures shall be as specified in Section 33 39 13.13, PRE-CAST CONCRETE MANHOLES.

END OF SECTION

SECTION 33 39 13.13 – PRECAST CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work for the construction of pre-cast manholes. The Contractor shall be responsible for the correct final elevations and slopes of manholes and the proper setting and elevations of manhole rings and covers.
- B. General Requirements:
 - 1. Manholes of different diameters are required on this project. See the Plans for manhole locations and sizes.
 - 2. The top surface of the barrel shall be constructed truly plumb and level, except where located within roadway limits where it shall match existing slopes and grades, and shall have a light broom finish. There shall be no exposed aggregate on the top edge of the barrel.
 - 3. Manholes where the top elevation is greater than 2-feet above adjacent ground shall use frames and covers conforming to Paragraph 2.5 of this specification. Manholes where the top elevation is less than 2-feet above adjacent ground shall use frames and covers conforming to either Paragraph 2.4 or 2.5 of this specification, at the Contractor's discretion.
- C. Related Sections:
 - 1. Section 01 11 00 – Summary of Work
 - 2. Section 03 30 00 – Cast-In-Place Concrete
 - 3. Section 03 60 00 - Grout
 - 4. Section 09 97 26.13 – Interior Coatings
 - 5. Section 09 97 26.23 – Exterior Coatings
 - 6. Section 31 23 16 – Excavation
 - 7. Section 31 22 19 - Grading
 - 8. Section 31 23 23.13 – Fill and Backfill
 - 9. Section 33 31 23 – Testing Sanitary Sewer Systems

1.2 QUALITY ASSURANCE:

- A. Manhole testing is specified in Section 33 31 23, TESTING SANITARY SEWER SYSTEMS.
- B. Concrete testing is specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

1.3 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (ASTM) latest edition.
 - 1. ASTM A48, Standard Specification for Gray Iron Castings
 - 2. ASTM C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
 - 3. ASTM C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 - 4. ASTM C478, Standard Specification for Precast Reinforced Concrete Manhole Sections
 - 5. ASTM D1248, Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable

1.4 SUBMITTALS

- A. Section 01 33 00, SUBMITTAL PROCEDURES: Procedures for submittals.

- B. Certificates: Certify that products meet or exceed specified requirements.
- C. Submit design calculations supporting reinforcing, thicknesses, and dimensions proposed for use on this project.

PART 2 - PRODUCTS

2.1 PRE-CAST MANHOLES

- A. Pre-cast manholes shall conform to ASTM C478 – Standard Specifications for Pre-Cast Reinforced Concrete Manhole Sections
- B. The top section shall be an eccentric cone section conforming to ASTM C478.
- C. All manhole joints exposed to soil shall be sealed with an external joint wrap material, six (8) inch minimum width, material shall be Infi-Shield Seal Wrap as manufactured by Sealing Systems Inc. or approved equal. Manhole joints not exposed to soil shall be patched with concrete.
- D. Integral pre-cast floors shall be allowed, subject to the approval of Engineer. Cast-in-place floors shall be allowed.
- E. Inverts may be pre-cast or field formed into the base section of the manhole, but in either case, shall meet the proper sewer line gradient and alignment shown in the Plans.
- F. Precast concrete manhole sections shall not be delivered to the site until the sections are at least ten (10) days old. Two lift holes shall be cast into each cone or riser section for the purpose of handling and placing. The Contractor shall provide and install water plugs into lift holes after laying the sections.
- G. Cutouts in the bottom sections shall be appropriate for the pipe being laid.
 - 1. Bottom sections shall have clear identifying markings to assure their being used in the right locations.
 - 2. Suitable openings for the inlet and outlet pipe shall be cored into the base section (and into the riser sections for drop or "pass-through" manholes).
 - 3. These openings shall be true size, circular and located as needed to maintain the proper sewer gradient for each manhole.
- H. Manufactured pipe-to-manhole connectors shall be installed at each opening to assure a flexible watertight seal of the pipe to the manhole.
 - 1. The connector shall be specifically designed for the pipe material and size being utilized on the project.
 - 2. No adhesives or lubricants shall be employed in the installation of the connector into the manhole.
 - 3. All stainless steel parts of the connector shall be totally non-magnetic Series 304 Stainless except the worm screw for tightening the steel band which shall be Series 305 Stainless. The worm screw shall be torqued by a break-away type torque wrench set for 60 – 70 in/lbs.
 - 4. The connector shall be installed in the manhole so that it shall have a minimum cover of 3-inches of concrete at all points and in strict accordance with the manufacturer's recommendations.
- I. Each manhole shall be made up with as few risers as possible. The joints between risers shall be leak proofed with a mechanical water stop seal as approved by the Engineer and meeting the requirements of ASTM C443 and C361. There shall be a suitable spigot cast into the

tongue of each component to contain the seal. The seal shall consist of a supporting compression section and a thin sliding flap which has been pre-lubricated. When the sections are fitted together, the edge of the bell shall encounter the flap which then slides towards the compression section.

- J. No more than 8 inches of concentric rings shall be allowed to bring the manhole to finished grade.

2.2 INVERTS

- A. Inverts shall be formed as shown on the detail drawings to the grades specified. Manholes with inverts not conforming to these grades may be subject to removal and replacement at the Contractor's expense.
- B. Concrete for inverts shall be Class A as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.3 STEPS

- A. Manhole steps are not required and will not be accepted.

2.4 NON-BOLTED FRAMES AND COVERS

- A. Frames:
 - 1. Frame material shall be cast iron or ductile iron conforming to ASTM A48, Class 35 or better. The frame shall exhibit a tensile strength of not less than 35,000 psi.
 - 2. Frames for standard manholes shall be Deeter 1266 for non-traffic areas and Deeter 1235-A for traffic areas, or approved equal(s), and shall have 4 - 3/4-inch diameter holes drilled in the bottom flange. The holes shall be centered in the flange and shall be equally spaced 90-degrees apart.
 - 3. Bearing surfaces between the ring and cover shall be machine finished or ground to assure nonrocking fit in any position, and interchangeability.
- B. Covers:
 - 1. The cover shall form a water resistant seal between the frame and manhole cover surface. The cover shall have concealed pick holes and a machined bearing surface on the bottom of the casting. The cover shall conform to ASTM A48, Class 35 or better, for Gray Iron. The cover shall have a tensile strength of 35,000 psi.
 - 2. A typical standard manhole cover design shall be Deeter 1266 for non-traffic areas and Deeter 1235-A for traffic areas, or approved equal(s).
 - 3. Covers shall set flush with the rim of the frame and shall have no larger than a 1/8-inch gap between the frame and cover.
 - 4. Bearing surfaces shall be machine finished.
 - 5. Lids shall have "SANITARY SEWER" cast on the surface.
- C. Watertight Manhole Inserts

This standard covers the furnishing and installation of watertight gasketed manhole inserts in the sanitary sewer collection system.

- 1. Materials (Stainless Steel)
 - a. Stainless steel inserts shall be installed at locations with outfall pipe diameters greater than 15-inches and as directed by the Engineer.
 - b. Stainless steel inserts shall be TETHERLOK stainless steel Rainstopper by Southwestern Packing and Seals, Inc., or approved equivalent.
 - c. Insert shall be constructed of 304 stainless steel

2.5 HINGED MANHOLE FRAMES AND COVERS

- A. Covers and frames shall conform to ASTM A48, Class 35 or better, for Gray Iron or equivalent ISO standard. Contractor shall provide verification of equivalency.
- B. Covers shall be hinged and incorporate a 90-degree blocking system to prevent accidental closure.
- C. Covers shall be one man operable using standard tools.
- D. Frames shall be circular with a 22-inch clear opening.
- E. The frame depth shall not exceed 4-inches, and the flange shall incorporate bedding slots, bolt holes and lifting eyes.
- F. Lids shall be lockable and lock/unlock hardware and tools shall be provided with each lid.
- G. Lids shall have "SANITARY SEWER" cast on the surface.

2.6 COATING

- A. The manhole shall be coated as specified in Section 09 97 26.13, INTERIOR COATINGS and Section 09 97 26.23, EXTERNAL COATINGS.

2.7 MANHOLE FRAME SEALS:

- A. The material for the seals between the frames and concrete shall be a bitumastic gasket material, meeting or exceeding ASTM C990. Bitumastic gasket material shall be Ram-Nek, EZ-STIK, or approved equal.

2.8 PIPE CONNECTIONS

- A. Manufactured pipe-to-manhole connectors shall be installed at each opening to assure a flexible watertight seal of the pipe to the manhole.
- B. The connector shall be capable of a 7-degree pipe deflection after installation without loss of sealing.
- C. The connector shall be manufactured expressly for embedment in the wall of concrete manholes and shall be specifically designed for the pipe material and size being utilized on the project.
- D. No adhesives or lubricants shall be employed in the installation of the connector into the manhole.
- E. All stainless steel parts of the connector shall be totally non-magnetic Series 304 Stainless except the worm screw for tightening the steel band which shall be Series 305 Stainless. The worm screw shall be torqued by a break-away type torque wrench set for 60 – 70 in/lbs.
- F. The connector shall be installed in the manhole so that it shall have a minimum cover of 3-inches of concrete at all points and in strict accordance with the manufacturer's recommendations.

2.9 STRUCTURAL GROUT

- A. Grout proposed for use to adjust manhole rings to critical grades, such as those located in streets or parking lots, shall conform to Section 03 60 00, GROUT.

PART 3 - EXECUTION

3.1 MANHOLE CONSTRUCTION

- A. Excavate to planned depth in accordance with Section 31 23 16, EXCAVATION.
- B. Place and compact 8-inches of Type A aggregate.
- C. Place concrete base.
- D. Place pre-cast manhole in accordance with manufacturer's recommendations, plumb, and to grade.
- E. Plug lifting holes on inside and outside. Grout lift holes on both sides.
- F. Manhole ring may be cast into top section or may be cast-in-place.
- G. Place concrete and form invert.
- H. Bolt manhole frame to manhole as shown in details.
- I. Install exterior manhole coating.
- J. Backfill in accordance with Section 31 23 23.13, FILL AND BACKFILL.
- K. Test manhole in accordance with Section 33 31 23.
- L. Install manhole coating in accordance with Section 09 97 26.13, INTERIOR COATINGS and Section 09 97 26.23, EXTERNAL COATINGS.
- M. Clean the manhole frame of all dirt and debris before placing the manhole insert on the rim. The manhole insert shall be fully seated around the manhole frame rim to retard water from seeping between the cover and the manhole frame rim.

END OF SECTION

SECTION 33 41 16 - DUCTILE IRON GRAVITY SEWER PIPE AND FITTINGS

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. This section includes the Work necessary to completely furnish and install Ductile Iron gravity sewer pipe and fittings.

1.2 RELATED SECTIONS

- A. 31 23 16.16 – Trenching for Water and Sewer Lines
- B. 31 23 23.16 - Trench Backfill
- C. 33 31 23 - Testing Sanitary Sewer Systems
- D. 33 39 13.13 – Pre-Cast Concrete Manholes
- E. 33 41 13 – Pipe Laying

1.3 GENERAL

- A. Like items of ductile iron pipe provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, and manufacturer's services.
- B. General Requirements: See Division 1, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- C. All pipe shall be circular and shall be of the sizes shown on the Plans and/or listed in the Unit Price Schedule. All pipe shall be new. Used pipe is prohibited.
- D. At the discretion of the Engineer, all pipe line and materials are subject to inspection and approval at the plant of the manufacturer.
- E. All materials shall equal or exceed the standards specified herein.
- F. During the process of unloading, all pipe materials shall be inspected by the Contractor and any damaged pipe set aside.
- G. After pipe lines are laid, the Contractor shall test for defects and leakage as specified in Section 33 31 23, TESTING SANITARY SEWER SYSTEMS of these specifications.
- H. Inspection of pipe at the manufacturer's plant, at the point of delivery, on the job site, or in place shall not relieve the Contractor of his responsibility and the material may be subject to rejection until final acceptance of the completed project.

1.4 SUBMITTALS

- A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

- B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:
 - 1. Quality Control Submittals:
 - a. Pipe size, class, and thickness.
 - b. Special shipping, storage and protection, and handling instructions.
 - c. Test procedures.
 - d. Test results, reports, and certifications.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Ductile iron gravity sewer pipe shall be provided to conform to materials of construction as specified herein.

2.2 DUCTILE IRON GRAVITY SEWER PIPE

- A. All pipe and pipe fittings furnished for underground sewer piping shall have either push-on or mechanical type joints.
- B. Flanged DIP and DI fittings shall be used only as indicated on the Plans. Flanged pipe and pipe fittings shall conform to ANSI/AWWA C115/21.15, Class 250 psi. Flanged drilling shall conform to ANSI B16.1, Class 125 flange.
- C. All DIP, 8 inch through 36 inch, shall conform to the requirements of ANSI/AWWA C150/A21.50 (Thickness Design of Ductile-Iron Pipe) and ASTM A746 (Ductile Iron Gravity Sewer Pipe) or ANSI/AWWA C151/A21.51 (Ductile Iron, Centrifugally-Cast for Water).
- D. The minimum acceptable size of all gravity sewer mains shall be eight (8) inches.
- E. DIP and DI fittings shall be designed by the pipe manufacturer based on laying condition Type 5, with an additional four (4) inches initial backfill above the top of the pipe, as described in ANSI/AWWA C150/A21.50, and the depth of bury as shown on the Plans, plus a single AASHTO H20 truck load.
- F. Pipe shall be designed for a thickness class of no less than Special Class 50. The pipe manufacturer shall check for depth of bury and furnish pipe of a heavier class if needed, in accordance with ANSI/AWWA C150/A21.50.
- G. Standard laying lengths shall be 20 feet \pm 1 inch, unless otherwise specified.

2.3 FITTINGS FOR DUCTILE IRON GRAVITY SEWER

- A. All fittings over 3-inches shall be ductile iron, mechanical joint fittings and shall conform to the requirements of AWWA C153. All fittings shall have a minimum pressure rating of 350 pounds per square inch and shall be lightweight (compact) fittings unless otherwise shown on the Plans.
- B. All fittings shall be furnished with gaskets. MJ fittings shall also be furnished with bolts, nuts, and iron glands. All plugs, caps, tees, and bends deflecting 22-1/2° or more shall be provided with reaction backing.
- C. All casting and mating surfaces shall be smooth and of a workmanlike quality, free from cracks, holes, scale, shrinkage, distortion, grooves, scratches, and other defects. Fittings and other

castings may be rejected if found to be unacceptable by the Engineer in accordance with these Specifications.

- D. A wye shall be installed for each anticipated future connection of sewer service.
- E. Joints shall be mechanical joint, shall conform to AWWA C111, and shall be furnished with Mega-lug type retainer glands and gaskets.
- F. Special fittings shall be in accordance with the pipe manufacturer's recommendations and as approved by the Engineer.
- G. All fittings and appurtenances placed on sanitary sewer lines shall meet with the requirements of the type of pipe used and shall be installed in accordance with the manufacturer's recommendations and as approved by the Engineer.
- H. Connections between different kinds of pipe shall be detailed on the Plans and provide self-cleansing sanitary flow and watertight joints and connections.

2.4 DUCTILE IRON PIPE JOINTS

- A. Joints shall be mechanical joints (MJ) or push-on type joints which conform to ANSI/AWWA C111/A21.11 (Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings), unless otherwise specified.
- B. Joints shall have the same pressure rating of the pipe or fittings of which they are a part.
- C. All pipe joints other than those specified herein shall be made in strict accordance with the manufacturer's recommendations and as approved.
- D. All joints shall be made watertight in accordance with the latest applicable AWWA and ASTM standards.

2.5 GASKETS FOR DUCTILE IRON JOINTS AND FITTINGS

- A. Gaskets shall be made of vulcanized styrene butadiene rubber (SBR).
- B. Gaskets shall be marked for nominal pipe size, manufacturer, and year of manufacture.
- C. Gaskets shall comply with the requirements of AWWA C111 (Rubber-Gasket joints for Ductile Iron Pressure Pipe and Fittings).

2.6 DUCTILE IRON JOINT AND FITTING LUBRICANT

- A. Lubricant shall be provided by the pipe manufacturer and applied as per the manufacturer's recommendations in accordance with ANSI/AWWA C111/A21.11 (Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings).
- B. Lubricant shall be non-toxic, not support the growth of bacteria and have no deteriorating effects on the gasket or pipe material.
- C. Lubricant containers shall be appropriately identified and labeled with the manufacturer's name.
- D. Each lubricant container shall have printed instructions for usage and joint assembly.

2.7 COATINGS

A. Interior Coatings

1. All DIP, fittings, valves, service wyes, and other appurtenances for gravity sewer or force mains shall receive the following interior lining treatment:
 - a. Epoxy Lining
 - 1) All DIP and DI fittings shall be lined with a high-build, multi-component amine-cured novalac epoxy lining, containing at least 20% ceramic quartz pigment, by volume.
 - 2) The lining system shall be Protecto 401 Ceramic Epoxy as manufactured by Vulcan Painters, Inc.
 - 3) The lining Applicator shall have a successful history of applying linings to the interior of DIP.
 - b. Condition of Ductile Iron Prior to Surface Preparation
 - 1) All DIP and DI fittings shall have a high-build protective lining on the interior. All DIP and DI fittings shall be delivered to the application facility without any lining on the interior surface. As removal of old linings may not be possible, the intent of this Specification is that the entire interior of DIP and DI fittings shall not have been lined with any substance prior to the application of the lining specified herein.
 - c. Surface Preparation
 - 1) Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, and other substances. Any areas where oil, grease, or another substance is detected and can be removed by solvent shall be solvent-cleaned using the guidelines outlined in SSPC-SP-1 (Solvent Cleaning).
 - 2) After the surface has been made free of grease, oil, and other substances, all areas to receive the protective compounds shall be abrasive blasted with sand or grit abrasive media.
 - 3) The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, and other sources of roughness shall be removed from the surface. If rust reappears before coating, the affected areas must be reblasted.
 - d. Lining
 - 1) Within eight (8) hours after surface preparation, the interior of the pipe shall receive approximately 40 mils dry film thickness of the protective lining.
 - 2) Lining shall not occur if the substrate or ambient temperature is below 40° F.
 - 3) The surface shall be dry and dustfree before lining.
 - 4) The linings shall not be used on the face of any flanged pipe or fitting, unless otherwise specified.
 - 5) All fittings shall be lined with approximately 40 mils of the protective lining. The 40 mils system shall not be applied in the gasket grooves.
 - e. Coating Gasket and End Spigots
 - 1) Due to the tolerances involved, the gasket area and exterior spigot end, up to six (6) inches back from the end of the spigot end, must be coated with 6 mils nominal, 10 mils maximum Protecto Joint Compound, or approved equal.
 - 2) This coating shall be applied by brush to ensure coverage. Care shall be taken so the coating is smooth, without excess buildup in the gasket groove or on the spigot end.
 - 3) All materials for the gasket groove and spigot end shall be applied after the application of the lining.
 - f. Number of Coats

- 1) The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The time between coats shall never exceed that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely recoatable without roughening of the surface.
- g. Touchup and Repair
 - 1) Protecto Joint Compound, or approved equal, shall be used for touchup or repair. Procedures for touchup and repair shall be in accordance with manufacturer's recommendations.
- h. Inspection and Certification
 - 1) Inspection
 - a) All DIP and DI fitting linings shall be checked for thickness using a magnetic film thickness gage. The thickness testing shall be as set forth in SSPC-PA-2 (Measurement of Dry Coating Thickness With Magnetic Gages).
 - b) The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects shall be repaired prior to shipment.
 - c) Each pipe joint and fitting shall be marked with the date of application of the lining system and the numerical sequence of application on that date.
 - 2) Certification
 - a) The pipe or fitting manufacturer shall supply a certificate attesting that the Applicator met the requirements of these Specifications, the material used was as specified, and the material was applied as required.

B. Exterior Coatings

1. All DIP and DI fittings shall have an exterior coating as set forth below.
 - a. Factory Primed Pipe
 - 1) Unless otherwise shown on the Plans, all exposed pipe and fittings within the limits of structure walls or exposed pipe and fittings located aboveground shall be delivered to the job site factory-blasted, cleaned, and primed with one (1) coat of Tnemec Series N140 Pota-Pox Plus, or approved equal compatible paint system.
 - b. Bituminous Coating
 - 1) All pipe and fittings indicated for buried service shall have a petroleum asphaltic coating approximately one (1) mil thick factory-applied to the outside of all pipe and fittings. The finished coating shall be continuous, smooth, neither brittle when exposed to the cold nor sticky when exposed to the sun, and shall be strongly adherent to the pipe or fitting. The bituminous coating shall not be applied to the first six (6) inches of the exterior of the spigot ends.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipe and fittings shall be installed in accordance with these specifications and the Plans.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.
- B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.3 FIELD QUALITY CONTROL

- A. Contractor shall visually inspect all pipe and fittings upon delivery and set aside and damaged or flawed materials and shall not install any damaged or flawed material.
- B. Contractor shall test for defects and leakage as specified in Section 33 31 23, TESTING SANITARY SEWER SYSTEMS.

3.4 INSTALLATION

- A. Installation shall be as specified in Section 33 41 13, PIPE LAYING.
- B. Pipe trenching shall be as specified in Section 31 23 16.13, TRENCHING FOR WATER AND SEWER LINES.
- C. Pipe bedding and backfill shall be as specified in Section 31 23 23.19, TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES.
- D. Pipe connections to concrete manholes and other concrete structures shall be as specified in Section 33 39 13.13, PRE-CAST CONCRETE MANHOLES

END OF SECTION

SECTION 33 41 19 – PIPE LAYING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: the Work necessary to install gravity sewer, force main pipe, water pipe and appurtenances.
- B. Related sections:
 - 1. Section 01 60 00 – Product Requirements
 - 2. Section 31 23 23.19 – Trench Bedding and Backfill for Water and Sewer Lines
 - 3. Section 33 31 23 – Testing Sanitary Sewer Systems
 - 4. Section 33 39 13.13 – Pre-Cast Concrete Manholes
 - 5. Section 33 34 13 – Ductile Iron Force Main Pipe and Fittings
 - 6. Section 33 41 16 – Ductile Iron Gravity Sewer Pipe and Fittings

1.2 GENERAL

- A. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All pipe materials shall be as specified on the Plans and conforming to these specifications.

2.2 WARNING TAPE

- A. Non-metallic sanitary sewer marking tape shall be warning tape as manufactured by Rhino Marking and Protection Systems, Harris Industries, Inc., or approved equal.
- B. Tape shall have a minimum thickness of 4 mils and manufactured with heavy metal-free polyethylene tape that is impervious to all known alkalis, acids, chemical reagents, and solvents found in soil. The minimum overall width of the tape shall not be less than 3-inches. Standard rolls shall be 1000' length.
- C. The tape for sewer lines shall be color coded Green and imprinted with the following message: Caution Buried Sewer Line Below.
- D. The tape for water lines shall be color coded Blue and imprinted with the following message: Caution Buried Water Line Below.

2.3 TRACER WIRE

- A. Tracer wire shall be 12-gauge, stranded coated copper for underground burial.
- B. Jacket color shall be GREEN and made of High Density Polyethylene (HDPE) or High Molecular Weight Polyethylene (HMWPE) designed for direct burial.
- C. Connectors shall be used for all splices or repairs. Connectors shall be moisture displacement style as manufactured by 3M DBR, or equal.

- D. A locate or conductivity test shall be performed prior to signing off on the project.

2.4 PIPE BEDDING AND BACKFILL

- A. Shall be in accordance with 31 23 23.19, TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipe, fittings, bedding, backfill, and all other appurtenances shall be installed in accordance with these specifications and the Plans.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.
- B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
- D. Pipe and accessories shall be handled in such a manner that will ensure their condition after installation to be sound and undamaged. Equipment, tools and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that they are not damaged. Under no circumstances shall loading forks, or other equipment, be inserted into the barrel of the pipe or fitting.
- E. Pipe having pre-molded joint rings shall be handled in such a manner that no weight, including the weight of the pipe itself, will bear on or be supported by the spigot rings at any time. Care shall be taken to avoid dragging the spigot ring on the ground or allowing it to come in contact with gravel, crushed stone, rocks, or other hard objects. Joint rings which have been damaged in any way will not be accepted and shall not be incorporated in the work.

3.3 FIELD QUALITY CONTROL

- A. Provide skilled workmen to insure embedment of pipe.
- B. Contractor shall test for defects and leakage as specified in Section 33 31 23, TESTING SANITARY SEWER SYSTEMS.

3.4 TRACE WIRE

- A. Regardless of pipe material, a trace wire shall be laid on top of the pipe and shall be looped around the pipe at least once every 10-feet and connected to all valves and fittings. At valves, the trace wire shall be brought up into the valve box as indicated in the plans. A tracing test of trace wire will be required prior to final acceptance.

3.5 PIPE DETECTION TAPE

- A. Pipe detection tape shall be provided in all trenches for force main and water line construction. Installation shall be per manufacturer's recommendations and shall be as close as practical to

finished grade while maintaining a required minimum of 18 inches between the detection tape and the top of any pipe.

3.6 LAYING PIPE

- A. Proper means and equipment shall be used for lowering pipe into the trenches.
- B. The Contractor shall have full responsibility for any diversion of drainage and for dewatering trenches.
- C. Recesses for the pipe bells are mandatory and shall be hand excavated so that the entire pipe barrel is uniformly supported by the bedding material.
- D. Pipe shall be protected from lateral displacement by means of pipe embedment material installed as provided in this specification. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.
- E. When jointed in the trench, the pipe shall form a true and smooth line. Pipe shall not be trimmed except for closures, and pipe not making a good fit shall be removed.
- F. Unless otherwise approved by the Engineer, the laying of pipe shall begin at the lowest point, and the pipe shall be installed so that the spigot ends point in the direction of flow.
- G. Pipe which is a part of a gravity sewer line shall be aligned and constructed to grades as shown on the plans. Lines not conforming to these grades shall be subject to removal and replacement at the Contractor's expense. Force main pipe shall match the horizontal alignment and shall closely match the grades shown on the plans.
- H. Pipe lines or runs intended to be straight shall be laid straight.
- I. During installation, each pipe and fitting shall be inspected for defects. All defective, damaged, or unsound pipe and fittings shall be rejected and removed from the site of the work.
- J. Dependent on type of application, gravity or pressure, place thrust blocking at all pipe fittings, including bends and reducers, as shown on the Plans.
- K. Prior to joining the pipe, the plain ends of the pipe and the bells of the pipe shall be thoroughly cleaned using a soapy water and cloth, removing all foreign materials from the bells, especially the gasket seats. Any burrs or imperfections in that part of the plain end or bell which will be in contact with the gasket shall be removed.
- L. The clean gasket shall be inserted in the bell and a thin film of lubricant shall be applied to the inside surface of the gasket.
- M. The cleaned plain end shall initially be entered in the bell straight. The plain end shall be forced inside the gasket and bell until the limit mark is just visible. The pipe may then be deflected as allowed by the manufacturer.
- N. Lubricants shall be supplied by the pipe manufacturer in sufficient quantities. No substitutes shall be made.
- O. The Contractor shall furnish such jacks, or other devices as are necessary for forcing the pipe into the bell and gasket. Care shall be exercised to avoid damage to the pipe where the pushing device or machine part contacts the pipe. A wood block or suitable pad shall be placed between the pipe and that part of the pushing device which contacts the pipe.

- P. All plain ends that enter a push on bell shall be beveled at 30° for at least one eighth (1/8) inch. All cut pieces or ends of pipe of other classifications shall be so beveled.

3.7 PIPE BEDDING DUCTILE IRON PIPE

- A. Bedding material shall be as specified in Section 31 23 23.19, TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES.
- B. Place 6-inches, minimum, of bedding between excavated trench bottom or stabilized trench bottom and bottom of pipe or fitting. Provide depression in bedding for joints so that barrel of pipe or fitting rests on bedding. Place bedding in 6-inch maximum layers, compacted to 95% standard maximum density, to a minimum total depth of 3/4 (75%) of the outside diameter of the pipe as indicated on the drawings.
- C. Bedding is considered to be an integral part of the pipe installation. Therefore particular care shall be given to insure that bedding is in intimate contact with the pipe in all directions and that no portion of the bedding shall be compacted to less than the specified density, particularly the area below the springline of the pipe.
- D. For areas undercut, whether by Contractor's negligence or by direction of Engineer, provide and place crushed aggregate, compacted to 95% standard maximum density, to bottom elevation of pipe bedding.
- E. When used, the bottom of trench boxes will be above the level of pipe bedding before bedding is compacted. In no case will pipe bedding be compacted against the trench box or before the trench box is raised to allow compaction of bedding.

3.8 TRENCH BACKFILL

- A. Shall be as specified in Section 31 23 23.19, TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES.

3.9 ALIGNMENT AND GRADE

- A. All pipe shall be laid straight between changes in alignment, except as shown on the Plans, and at a uniform grade between changes in grade. All lines shall be laid so that each section between manholes will lamp.

3.10 JOINTING

- A. Boltless gasketed joints: All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations, shall be observed and followed by the Contractor. All joint surfaces shall be lubricated as recommended by the manufacturer immediately before the joint is completed.
- B. Mechanical joints: Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned and reassembled. Overtightening bolts to compensate for poor installation practice will not be permitted.

3.11 CUTTING PIPE

- A. Cutting of pipe shall be done in a neat manner, without damage to the pipe or to the lining therein. Pipe cuts shall be smooth, straight and at right angles to the pipe axis. All cutting of pipe shall be done with mechanical pipe cutters of an approved type except that in locations

where the use of mechanical cutters would be difficult or impracticable, existing pipe may be cut with diamond point chisels, saws, or other tools which will cut the pipe without damaging impact or shock.

3.12 CLEANING

- A. The interior of all pipe shall be cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted. All lumps, blisters and excess coating shall be removed from exterior spigot and interior bell surfaces. Such surfaces shall be wire brushed and wiped clean, dry, and free from oil and grease before placing the spigot in the bell. All joint contact surfaces shall be kept clean until the jointing is completed.
- B. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe.
- C. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug.

3.13 WATER AND SEWER LINE CROSSINGS

- A. Water and sewer lines crossing one another shall have a minimum 24-inch vertical separation.
- B. In general water lines shall be above sewer lines, however if water line cannot be above sewer line because of cover limitations or other obstructions, the water line may be below the sewer line but either the water or sewer line shall be encased 10 feet either side of the crossing line in steel encasement.
- C. Water lines shall not pass through manholes.

3.14 PARALLEL WATER AND SEWER LINES

- A. Water and sewer line shall have a minimum 10 feet horizontal separation.
- B. Water and sewer lines shall not be installed within the same trench.

3.15 TESTING

- A. Acceptance testing for gravity lines and force mains shall conform to Section 33 31 23, TESTING SANITARY SEWER SYSTEMS.

3.16 CONNECTION OF NEW SEWER PIPELINES TO EXISTING SANITARY SEWERS

- A. Construct, clean, test, and obtain Engineer's approval for pipelines and manholes before connecting new pipeline to the existing sewer.
- B. If, in the opinion of the Engineer, conditions exist which require connection prior to final line acceptance, plug all lines entering the manhole connecting to the existing system until the new system is accepted. In addition, plug the line leaving the first manhole upstream. Never allow water being used to flush the new lines to enter the existing system.
- C. All new pipelines must connect to the existing system at a new or existing manhole. If a new manhole is built over an existing sewer line, do not break out the top of the existing pipe until the new line is accepted. Flexible pipe couplings, as manufactured by Fernco or equal, may be used to connect existing gravity sewer line to new gravity sewer lines as approved by the Engineer.

- D. If a new pipeline is to discharge into an existing manhole, divert the sewage flow around the existing manhole while the tie-in is under construction. Intercept the sewage flow at the existing manhole first upstream from the tie-in construction. Provide suitable pumping equipment and re-routing conduit to pump the sewage around the tie-in construction. Discharge into an appropriate manhole downstream from the construction.
- E. Connection to an existing manhole shall be made by core drilling. A concrete manhole adapter, A-LOK G3 boot system or equal, shall be installed on the sewer pipe, and the annular space grouted.
- F. Connect new pipelines to existing manholes in a neat, workmanlike manner, to ensure a watertight connection.

3.17 TRENCHING

- A. Pipe trenching shall be as specified in DIVISION 31.

3.18 CONNECTIONS TO MANHOLES

- A. Pipe connections to concrete manholes and other concrete structures shall be as specified in Section 33 39 13.13, PRE-CAST CONCRETE MANHOLES

END OF SECTION

DIVISION 40
PROCESS INTEGRATION

SECTION 40 05 00 – PIPING SYSTEMS TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Test requirements for piping systems.
- B. Related Sections:
 - 1. Section 01 41 00 – Regulatory Requirements.
 - 2. Section 01 50 00 – Temporary Facilities and Controls.
 - 3. Section 40 23 39 – Process Piping General.

1.2 REFERENCES

- A. National Fuel Gas Code (NFGC):
 - 1. ANSI Z 223.1 or NFPA 54.
- B. American Society of Mechanical Engineers (ASME):
 - 1. B31.8 – Gas Transmission and Distribution Piping Systems.
 - 2. B31.1 – Power Piping.
 - 3. B31.3 – Process Piping.

1.3 TESTING REQUIREMENTS

- A. General Requirements:
 - 1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 40 23 39; are specified in the specifications covering the various types of piping; and are specified herein.
 - 2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
 - 3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01 41 00, and UL requirements.
 - 4. Test Natural Gas or Digester Gas Piping:
 - a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01 41 00, or the National Fuel Gas Code, whichever is more stringent.
 - b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
 - 5. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.
- B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.
- C. Water for Testing, Cleaning, and Disinfecting:
 - 1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01 50 00.
- D. Pipes to be Tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and

install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

- E. Unsuccessful Tests:
 - 1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
 - 2. Repeat testing until tests are successful.
- F. Test Completion: Drain and leave piping clean after successful testing.
- G. Test Water Disposal: Dispose of testing water at the RPCF Sludge Handling Facility in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 00.
- B. Schedule and Notification of Tests:
 - 1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
 - 2. Notification of Readiness to Test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.5 SEQUENCE

- A. Clean piping before pressure or leak tests.
- B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.
- C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.
- D. Backfill and compact trench or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.
- E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING, ALIGNMENT, GRADE, AND DEFLECTION

- A. Alignment and Grade:
 - 1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
 - 2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.
- B. Deflection Test:
 - 1. Pull a mandrel through the clean piping section under test.

2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within one percent plus or minus.
4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.2 AIR TESTING METHOD FOR PRESSURE PIPING

- A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.
- B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
 1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.
- C. Test at pressure as specified in Piping Schedule in Section 40 23 39:
 1. Provide temporary pressure relief valve for piping under test. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
 2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASME B31.3, ASME B31.8, or the pipe manufacturer's stated maximum working pressure.
 3. Gradually increase test pressure to an initial test pressure equal to the lesser of one-half the test pressure or 25 pounds per square inch gauge.
 4. Perform initial check of joints and fittings for leakage.
 5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage at each step increase until test pressure reached.
 6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
 7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.3 TESTING GRAVITY FLOW PIPING

- A. Test Gravity Flow Piping indicated with "G" in the Piping Schedule, as follows:
 1. Unless specified otherwise, subject gravity flow piping to the following tests:
 - a. Alignment and grade.
 - b. For plastic piping test for deflection.
 - c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
 2. Inspect piping for visible leaks before backfilling. Provide temporary restraints when needed to prevent movement of piping. Pressure test piping with maximum leakage allowance after backfilling.
 3. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours.
 - a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
 - b. Maintain piping with water or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
 - c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of four hours while accurately measuring the volume of water added to maintain the test pressure.
 - 1). Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:

- a). For Concrete Piping with Rubber Gasket Joints: 80 gallons per day per inch of diameter per mile of piping under test.
 - (1) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
 - (2) For Vitrified Clay and Other Piping: 500 gallons per day per inch of diameter per mile of piping under test.

3.4 TESTING HIGH-HEAD PRESSURE PIPING

- A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.
- B. General:
 - 1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
 - 2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
 - 3. Do not include valves, equipment or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item's manufacturer.
 - 4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
 - 5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
 - 6. When test results indicate failure of selected sections, limit tests to piping:
 - a. Between valves.
 - b. Between a valve and the end of the piping.
 - c. Less than 500 feet long.
 - 7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.
- C. Testing Procedures:
 - 1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule.
 - 2. Before pressurizing for the test, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
 - 3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.
- D. Pressure Test with Maximum Leakage Allowance:
 - 1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
 - 2. Pressure test piping after completion of visible leaks test.
 - 3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
 - a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
 - b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
 - c. Successful completion of the pressure test with maximum leakage allowance shall have been achieved with the observed leakage during the test period is equal or

less than the allowable leakage and no damage to piping and appurtenances has occurred.

- d. When leakage is allowed, calculate the allowable leakage by the following formula:

$$L = \frac{S D \sqrt{P}}{148,000}$$

Where:

L = testing allowance (makeup water) (gph)

S = length of pipe tested (ft)

D = nominal diameter of the pipe (in.)

P = average test pressure during the hydrostatic test (psi [gauge])

3.5 TESTING LOW-HEAD PRESSURE PIPING

- A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.
- B. General:
1. Test pressures shall be as scheduled in Section 40 23 39.
 2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
 3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
 4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.
- C. Visible Leaks Test:
1. Subject piping under test to the specified pressure measured at the lowest end.
 2. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule.
 3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
 4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.
- D. Pressure Test with Maximum Leakage Allowance:
1. Pressure test piping after completion of visible leaks test.
 2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
 - a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours and no damage to piping and appurtenances has occurred.
 - b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
- E. Optional Joint Test:
1. When Joint Testing Is Allowed by Note in the Piping Schedule, the Procedure Shall Be as Follows:
 - a. Joint testing will be allowed only for low head pressure piping.
 2. Joint testing may be performed with water or air.
 3. Joint test piping after completion of backfill and compaction to the top of the trench.
 4. Joint Testing with Water:

- a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
 - b. Maintain test pressure for one minute.
 - c. Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
 - d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
 - e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
5. Joint Testing with Air:
- a. Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
 - b. Maintain test pressure for 2 minutes.
 - c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION

SECTION 40 23 39 - PROCESS PIPING - GENERAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Basic Process Piping Materials, Methods, and Appurtenances.
- B. Related sections:
 - 1. Section 01 60 00 – Product Requirements.
 - 2. Section 03 30 00 – Cast-In-Place Concrete.
 - 3. Section 09 90 00 – Painting and Protective Coatings.
 - 4. Section 22 05 29 – Process Supports and Anchors.
 - 5. Section 22 05 53 – Mechanical Identification.
 - 6. Section 31 23 23.16 – Trench Backfill.
 - 7. Section 40 24 00 – Process Piping Specialties.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this Section and any supplemental Data Sheets:
 - 1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
 - 2. American National Standards Institute (ANSI):
 - a. A21.52, Ductile Iron Pipe, Centrifugally Cast, for Gas.
 - b. B1.20.1, Pipe Threads, General Purpose (Inch).
 - c. B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 - d. B16.3, Malleable Iron Threaded Fittings.
 - e. B16.5, Pipe Flanges and Flanged Fittings.
 - f. B16.9, Factory-Made Wrought Steel Butt welding Fittings.
 - g. B16.11, Forged Fittings, Socket-Welding and Threaded.
 - h. B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
 - i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
 - j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150,300,400,600,900, 1500 and 2500.
 - l. B16.25, Butt Welding Ends.
 - m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.
 - 3. American Petroleum Institute (API): 5L, Specification for Line Pipe.
 - 4. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code, Section VITI, Division 1, Pressure Vessels.
 - b. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
 - c. B31.1, Power Piping.
 - d. B31.3, Chemical Plant and Petroleum Refinery Piping.
 - e. B31.9, Building Services Piping.
 - f. B36.10M, Welded and Seamless Wrought Steel Pipe.
 - 5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Nondestructive Testing Personnel Qualifications.
 - 6. American Society for Testing and Materials (ASTM):
 - a. A47, Standard Specification for Ferritic Malleable Iron Castings.
 - b. A53 Rev A, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A105/A105M, Standard Specification for Forgings, Carbon Steel, for Piping Components.
 - d. A106, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.

- e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- f. A135, Standard Specification for Electric-Resistance-Welded Steel Pipe.
- g. A139 Rev A, Standard Specification for Electric-Fusion (Arc) -Welded Steel Pipe (NPS 4 and Over).
- h. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- i. A181/A181M Rev A, Standard Specification for Forgings, Carbon Steel, for General-Purpose Piping.
- j. A182/A182M Rev C, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
- k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
- l. A193/A193M Rev A, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
- m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
- n. A197, Standard Specification for Cupola Malleable Iron.
- o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
- p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- q. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
- r. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
- s. A283/A283M Rev A, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- t. A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength.
- u. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- v. A312/A312M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
- w. A320/A320M, Standard Specification for Alloy Steel Bolting Materials for Low-Temperature Service.
- x. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- y. A403/ A403M Rev A, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
- aa. A536, Standard Specification for Ductile Iron Castings.
- bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- cc. 587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
- dd. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- ee. A778 Rev A, Standard Specification for Welded, Un-annealed Austenitic Stainless Steel Tubular Products.
- ff. B32, Standard Specification for Solder Metal.
- gg. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- hh. B61, Standard Specification for Steam or Valve Bronzed Casting.
- ii. B62, Standard Specification for Composition Bronzed or Ounce Metal Castings.
- jj. B75, Standard Specification for Seamless Copper Tube.
- kk. B88 Rev A, Standard Specification for Seamless Copper Water Tube.
- ll. B98, Standard Specification for Copper-Silicone Alloy Rod, Bar, and Shapes.

- mm. 582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.
 - nn. D412, Standard Testing Method for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.
 - oo. D413, Standard Testing Methods for Rubber Property-Adhesion to Flexible Substrate.
 - pp. D1248, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
 - qq. D1784, Standard Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - rr. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - ss. D2000, Standard Classification System for Rubber Products in Automotive Applications.
 - tt. D2310, Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
 - uu. D2464, Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - vv. 2466, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - ww. D2467, Standard Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - xx. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 - yy. D2665, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe for Drain, Waste, and Vent Pipe and Fittings, Schedule 40.
 - zz. D2996, Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
 - aaa. D3222 Rev A, Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
 - bbb. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - ccc. D4101 Rev B, Standard Specification for Propylene Plastic Injection and Extrusion Materials.
 - ddd. F437, Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 - eee. F439 Rev A, Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 - fff. F441, Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
 - ggg. F491 Rev A, Standard Specification for Poly (Vinylidene Fluoride) (PVDF) Plastic-Lined, Ferrous Metal Pipes, and Fittings.
 - hhh. F493 Rev A, Standard Specification for Solvent Cements for Chlorinated Poly Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
 - iii. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) based on outside diameter.
7. American Welding Society (AWS):
 - a. A5.8, Specification for Filler Metals for Brazing and Braze Welding.
 - b. QC 1, Standard for AWS Certification of Welding Inspectors.
 8. American Water Works Association (AWWA):
 - a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - b. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3" through 48"for Water and Other Liquids.
 - c. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - d. C115/A21.15, Flanged Ductile-Iron Pipe with Threaded Flanges.
 - e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.

- f. C153/A21.53, Ductile-Iron Compact Fittings 3" through 16", for Water and Other Liquids.
 - g. C200, Steel Water Pipe – 6" and Larger.
 - h. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4" and Larger-Shop Applied.
 - i. C207, Steel Pipe Flanges for Water Works Service, Sizes 4" through 144".
 - j. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
 - k. C214, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - l. C606, Grooved and Shouldered Type Joints.
 - m. M11, Steel Pipe - A Guide for Design and Installation.
9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP 43, Wrought Stainless Steel Butt-Welding Fittings Including Reference to Other Corrosion Resistant Materials.
 10. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 DEFINITIONS

- A. Submerged or Wetted:
 1. Zone below elevation of:
 - a. Top face of channel walls and cover slabs.
 - b. Top face of basin walkways.
 - c. Top face of clarifier walkways.
 - d. Top face of digester walls, including structure piping penetrations.
 - e. Liquid surface or within 2 feet above top of liquid surface.
 - f. Top of tank wall or under tank cover.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. Shop Fabricated Piping:
 - a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
 - b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
 2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
 3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
 4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
 5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
 6. Gasket material, temperature rating, and pressure rating for each type of pipe and each type of service.
- B. Quality Control Submittals:
 1. Manufacturer's Certification of Compliance.
 2. Qualifications:
 - a. Weld Inspection and Testing Agency: Certification and qualifications.
 - b. Welding Inspector: Certification and qualifications.
 - c. Welders:
 - 1). List of qualified welders and welding operators.
 - 2). Current test records for qualified welder(s) and weld type(s) for factory and field welding.

3. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
4. Nondestructive inspection and testing procedures.
5. Manufacturer's Certification of Compliance:
 - a. Pipe and fittings.
 - b. Factory applied resins and coatings.
6. Certified weld inspection and test reports.
7. Test logs.

1.5 QUALITY ASSURANCE

- A. Weld Inspection and Testing Laboratory Qualifications:
 1. Retain approved independent testing laboratory that will provide the services of an AWS certified welding inspector qualified in accordance with AWS QC1 with prior inspection experience of welds specified herein.
 2. Perform weld examinations with qualified testing personnel who will carry out radiography, ultrasonic, magnetic particle, and other nondestructive testing methods as specified herein.
 3. Welding Inspector:
 - a. Be present when shop or field welding is performed to certify that welding is in accordance with specified standards and requirements.
 - b. Duties include, but are not limited to, the following:
 - 1). Job material verification and storage.
 - 2). Qualification of welders.
 - 3). Certify conformance with approved welding procedure specifications.
 - 4). Maintain records and prepare reports in a timely manner.
 - 5). Notify Engineer within 1 hour of discovery of unsatisfactory weld performance and within 24 hours of weld test failure.
 - 6). Supervision of testing personnel.
- B. Welder and Welding Operator Performance:
 1. Qualify welders and welding operators by approved testing laboratory before performing any welding under this section.
 2. Perform welder qualification tests in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code.
 3. Qualification tests may be waived if evidence of prior qualification is deemed suitable by the Engineer.
 4. Qualify welders and operators in the performance of making groove welds in each different pipe material, including carbon steel pipe, in Positions 2G and 5G for each welding process to be used.
 5. Qualify welders and welding operators for stainless steel as stated herein on the type of stainless steel being welded with the welding process used.
- C. Certifications:
 1. Coal-Tar Epoxy Applicator: Certified by Piping Manufacturer to be qualified to apply coal-tar epoxy coating to submerged or embedded ductile iron or cast iron soil piping.
 2. Weld Testing Agency: Certified in accordance with current American Society for Nondestructive Testing (4153 Arlingate Plaza, Columbus, OH 43228) recommended practice SNT-TC-1A, NDT Level II.
- D. Quality Control Submittals:
 1. Manufacturer's Certification of Compliance.
 2. Laboratory Testing Equipment: Certified calibrations, Manufacturer's product data, and test procedures.
 3. Certified welding inspection and test results.
 4. Qualifications:

- a. Weld Inspection and Testing Agency: Certification and qualifications.
- b. Welding Inspector: Certification and qualifications.
- c. Welders:
 - 1). List of qualified welders and welding operators.
 - 2). Current test records for qualified welder(s) and weld type(s) for factory and field welding.
- 5. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
- 6. Nondestructive inspection and testing procedures.
- 7. Manufacturer's Certification of Compliance:
 - a. Pipe and fittings.
 - b. Welding electrodes and filler materials.
 - c. Factory applied resins and coatings.
- 8. Certified weld inspection and test reports.
- 9. Pipe coating applicator certification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01 60 00, PRODUCT REQUIREMENTS, and:
 - 1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
 - 2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
 - 3. Linings and Coatings: Prevent excessive drying.
 - 4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
 - 5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 - PRODUCTS

2.1 PIPING

- A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.
- B. Diameters Shown:
 - 1. Standardized Products: Nominal size.
 - 2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME 836.10M.
 - 3. Cement-Lined Steel Pipe: Lining inside diameter.

2.2 JOINTS

- A. Grooved End System:
 - 1. Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, furnish flexible type.
 - 2. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.
- B. Flanged Joints:
 - 1. Flanges for ductile iron pipe shall conform to AWWA C115 at pressure rating meeting requirements of the connecting piping.
 - 2. Flanges for steel pipe shall conform to ANSI/ASME B16.5 at pressure rating meeting requirements of the connecting piping
 - 3. Higher pressure rated flanges as required, to mate with equipment when equipment flange is of higher pressure rating than required for piping.
- C. Threaded Joints: NPT taper pipe threads in accordance with ANSI B 1.20. 1.

- D. Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.
- E. Mechanical Joint Anchor Gland Follower:
 - 1. Ductile iron anchor type, wedge action, with break off tightening bolts.
 - 2. Manufacturer and Product: EBAA Iron Inc.; Megalug.
- F. Flexible Mechanical Compression Joint Coupling:
 - 1. Stainless steel, ASTM A276, Type 305 bands.
 - 2. Manufacturers:
 - a. Pipeline Products Corp.
 - b. Ferno Joint Sealer Co.
- G. Mechanical connections of the high density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:
 - 1. A polyethylene stub end thermally butt-fused to the end of the pipe.
 - 2. ASTM A240, Type 304 stainless steel backing flange, 125-pound, ANSI B16.1 Standard. Insulating flanges shall be used where shown.
 - 3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the Manufacturer's standard. Re-torque the nuts after 4 hours.
 - 4. Gaskets as specified on Data Sheet.
 - 5. Connection to buried mechanical joint fittings and valves shall be by restrained mechanical joint follower glad designed for HDPE pipe. Provide stainless steel stiffener as required by pipe manufacturer.

2.3 COUPLINGS

- A. Steel Middle Rings and Followers:
 - 1. Fusion bonded, epoxy-lined, and coated in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.
- B. Flexible Couplings:
 - 1. Manufacturers and Products:
 - a. Steel Pipe:
 - 1). Dresser; Style 38.
 - 2). Smith-Blair; Style 411.
 - 3). Romac 501
 - b. Ductile Iron Pipe:
 - 1). Dresser; Style 38.
 - 2). Smith-Blair; Style 411.
 - 3). Romac 501
- C. Transition Couplings:
 - 1. Manufacturers and Products:
 - a. Dresser; Style 62.
 - b. Smith-Blair; Style 413.
 - c. Romac RC501
- D. Flanged Coupling Adapters:
 - 1. Manufacturers and Products:
 - a. Steel Pipe:
 - 1). Smith-Blair; Series 913.
 - 2). Dresser Industries, Inc.; Style 128-W.
 - 3). Romac FC400

- b. Ductile Iron Pipe:
 - 1). Smith-Blair; Series 912.
 - 2). Dresser Industries, Inc.; Style 128-W.
 - 3). Romac FCA501

- E. Dismantling Joints:
 - 1. Manufacturers and Products:
 - a. Steel or Ductile Iron Pipe:
 - 1). Smith-Blair; Series 975.
 - 2). Dresser Industries, Inc.; Style 131.
 - 3). Romac DJ400.

2.4 HARDWARE

- A. All hardware on submerged piping or piping below the top elevation of tanks and directly exposed to water, wastewater and/or wastewater solids , including but not limited to bolts, nuts, washers, and threaded rod shall be stainless steel.

2.5 GASKET LUBRICANT

- A. Lubricant shall be supplied by pipe Manufacturer and no substitute or “or-equal” will be allowed.

2.6 DOUBLE WALL CONTAINMENT PIPING SYSTEM

- A. All system components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.7 THRUST RESTRAINT

- A. Buried piping shall be restrained joint piping unless specified otherwise or when connecting to existing pipe lines. When connecting to existing pipe lines concrete thrust blocking shall be used as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- B. All above grade piping shall be adequately restrained and supported.

2.8 VENT AND DRAIN VALVES

- A. Pipeline 2-1/2” Diameter and Larger: Vent connections shall be 3/4-inch with V300 ball valve. Drain connection shall be 1-inch with V300 ball valve, unless shown otherwise.
- B. Pipeline 2” Diameter and Smaller: Vent connections shall be 1/2-inch with V300 ball valve. Drain connection shall be 1-inch with V300 ball valve, unless shown otherwise.
- C. Provide galvanized steel pipe plug in each ball valve.

2.9 FABRICATION

- A. Mark each pipe length on outside:
 - 1. Size or diameter and class.
 - 2. Manufacturer’s identification and pipe serial number.
 - 3. Location number on laying drawing.
 - 4. Date of manufacture.
- B. Code markings according to approved Shop Drawings.

- C. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the Manufacturer.

2.10 FINISHES

- A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s), Piping Schedule, and Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.
- B. Galvanizing:
 - 1. Hot-dip applied, meeting requirements of ASTM A153.
 - 2. Electroplated zinc or cadmium plating is unacceptable.
 - 3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.
- C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.2 PREPARATION

- A. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.
- B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- C. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with Manufacturer's instructions, except for damaged glass-lined pipe or PVDF-lined pipe that is to be promptly removed from the site.

3.3 WELDING

- A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting Manufacturer.
- B. Weld Identification: Mark each weld with symbol identifying welder.
- C. Pipe End Preparation:
 - 1. Machine Shaping: Preferred.
 - 2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
 - 3. Beveled Ends for Butt Welding: ANSI B16.25.
- D. Surfaces:
 - 1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
 - 2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.

3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
- E. Alignment and Spacing:
1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
 2. Root Opening of Joint: As stated in qualified welding procedure.
 3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1", whichever is greater.
- F. Climatic Conditions:
1. Do not perform welding if there is impingement of any rain, snow, sleet or high wind on the weld area, or if the ambient temperature is below 32 °F.
 2. Stainless Steel and Alloy Piping: If the ambient is less than 32° F, local preheating to a temperature warm to the hand is required.
- G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.
- H. Surface Defects: Chip or grind out those affecting soundness of weld.
- I. Weld Passes: As required in welding procedure.
- J. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

3.4 INSTALLATION - GENERAL

- A. Join pipe and fittings in accordance with Manufacturer's instructions, unless otherwise shown or specified.
- B. Remove foreign objects prior to assembly and installation.
- C. Flanged Joints:
1. Install perpendicular to pipe centerline.
 2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
 3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
 4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
 5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
- D. Threaded and Coupled Joints:
1. Conform to ANSI B1.20.1.
 2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
 3. Countersink pipe ends, ream and clean chips and burrs after threading.
 4. Make connections with not more than three threads exposed.
 5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.
- E. Soldered Joints:
1. Use only solder specified for particular service.

2. Cut pipe ends square and remove fins and burrs.
 3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply non-corrosive flux to the male end only.
 4. Wipe excess solder from exterior of joint before hardened.
 5. Before soldering, remove stems and washers from solder joint valves.
- F. Couplings:
1. General:
 - a. Install in accordance with Manufacturer's written instructions.
 - b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
 - c. Remove pipe coating if necessary to present smooth surface.
 2. Application:
 - a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
 - b. Nonmetallic Piping Systems: Teflon bellows connector.
 - c. Concrete Encased Couplings: Sleeve type coupling.
 - d. Corrosive Service Piping: Elastomer bellows connector.
 - e. Grit Slurry Piping: Elastomer bellows connector.
- G. Pipe Connections at Concrete Structures: As specified in article PIPING FLEXIBILITY PROVISIONS in Section 40 24 00, PROCESS PIPING SPECIALTIES.
- H. Penetrations:
1. Watertight Penetrations:
 - a. Provide wall pipes with thrust collars, as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
 - b. Provide taps for stud bolts in flanges to be set flush with wall face.
 2. Non-watertight Penetrations:
 - a. Pipe sleeves with seep ring as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
 - b. Pipe sleeves with modular mechanical seal may be provided where fabrication of seep ring on pipe sleeve is impractical.
 3. Existing Walls:
 - a. Rotary drilled holes with modular mechanical seal as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
 4. Fire-Rated or Smoke-Rated Walls, Floor, or Ceilings: Insulated and encased pipe sleeves as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
- I. PVC and CPVC Piping:
1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
 2. Use strap wrench for tightening threaded plastic joints. Do not over tighten fittings.
 3. Do not thread Schedule 40 pipe.
- J. Ductile Iron, Cement-Lined Ductile Iron, and Glass-Lined Ductile Iron Piping:
1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
 2. Dressing Cut Ends:
 - a. General: As required for the type of joint to be made.
 - b. Rubber Gasketed Joints: Remove sharp edges or projections.
 - c. Push-On Joints: Bevel, as recommended by pipe Manufacturer.
 - d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter Manufacturer.

3.5 INSTALLATION-EXPOSED PIPING

- A. Piping Runs:
 - 1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
 - 2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.
- B. Supports: As specified in Section 22 05 29, PROCESS SUPPORTS AND ANCHORS.
- C. Group piping wherever practical at common elevations; installing to conserve building space and not interfere with use of space and other work.
- D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.
- E. Install piping so that no load or movement in excess of that stipulated by equipment Manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.
- F. Piping clearance, unless otherwise shown:
 - 1. Over Walkway and Stairs: Minimum of 7' 6", measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3' 0", measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 3. From Adjacent Work: Minimum 1" from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
 - 5. Head room in front of openings, doors, and windows shall not be less than the top of the opening.
 - 6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
 - 7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.6 INSTALLATION-BURIED PIPE

- A. Joints:
 - 1. Dissimilar Buried Pipes:
 - a. Provide flexible mechanical compression joints for pressure pipe.
 - b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.
 - 2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete unless specifically shown.
- B. Placement:
 - 1. Keep trench dry until pipe laying and joining are completed.
 - 2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.16, TRENCH BACKFILL.
 - 3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
 - 4. Measure for grade at pipe invert, not at top of pipe.
 - 5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
 - 6. Prevent foreign material from entering pipe during placement.

7. Close and block open end of last pipe section laid when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in the direction the pipe is laying.
9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
 - a. Shorter pipe lengths.
 - b. Special mitered joints.
 - c. Standard or special fabricated bends.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC and CPVC Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by Manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 °F, or above 90 °F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2".
2. Deflection from Vertical Grade: Maximum 1/4".
3. Joint Deflection: Maximum of 75% of Manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75' from position shown.
5. Pipe Cover: Minimum 5', unless otherwise shown.

3.7 THRUST RESTRAINT

A. Location:

1. Buried Piping: At pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
2. Exposed Piping: At all joints in pressure piping.

B. Thrust Ties:

1. Install as detailed.
2. Anchoring retainer glands or thrust ties with setscrews is unacceptable.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint Manufacturer's adapter gland follower and pipe end retainer, or thrust tie-rods and socket clamps.

D. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.8 BRANCH CONNECTIONS

- A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.
- B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.
- C. Threaded Pipe Tap Connections:
 - 1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
 - 2. Welded Steel or Alloy Piping: Connect only with welded thread-o-let or half-coupling as specified on Piping Data Sheet.
 - 3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.9 VENTS AND DRAINS

- A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install the vents on high points, and drains on low points of pipelines, whether shown or not.

3.10 CLEANING

- A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.
- B. Blow clean of loose debris plant process air, natural gas, and instrument air-lines with compressed air at 4,000 fpm; do not flush with water.
- C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.
- D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- E. Remove accumulated debris through drains 2" and larger or by removing spools and valves from piping.

3.11 DISINFECTION

- A. Disinfect pipelines intended to carry potable water (W1).
- B. See Division 33.

3.12 FIELD FINISHING

- A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.
- B. As specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

3.13 PIPE IDENTIFICATION

- A. See Section 22 05 53, MECHANICAL IDENTIFICATION and 09 90 00 PAINTING AND PROTECTIVE COATINGS.

3.14 HEAT TRACING

- A. See Section 40 41 13, HEAT TRACING.

3.15 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified. See Division 33.
- B. Minimum Duties of Welding Inspector:
 - 1. Job material verification and storage
 - 2. Qualifications of welders.
 - 3. Certify conformance with approved welding procedures.
 - 4. Maintenance of records and preparation of reports in a timely manner.
 - 5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.
- C. Required Weld Examinations:
 - 1. Perform Examinations in accordance with Piping Code ASME B31.1.
 - 2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.
 - 3. Examine at least one of each type and position of weld made by each welder or welder operator.
 - 4. For each weld found to be defective under the acceptable standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above 3. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.16 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION," are a part of this Specification.
 - 1. Piping Schedule.
 - 2. Data Sheets.

Number	Title
40 23 39.13	Ductile Iron Pipe and Fittings

END OF SECTION

PROCESS PIPING SCHEDULE										
Service	Flow Stream Identifier	Installation (Note 1)	Pipe Size (Note 2)	Material (Note 3)	Spec / Data Sheet No.	Max Operating Temp (°F)	Max Operating Pressure (psig)	Test Pressure (psig) & Method (Note 4)	Pipe Color (Note 5)	Remarks
Raw Sewage	RS	Exposed Buried Encased	>4" >4" >4"	CEDI CEDI CEDI	40 23 39.19	85	75	100, H	Green	1
PROCESS PIPING SCHEDULE										
<p>Notes:</p> <p>1 Exposed - Inside/Outside Exposed Submerged Buried - Directly into Soil Encased</p> <p>2 > Greater Than < Less Than <= Less Than or Equal To >= Greater Than or Equal To</p> <p>3 CLDI - Cement Lined Ductile Iron CEDI-Ceramic Epoxy Lined Ductile Lined CPVC - Chlorinated Polyvinyl Chloride CU - Copper DWCP - Double Wall Containment Pipe FRP - Fiberglass Reinforced Plastic Pipe GALV - Galvanized Pipe SST - Stainless Steel WS - Welded Steel</p> <p>4 H - Hydrostatic Test P - Pneumatic Test G - Gravity Piping See Section 40 05 00 for Piping Systems Testing for requirements Pipe testing required as specified above.</p> <p>5 See Section 09 90 00 for required painting. For buried piping, no color shall be required; coordinate for proper coatings, as necessary.</p> <p>6 Where no color is indicated, color to be selected by Owner For exposed piping not coated, provide colored banding and identification. General - Deviations from this schedule are indicated directly by note on Drawings where deviation is required General - The piping material shall conform to the requirements for the service listed being drained or vented</p>										
<p>Remarks:</p> <p>1 See Section 40 23 39 for additional requirements.</p>										

**SECTION 40 23 39.13
DUCTILE IRON PIPE AND FITTINGS**

Item	Description
Pipe	<p>Buried Liquid Service: Push-On, Mechanical, or Proprietary Restrained Joints: AWWA C110/A21.10-93, AWWA C115/A21.15-88, and AWWA C151/A21.51-91, pressure class conforming to Tables 51.1 and 51.3 for Type 4 trench, 250 psi minimum working pressure.</p> <p>Exposed Pipe: Grooved End or Flange Joints: AWWA C115/A21.15-88, and AWWA C151/A21.51-91, thickness Class 53 minimum conforming to Table 51.7, 250 psi minimum working pressure.</p>
Coating	<p>Buried Pipe: Exterior coating used under normal conditions shall be an asphaltic coating approximately 1 mil (25 µm) thick and per AWWA C151/A21.51-17.</p> <p>Exposed Pipe: Shall be as indicated in the schedule.</p>
Encasement	<p>Polyethylene encasement shall be used on all underground ductile iron pipe, fittings, valves, and appurtenances. See Specification Section 40 42 13.16 – POLYETHYLENE ENCASEMENT FOR DUCTILE IRON AND CAST IRON PIPE.</p>
Lining	<p>Lining shall be Cement-Mortar AWWA C104/A21.4-90 unless noted otherwise. Ceramic Epoxy Protecto 401 or equal shall be used where indicated in the pipe schedule. Glass Lining: VITCO Corp. SG-14 or equal shall be used where indicated in the schedule. Linings for fittings shall be as indicated below.</p>
Joints	<p>Push-On: 250 psi minimum working pressure, AWWA C110/A21.10-93 and C111/A21.11-90. American Cast Iron Pipe Co., Fastite Joints; U.S. Pipe and Foundry, Tyton Joint.</p> <p>Mechanical: 250 psi minimum working pressure, AWWA C111. American Cast Iron Pipe Co., Mechanical Joint; U.S. Pipe and Foundry, Mechanical Joint.</p> <p>Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex.</p> <p>Grooved End: Rigid type radius cut conforming to AWWA C606-87, 250 psi minimum working pressure. Victaulic; Gustin-Bacon.</p> <p>Flange: 125-pound flat face, 250-pound raised face, ductile iron, threaded conforming to AWWA C115/A21-15.88. Gray cast iron will not be allowed.</p>

**SECTION 40 23 39.13
DUCTILE IRON PIPE AND FITTINGS**

Item	Description
Fittings	<p>Push-On: AWWA C110/A21.10-93 and C111/A21.11-90, gray or ductile iron, 250 psi minimum working pressure. American Cast Iron Pipe Co., Fastite Joints; U.S. Pipe and Foundry, Tyton Joint.</p> <p>Mechanical Joint: For Buried Service. AWWA C110/A21.10-93, C111/A21.11-90, and C153/A21.53-88 gray or ductile iron, 250 psi minimum working pressure. Coating/lining shall be Fusion-Bonded Epoxy meeting AWWA C116. American Cast Iron Pipe Co., Mechanical Joint; U.S. Pipe and Foundry, Mechanical Joint.</p> <p>Proprietary Restrained Joint: AWWA C111/A21.11-90 and C153/A21.53-88, ductile iron, 250 psi minimum working pressure. Coating/lining shall be Fusion-Bonded Epoxy meeting AWWA C116. Clow Corp., Super-Lock Joint; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring Joint; U.S. Pipe, TR Flex.</p> <p>Proprietary Restrained River Crossing: Clow Ball and Socket; U.S. Pipe Usiflex. Coating/lining shall be Fusion-Bonded Epoxy meeting AWWA C116.</p> <p>Grooved End: AWWA C606-87 and C110/A21.10-93, ductile iron, 250 psi minimum working pressure. Lining and coating shall match connecting pipe. Victaulic; Gustin-Bacon.</p> <p>Flange: AWWA C110/A21.10-93 and ANSI B16.1-89, ductile or gray cast iron, faced and drilled, 125-pound flat face or 250-pound raised face. Gray cast iron will not be allowed. Lining and coating shall match connecting pipe.</p>
Couplings	<p>Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47-90 or ductile iron per ASTM A536-84. Victaulic; Gustin-Bacon.</p> <p>Grooved End Adapter Flanges: 250-pound malleable iron per ASTM A47-90 or ductile iron per ASTM A536-84. Victaulic; Gustin-Bacon.</p>
Bolting	<p>Mechanical, Proprietary Restrained, and Grooved End Joints: 316 Stainless Steel Hardware.</p> <p>125-pound Flat-Faced Flange: Exposed piping - ASTM A307-94, Grade A carbon steel hex head bolts and ASTM A563-93, Grade A steel hex head nuts.</p> <p>250-pound Raised-Face Flange: Exposed piping - ASTM A307-94, Grade B carbon steel hex head bolts and ASTM A563-93, Grade A carbon steel heavy hex head nuts.</p> <p>All hardware on submerged piping or piping below the top elevation of tanks and directly exposed to water, wastewater and/or wastewater solids, including but not limited to bolts, nuts, washers, and threaded rod shall be stainless steel.</p>

**SECTION 40 23 39.13
DUCTILE IRON PIPE AND FITTINGS**

Item	Description
Gaskets	<p>Mechanical, and Proprietary Restrained Joints, Water and Sewage: Rubber conforming to ANSI/AWWA C111/A21.11-90 Locking gaskets produced in accordance with AWWA C111 are acceptable for use as a joint restraint mechanism for buried push-on type joints. Locking gaskets shall be rated for the same working pressure as the pipe. American Cast Iron Pipe Co., Fast-Grip Gasket; US Pipe, Field LOK Gaskets.</p> <p>Mechanical and Proprietary Restrained Joints, Air: Viton, Fluorel, or Manufacturer's standard for high temperature air service, rated to 300 degrees F minimum, conforming to ANSI/AWWA C111/A21.11-90</p> <p>Grooved End Joints: Halogenated butyl conforming to ASTM D2000-90 and AWWA C606-87. Gaskets for air service shall be pressure-responsive synthetic rubber, rated to 300 degrees F minimum, conforming to ASTM D2000.</p> <p>Flanged, Water and Sewage Services: 1/8-inch thick, unless otherwise specified, homogenous black rubber (EPDM), hardness 60 (Shore A), rated to 212 degrees F., conforming to ANSI B16.21 and ASTM D1330 Steam Grade.</p> <p>Flanged, Air Service: 1/8-inch thick, unless otherwise specified, Teflon, PTFE, or compressed inorganic fiber with nitrile binder, rated to 300 degrees F. minimum, conforming to ANSI B16.21 and ASTM D1330.</p> <p>Ring gaskets shall not be permitted.</p> <p>Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.</p> <p>Gasket pressure rating equal to the pressure rating as the pipe or fitting.</p>
Joint Lubricant	Manufacturer's Standard.

END OF SECTION

SECTION 40 23 43 - PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Basic requirements for Process Valves.
- B. Related sections:
 - 1. Section 01 33 00 – Submittal Procedures.
 - 2. Section 01 60 00 – Product Requirements.
 - 3. Section 01 78 23 – Operation and Maintenance Data.
 - 4. Section 01 79 00 – Demonstration and Training.
 - 5. Section 09 90 00 – Painting and Protective Coatings.
 - 6. Section 22 05 53 – Mechanical Identification.
 - 7. Section 40 23 39 – Process Piping General.

1.2 GENERAL

- A. See Section 40 23 39, PROCESS PIPING GENERAL, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Certain valves are specified in Division 44 to be furnished by equipment manufacturer as part of their equipment package and/or system. These valves are to be installed by the Contractor as specified herein. In addition to installation, the Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in start-up services as required to the place the valves into continuous, reliable operation.

1.3 SUBMITTALS

- A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS. The following specific information shall be provided:
 - 1. Shop Drawings:
 - a. Product data sheets for make and model.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Refer to specific valve type for additional submittal requirements.
 - 2. Quality Control Submittals:
 - a. Tests and inspection data.
 - b. Manufacturer's Certificate of Proper Installation.
 - c. Manufacturer's printed installation instructions.
 - d. Special shipping, storage and protection, and handling instructions.
 - e. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
 - f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

1.4 OPERATION AND MAINTENANCE DATA

- A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
- B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Valve to include operator, actuator, hand wheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.
- B. Valve shall be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- C. Valve shall be the same size as adjoining pipe.
- D. Valve ends to suit adjacent piping.
- E. Valve shall open by turning counterclockwise unless otherwise specified.
- F. Operator, actuator, and accessories shall be factory mounted.
- G. EFFECTIVE JANUARY 4, 2014 ANY VALVE, PIPE, FITTING, SOLDER, OR FLUX USED OR IN CONTACT WITH POTABLE WATER MUST COMPLY WITH THE REDUCTION OF LEAD IN DRINKING WATER ACT, AN AMENDMENT TO SECTION 1417 OF THE SAFE DRINKING WATER ACT (SDWA). VALVES SPECIFIED IN THIS SECTION MAY NOT MEET REQUIREMENTS OF THIS ACT, HOWEVER THIS DOES NOT RELIEVE THE CONTRACTOR FROM PROVIDING A VALVE TO MEET REQUIREMENTS OF THE (SDWA) AND THE SAME FUNCTIONAL REQUIREMENTS OF THIS SPECIFICATION.

2.2 SCHEDULE

- A. Requirements relative to this section for certain type of actuated or process valves are shown on the Valve Schedules attached as Supplements to the related Sections.

2.3 MATERIALS

- A. Brass and bronze valve components and accessories that have surfaces in contact with water shall be alloys containing less than 16% zinc and 2% aluminum.
- B. Approved alloys are of the following ASTM designations:
 - 1. B61, B62, B98 (Alloy UNS No.C65100, C65500, or C66100), B139 (Alloy UNS No.C51000), B584 (Alloy UNS No.C90300 or C94700), B164, B194, and B127.
 - 2. Stainless steel, AISI Type 316 may be substituted for bronze.

2.4 FACTORY FINISHING

- A. Epoxy Lining and Coating:
 - 1. In accordance with AWWA C550 unless otherwise specified. Coating shall be either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.
 - 2. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.
- B. Exposed Valves Field Finish:
 - 1. Final paint coating shall be in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS. System and color shall match adjacent piping system.
 - 2. Safety isolation valves and lockout valves with handles, hand wheels, or chain wheels "safety yellow."

2.5 VALVES

A. Gate Valves:

1. Type V140: Gate Valve, Less Than 3 Inches
 - a. General:
 - 1) Service: Aboveground, clean water and air.
 - 2) 150 psi Class
 - 3) Rising Stem type
 - 4) Threaded ends
 - 5) Conform to MSS-SP-80, Type 2
 - b. Materials:
 - 1) Body & bonnet: Bronze, ASTM B62 alloy C83600
 - 2) Disc: Bronze, ASTM B62 alloy C83600
 - 3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400
 - c. Manufacturers and Products:
 - 1) Crane – Figure 431.
 - 2) Jenkins – Figure 2810J
 - 3) Nibco – T-131
2. Type V141: Buried Gate Valve, 3 Inches and Larger
 - a. Valve shall be resilient wedge type, of non-rising stem design and rated for 250 psig cold water working pressure.
 - b. Valve shall meet or exceed all requirements of the latest revision of AWWA C515.
 - c. Valve shall have mechanical joint ends, except tapping valves may be flanged by mechanical joint.
 - d. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
 - e. Each valve shall have maker's name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
 - f. Valves 14" and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.
 - g. Materials:
 - 1) All cast ferrous components shall be ductile iron, ASTM A536.
 - 2) The body, bonnet and O-ring plate shall be fusion-bonded epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.
 - 3) Wedge shall be ductile iron fully encapsulated in EPDM rubber.
 - 4) Hardware shall be 304 stainless steel
 - 5) Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem
 - 6) Provide standard AWWA 2-inch operating nut, matching valve key, and valve box for operating stem.
 - h. Manufacturers and Products:
 - 1) M&H/Kennedy Valve Company.
 - 2) Mueller.
 - 3) American.
 - 4) Crispin-Ludlow Valve.
3. Type V142: Exposed Gate Valve, 3 Inches and Larger
 - a. Valve shall be resilient wedge type, of non-rising stem design and rated for 250 psig cold water working pressure.

- b. Valve shall meet or exceed all requirements of the latest revision of AWWA C515.
 - c. Valve shall have flanged ends.
 - d. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
 - e. Each valve shall have maker's name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
 - f. Valves 14" and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.
 - g. Materials:
 - 1) All cast ferrous components shall be ductile iron, ASTM A536.
 - 2) The body, bonnet and O-ring plate shall be fusion-bonded epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.
 - 3) Wedge shall be ductile iron fully encapsulated in EPDM rubber.
 - 4) Hardware shall be 304 stainless steel
 - 5) Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem
 - 6) Provide handwheel, chainwheel, 2" nut, or actuator as noted on the drawings or specified in the valve schedule.
 - h. Manufacturers and Products:
 - 1) M&H/Kennedy Valve Company.
 - 2) Mueller.
 - 3) American.
 - 4) Crispin-Ludlow Valve.
4. Type V145: Knife Gate Valve, 2 Inches to 36 Inches
- a. Suitable for service under pressures equal to and less than 150 pounds per square inch.
 - b. Full round port, metal seated, raised face design.
 - c. Flanged wafer design, drilled and tapped to ANSI Class 125/150 standard.
 - d. Founded gate with beveled edge, finish-ground to 32 RMS, maximum, on both sides.
 - e. Body to incorporate guides and jams to assist in seating.
 - f. Materials:
 - 1) Body: Cast or ductile iron or cast steel, with Type 316 stainless steel lining or cast Type 316 stainless steel.
 - 2) Wetted Components (including gate): Type 316 stainless steel.
 - 3) Yoke Sleeve: Acid resisting bronze or aluminum bronze.
 - 4) Packing: PTFE.
 - g. Outside screw and yoke (OS&Y) with handwheel operator.
 - h. Manufacturers and Products:
 - 1) DeZurik.
 - 2) Fabri Valve.

B. Globe Valves:

- 1. Type V200: Globe Valve, 3 Inches and Smaller
 - a. General:
 - 1) Service: Aboveground, clean water.
 - 2) 150 psi Class
 - 3) Rising Stem type
 - 4) Union Bonnet
 - 5) Threaded ends

- 6) Conform to MSS-SP-80, Type 2
 - b. Materials:
 - 1) Body & bonnet: Bronze, ASTM B62 alloy C83600
 - 2) Disc: PTFE
 - 3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400
 - c. Manufacturers and Products:
 - 1) Stockham; B-22T, threaded end.
 - 2) Crane. Co.; 7TF, threaded end.
 - 3) Nibco: T-235-Y
2. Type V201: Angle Pattern Valve, 2 Inches and Smaller
- a. General:
 - 1) Service: Aboveground, clean water.
 - 2) 150 psi Class
 - 3) Rising Stem type
 - 4) Union Bonnet
 - 5) Threaded ends
 - 6) Conform to MSS-SP-80, Type 2
 - b. Materials:
 - 1) Body & bonnet: Bronze, ASTM B62 alloy C83600
 - 2) Disc: PTFE
 - 3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400
 - c. Manufacturers and Products:
 - 1) Stockham; Figure B-222T.
 - 2) Crane Co.; Cat. No. 17TF.
 - 3) Nibco: T-335-Y
3. Type V235: Angle Type Hose Bibb Valve
- a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE Standard 1011 and IAPMO code.
 - b. Manufacturers and Products:
 - 1) Acorn; 8126, surface pipe mount valve, bent nose without flange:
 - 2) Acorn; 8121, surface mount through wall valve, bent nose with flange.
 - 3) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
 - 4) Acorn; 8136, pedestal mounted valve located lower than 6 inches inverted nose.
4. Type V236: Angle Pattern Hose Valve, 1 Inch Through 3 Inches
- a. All-bronze, screwed ends, inside screw, rising stem, '1F±. disc, outlet of cast brass NST by NPT, male by male, nipple adapter with hexagonal wrench feature, rated 300 WOG.
 - b. Manufacturers and Products:
 - 1) Stockham; Figure B-222T.
 - 2) Crane Co.; Cat. No. 17TF.
 - 3) James Jones Co.: J-300 Series, angle fire hydrant valve with NPT inlet and National Hose thread outlet.
 - 4) ITT Kennedy; Figure 936, angle fire hydrant valve with NPT inlet and National Hose thread outlet.

C. Ball Valves:

- 1. Type V300: Metal Body Ball Valve, Less than 6 Inches
 - a. General
 - 1) Type: Non-lubricated and capable of sealing in either flow direction.
 - 2) End Connections:

- a) Threaded or solder ends for sizes 3-inch and smaller.
 - b) Class 150 flanged for sizes larger than 3 inch. Flanges shall conform to ANSI/ASME B16.1 standards.
 - 3) Stem Packing: Manually adjustable while valve is under pressure.
 - 4) Shafts: Rigidly connected to the ball by a positive means. The connection shall be designed to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
 - 5) Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
 - 6) Temperature Limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.
 - b. Materials:
 - 1) Valves in Copper Lines: Bronze body
 - 2) Valves in Steel and Ductile Iron Piping: Ductile iron or cast steel bodies.
 - 3) Ball: Type 304 or 316 stainless steel.
 - 4) Seats: PTFE.
 - 5) Stem Seals: TFE or Viton
 - 6) Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
 - c. Manufacturers and Products:
 - 1) Apollo.
 - 2) Nibco.
 - 3) Milwaukee Valve.
2. Type V302: Metal Body Ball Valve, 6 Inches and Larger
 - a. General
 - 1) Type: Non-lubricated and capable of sealing in either flow direction.
 - 2) Conform to AWWA C 507.
 - 3) Stem Packing: Manually adjustable while valve is under pressure.
 - 4) ANSI B16.1, Class 125 flanged ends.
 - b. Materials
 - 1) Body: ASTM A48 cast iron and integrally cast bronze bushed trunnions.
 - 2) Ball: Type 304 or Type 316 stainless steel.
 - 3) Seats: TFE.
 - 4) Stem Seals: TFE or Viton.
 - c. Manually operated ball valves shall have self-locking worm gear type actuator with position indicator. Gearing shall be permanently lubricated. Provide adjustable screws to stop travel at both Open and Closed positions.
 - d. Manufacturers and Products:
 - 1) Henry Pratt.
 - 2) McANNA/MARPAC
3. Type V303 Instrumentation Ball Valves
 - a. Brass or stainless steel body ball valve, nylon handle.
 - b. Manufacturers and Products:
 - 1) Swagelok, 40G Series.
 - 2) Imperial Eastman; Series 200.
4. Type V330 PVC Body Ball Valve
 - a. General:
 - 1) Type: Non-lubricated and capable of sealing in either flow direction.
 - 2) End Connections: True union; solvent or heat welded to piping.
 - 3) Operator Handle: Lever.
 - 4) All ball valves on sodium hypochlorite lines and/or chlorine dioxide lines shall be venting type valves.
 - b. Materials

- 1) Body: Polyvinyl chloride (PVC).
- 2) Ball: Polyvinyl chloride (PVC).
- 3) Seats: Teflon (TFE).
- 4) O-rings: Viton (FPM).
- c. Manufacturers and Products:
 - 1) Asahi/America, Inc.
 - 2) Nibco.

D. Plug Valves:

- 1. Type V404: Eccentric Plug Valve, 1/2 Inch through 3 Inches
 - a. Non-lubricating type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body, or stainless steel body where indicated, with threaded NPT full size inlets. Connection shall be hexagonal for a wrench connection. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.
 - b. Provide valves with wrench lever manual operator.
 - c. Manufacturers and Products:
 - 1) DeZurik.
 - 2) Henry Pratt.
 - 3) Val-Matic.
 - 4) Crispin Valve
- 2. Type V405: Eccentric Plug Valve, 4 Inches through 12 Inches
 - a. Non-lubricating type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body, or stainless steel body where indicated, with flanged ends or grooved ends in accordance with AWWA C606 for rigid joints, mechanical joint ends for buried valve. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.
 - b. 4" valve with wrench lever manual operator and 6 through 12" valve with totally enclosed, geared, manual operator with hand wheel, 2" nut, or chain wheel.
 - c. Manufacturers and Products:
 - 1) DeZurik.
 - 2) Henry Pratt.
 - 3) Val-Matic.
 - 4) Crispin Valve.
- 3. Type V406: Eccentric Plug Valve, 14 Inches and Larger
 - a. Non-lubricating type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body with flanged ends or grooved ends in accordance with AWWA C606 for rigid joints, mechanical joint ends for buried valve. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.
 - b. Provide with totally enclosed, geared, manual operator with hand wheel, 2" nut, or chain wheel.
 - c. Manufacturers and Products:
 - 1) DeZurik.
 - 2) Henry Pratt.
 - 3) Val-Matic.
 - 4) Crispin Valve.

E. Butterfly Valves:

1. General: Provide valves designed and manufactured in accordance with AWWA C504, Class 150B or Class 250B, AWWA C516, and the following requirements:
 - a. Valve class shall meet the requirements of the connecting line or as indicated in valve schedule or as indicated on the drawings.
 - b. Suitable for throttling operations and infrequent operation after periods of inactivity.
 - c. Elastomer seats bonded to body shall have adhesive integrity of bond between seat and body assured by testing with minimum 75-pound pull in accordance with ASTM D429, Method B. Seat may be retained by mechanical means on valves 24-inches and larger. No epoxy attachment method will be allowed.
 - d. Bubble-tight with rated pressure, or any pressure lower than rated, applied from either side with the valve mounted in any orientation.
 - e. No travel stops for the disc on interior of the body.
 - f. Shaft seal shall include V-type packing for self-adjusting and wear compensation.
 - g. Isolate metal-to-metal thrust bearing surfaces from flow stream.
 - h. Valves intended for air service shall meet ANSI B16.104 and ANSI B16.5.

2. Type V500: Butterfly Valve, 4 Inches and Larger
 - a. Valve Style: Flanged end, short body type.
 - b. Flanged end connections shall fully conform with ANSI B16.1 Class 125 or Class 250, or AWWA C207 Class D.
 - c. Materials:
 - 1) Body: Class 150B valve bodies shall be ASTM A126, Class B gray iron or ASTM A536 Grade 65-45-12 ductile iron. Class 250B valve bodies shall be ASTM A536 Grade 65-45-12 ductile iron.
 - 2) Disc: Valve disc shall be made from cast iron ASTM A-126 Class B or stainless steel ASTM A351 in sizes 20" and smaller. Sizes 24" and larger shall be built from ductile iron in conformance to ASTM A-536. Disc shall be furnished with Type 316 stainless steel seating edge to mate with the rubber seat on the body.
 - 3) Shafts: Shafts shall be Stainless Steel. ASTM A276 Type 304, or Type 316, or ASTM A564, grade 630.
 - 4) Seat: Valve seat shall be Buna-N rubber located on the valve body. In sizes 20" and smaller, valves shall have bonded seats that meet test procedures outlined in ASTM D-429 Method B. Sizes 24" and larger shall be retained in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream.
 - 5) Bearings: Shall be sleeve type that is corrosion resistant and self-lubricating.
 - 6) Manual Actuators: Shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 ft. lbs. against the stop. The traveling nut shall engage alignment grooves in the housing. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.
 - 7) Hardware: All seat retaining hardware shall be Type 316 stainless steel.
 - d. Manufacturers and Products:
 - 1) Henry Pratt /Mueller
 - 2) DeZurik - AWWA Butterfly Valves (BAW) 150B or 250B
 - 3) Crispin Valve
 - 4) Val-Matic – American BFV 150B or 250B

3. Type V504: Buried Butterfly Valve, 4 Inches and Larger
 - a. Valve Style: Mechanical joint end type
 - b. Mechanical joint end connections shall fully conform to ANSI/AWWA C111/A21.11.
 - c. Valve position indicator at valve box locations. Indicator to be hermetically sealed and show valve disc position, direction of rotation, and number of turns from FULLY OPENED to FULLY CLOSED.
 - d. Materials:

- 1) Body: Class 150B valve bodies shall be ASTM A126, Class B gray iron or ASTM A536 Grade 65-45-12 ductile iron. Class 250B valve bodies shall be ASTM A536 Grade 65-45-12 ductile iron.
 - 2) Disc: Valve disc shall also be made from cast iron ASTM A-126 Class B in sizes 20" and smaller. Sizes 24" and larger shall be built from ductile iron in conformance to ASTM A-536. Disc shall be furnished with Type 316 stainless steel seating edge to mate with the rubber seat on the body.
 - 3) Shafts: Shafts shall be Stainless Steel. ASTM A276 Type 304, or Type 316, or ASTM A564, grade 630.
 - 4) Seat: Valve seat shall be Buna-N rubber located on the valve body. In sizes 20" and smaller, valves shall have bonded seats that meet test procedures outlined in ASTM D-429 Method B. Sizes 24" and larger shall be retained in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream. No epoxy attachment method will be allowed.
 - 5) Bearings: Shall be sleeve type that is corrosion resistant and self-lubricating.
 - 6) Manual Actuators: Shall be suitable for buried service. Shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 ft. lbs. against the stop. The traveling nut shall engage alignment grooves in the housing. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.
 - 7) Hardware: All seat retaining hardware shall be Type 316 stainless steel.
- e. Manufacturers and Products:
- 1) Pratt / Mueller
 - 2) Henry Pratt - Class 150B - Groundhog
 - 3) Class 250B - HP-250II
 - 4) Mueller Co. - Class 150 B - Lineseal III
 - 5) Class 250 B – Lineseal XP
 - 6) DeZurik - AWWA Butterfly Valves (BAW) 150B or 250B
 - 7) Crispin Valve
 - 8) Val-Matic - American BFV 150B or 250B
4. Type V510: Lug Style Butterfly Valve, 2 Inches and Larger
- a. Cast iron ASTM A126 body, ASTM A351-CF8M discs, Type 18-8 stainless steel or Type 416 stainless steel one-piece stem/shaft, self-lubricating sleeve-type Teflon or bronze bearing, EPDM replaceable resilient seat, self-adjusting multi-ring V-type packing, suitable for temperatures up to 250°F, bubble-tight at 150 psi differential pressure. Flanges and/or mounting design shall be for ANSI B16.1 125- or 150-pound flanges.
 - b. Manufacturers:
 - 1) Henry Pratt – Series 397
 - 2) DeZurik – BOS-CL
 - 3) Bray Valve
5. Type V511: Wafer-Style Butterfly Valve, 2 Inches and Larger
- a. Cast iron body, cast iron or ductile iron discs, Type 18-8 stainless steel one-piece stem, self-lubricating sleeve type bearing, EPDM replaceable resilient seat, self-adjusting packing, suitable for temperatures up to 250 degrees F, bubble-tight at 50 psi differential pressure, valve body to fit between ANSI B16.1 flanges.
 - b. Manufacturers:
 - 1) Henry Pratt.
 - 2) DeZurik
 - 3) Bray Valve
6. Type V512: Plastic Body Butterfly Valve, 8 Inches and Smaller

- a. PVC or CPVC body, CPVC discs, 316 SS stem/shaft, Viton (FKM) seats and seals, suitable for pressures of up to 150 psi at 70°F. The liner seal shall be full seat design such that the disc and seat are the only wetted parts. Flanges and/or mounting design shall be for ANSI B16.5 or ANSI B16.10 bolt patterns
- b. Manufacturers
 - 1) Asahi/America, Inc.

F. Check and Flap Valve:

- 1. Type V600: Check Valve, 2 Inches and Smaller
 - a. All-bronze, screwed ends and cap, swing type replaceable Buna-N disc, rated 125-pound SWP, 200-pound WOG.
 - b. Manufacturers:
 - 1) Stockham.
 - 2) Milwaukee Valve.
- 2. Type V605: Resilient Seated Swing Check Valve, 3 Inches and Larger
 - a. Valve Connections: Flanged in accordance with ANSI B16.1, Class 125
 - b. The valve shall be in conformance with AWWA C508
 - c. The valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components – Health Effects, and certified to be Lead-Free in accordance with NSF/ANSI 372.
 - d. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. (100mm) valve shall be capable of passing a 3 in. (75mm) solid. The seating surface shall be a minimum of 35 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion device without special tools or removing the valve from the line.
 - e. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.
 - f. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and reinforced with alloy steel. The flex portion of the disc shall have no penetrations, contain nylon reinforcement and shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a disc accelerator to provide a cracking pressure of 0.3 psig.
 - g. The disc accelerator shall be of one piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place captured between the cover and disc. It shall be formed with a large radius to allow smooth movement over the disc surface
 - h. Materials:
 - 1) Body: The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B gray iron for 30 in. (800mm) and larger. The exterior and interior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.
 - 2) Disc: The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG.
 - 3) Hardware: All retaining hardware shall be Type 316 stainless steel.
 - i. Manufacturers and Products:
 - 1) Val-Matic - Surgebuster
 - 2) Henry Pratt – RD-Series
 - 3) DeZurik/APCO – Series 100
 - 4) Crispin – RF/ASR

3. Type V608: Swing Check Valve, 2 Inches and Larger
 - a. AWWA C508, flanged end, cast iron body, bronze mounted valve, solid bronze hinges, stainless steel hinge shaft.
 - b. Valve 2" through 12" rated 175-pound and 14" through 36" rated 150-pound cold water, non-shock. Valve fitted with adjustable outside lever and weight or lever and spring as shown on the drawings. Increasing-pattern body valve may be used where increased outlet piping size is shown.
 - c. Manufacturers:
 - 1) Crispin Valve
 - 2) Val-Matic.
 - 3) DeZurik.

4. Type V609: Air Cushioned Swing Check Valve, 3 Inches and Larger
 - a. AWWA C508, flanged end, cast iron body, bronze mounted valve, solid bronze hinges, stainless steel hinge shaft.
 - b. Valve closure shall be cushioned by the action of a bronze piston in a bronze cushion cylinder. The cushion chamber assembly shall be non-pivoting and be mounted to the side of the valve body on machined pads without the need for brackets. The amount of cushioning shall be adjustable. Pivoting and/or commercial pneumatic cylinders are not acceptable.
 - c. A ductile iron disc arm shall be keyed to and suspended from the hinge shaft. A non-rotational, cast iron disc with replaceable Buna-N rubber disc seat ring shall be attached to the disc arm by means of a center pin and nut providing 360-degree oscillation. The disc seat ring shall be retained by a Type 316 stainless steel follower ring and stainless steel screws.
 - d. Manufacturers:
 - 1) GA Industries – GA Figure 250
 - 2) Or approved equal

5. Type V612: Double Disc Swing Check Valve, 2 Inches and Larger
 - a. Lug wafer style, spring loaded, cast or ductile iron body, aluminum-bronze or ductile iron doors, resilient seats, stainless steel hinge pin, stop pin spring.
 - b. Valve 2 inches through 12 inches rated 200-pound cold water and valve 14 inches through 54 inches rated 150-pound cold water.
 - c. Manufacturers:
 - 1) Crispin Valve.
 - 2) DeZurik.

6. Type V614: Stainless Steel Check Valve, 2 Inches and Smaller
 - a. Type 316 stainless steel body, disc, cap, and trim. Screwed ends and cap, swing-type disc; Class 150.
 - b. Manufacturers and Products.
 - 1) Stockham.
 - 2) Or equal.

7. Type V625: Slanting Disc Check Valve, 2 Inches and Larger
 - a. Two-piece cast iron construction, Body shall be ASTM A126, Grade B cast iron. Disc shall be bronze ASTM B584. Pivot pins and bushing shall be stainless steel. The valve shall be provided with a bottom mounted hydraulic buffer. The buffer shall contact and control the disc closure rate.
 - b. Manufacturer:
 - 1) DeZurik.
 - 2) Val-Matic.
 - 3) Crispin Valve.

8. Type V631: CPVC Ball Check Valve, 4 Inches and Smaller

- a. ASTM D1784 Cell Class 23477B chlorinated polyvinyl chloride body, single or dual union socket weld ends, rated 150 psi at 73 °F, 110 psi at 140 °F, Viton seat and seal.
 - b. Manufacturers:
 - 1) Asahi/America, Inc.
 - 2) Nibco.
 - 3) Spears.
9. Type V632: CPVC Foot Valve with Strainer, 4 Inches and Smaller
- a. ASTM D1784 Cell Class 23477B chlorinated polyvinyl chloride body, single or dual union socket weld ends, rated 150 psi at 73 °F, 110 psi at 140 °F, CPVC screen, Viton seat and seal.
 - b. Manufacturers:
 - 1) Asahi/America, Inc.
 - 2) Nibco.
 - 3) Spears.
10. Type V635: Check Valve for Air Service, 2 Inches and Larger:
- a. Check valves for low pressure process air service shall be carbon steel type with 150# flanged ends, rated 150 psig at 300 °F. Valve shall have stainless steel split disc mounted on Type 316 stainless steel center post, such that wafer type butterfly valve can be mounted directly downstream of check valve when discs of both valves are in the OPEN position.
 - b. Manufacturers:
 - 1) Techno Corporation, Style 5003
 - 2) Crane, Style H
11. Type V641: Double Check Valve Assembly, 2-1/2 Inches through 10 Inches
- a. General:
 - 1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
 - 2) Valve Body: Bronze
 - 3) End Connections: Flanged, ANSI B 16.1.
 - 4) Maximum Working Pressure: 175 PSI, (350 Hydrostatic Test Pressure).
 - 5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
 - b. Manufacturers:
 - 1) Febco.
 - 2) Watts.
 - 3) Hersey.
12. Type V642: Reduced Pressure Backflow Preventer, 3/4 Inches and Larger
- a. General, (3/4 Inches through 2 Inches):
 - 1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
 - 2) Valve Body: Bronze
 - 3) End Connection: Threaded, NPT ANSI/ASME B1.20.1
 - 4) Maximum Working Pressure: 175 PSI, (350 Hydrostatic Test Pressure).
 - 5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
 - 6) Shut-off Valves: Full port resilient seated, bronze ball valves with bronze ball valve test cocks.
 - 7) Size(s) and rating(s) as shown in the schedules following this Section.
 - 8) Manufacturers:
 - a) Febco.
 - b) Watts.
 - b. General, (2 Inches and Larger):

- 1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
 - 2) Valve Body: Ductile or Cast Iron, Class 125
 - 3) End Connections: Flanged, ANSI B 16.1
 - 4) Maximum Working Pressure: 175 PSI, (350 Hydrostatic Test Pressure).
 - 5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
 - 6) Shut-off Valves: Non-rising stem, resilient seated gate valves with bronze ball valve test cocks.
 - 7) Accessories: Drain line with air gap.
 - 8) Size(s) and rating(s) as shown in the schedules following this Section.
 - 9) Manufacturers:
 - a) Febco.
 - b) Watts.
13. Type V650: Stainless Steel Flap Valve
- a. General, (4 Inches and 6 Inches):
 - 1) Valve Body: 316 stainless steel
 - 2) End Connection: Flanged, 125# ANSI B 16.1
 - 3) Seat: buna-n seal
 - 4) Manufacturers:
 - a) Troy Valve.
 - b) Golden Harvest.

G. Self-Contained Automatic Valves:

1. Type V710: Pressure Regulating Valve, 2-1/2 Inches and Smaller
 - a. General:
 - 1) Maximum Inlet Pressure: 200 psig.
 - 2) Outlet Pressure Ranges: 20 to 80 psig.
 - 3) Maximum Allowable Outlet Pressure: 10% above spring setting, or 5 psig above setting, whichever is greater.
 - 4) Maximum Operating Differential: 5 psi.
 - 5) Maximum Operating Temperature: -20 Degrees to 150 Degrees Fahrenheit.
 - b. Construction Materials:
 - 1) Body: Bronze.
 - 2) Spring Case: Cast Iron.
 - 3) Valve Disk and Holder: Nitrile (NBR) and bronze.
 - 4) Diaphragm: Nitrile (NBR)
 - c. Manufacturers:
 - 1) Fisher.
 - 2) Mueller.
2. Type V711: High-Pressure Regulating Valve, 2 Inches and Smaller
 - a. General:
 - 1) Maximum Inlet Pressure: 300 psig.
 - 2) Outlet Pressure Ranges: 5 to 150 psig.
 - 3) Maximum Operating Temperature: 150 Degrees Fahrenheit.
 - b. Construction Materials:
 - 1) Body: Stainless Steel.
 - 2) Spring Case: Stainless Steel.
 - 3) Valve Disk and Holder: Nitrile (NBR) and bronze.
 - 4) Diaphragm: Nitrile (NBR)
 - c. Manufacturers:
 - 1) Fisher.
 - 2) Mueller.
3. Type V712: High-Pressure Regulating Valve, 3 Inches and Smaller

- a. General:
 - 1) Maximum Inlet Pressure: 150 psig.
 - 2) Outlet Pressure Ranges: 5 to 125 psig.
 - 3) Maximum Operating Temperature: 140 Degrees Fahrenheit.
 - b. Construction Materials:
 - 1) Body: Machined PVC
 - 2) Seals: Viton
 - c. Manufacturers:
 - 1) Plast-O-Matic Valves, Inc.
4. Type V713: Pressure Reducing Valve, 1 Inch through 4 Inches
- a. General:
 - 1) Maximum Inlet Pressure: 250 psig (Cast Iron), 300 psig (Steel).
 - 2) Droop: 10% of outlet pressure setting.
 - 3) Maximum Differential Pressure: 150 psig or body rating limit, whichever is lower.
 - 4) Body: Ductile Iron, Cast Steel, or Bronze.
 - 5) Disc Retainer and Diaphragm Washer: Cast Iron, Cast Steel, or Bronze.
 - 6) Stem, Nut and Spring: Stainless Steel
 - 7) Diaphragm: Nylon Reinforced Buna-N Rubber
 - b. Manufacturers:
 - 1) Cla-Val.
 - 2) Fisher.
 - 3) Ross Valve.
5. Type V730: Pressure Relief Valve, 2 Inches and Smaller
- a. Direct diaphragm, spring controlled, Type 316 stainless steel body, spring case, Type 316 stainless steel diaphragm, stainless steel valve stem.
 - b. Capable of opening when upstream-pressure reaches a maximum set point.
 - c. Manufacturers:
 - 1) Fisher.
 - 2) Or equal.
6. Type V731: Pressure Relief Valve, 1/4 Inch through 2 Inches
- a. General:
 - 1) Maximum Line Pressure: 150 psi
 - 2) Setting Range: 15-150 psi
 - b. Capable of opening when upstream-pressure reaches a maximum set point.
 - c. Construction Materials:
 - 1) Body: PVC, CPVC
 - 2) Spring Case: PVC
 - 3) Spring Keepers: PVC
 - 4) Diaphragm: PVC, PTFE
 - 5) Orifice Seal: EPDM, FKM
 - 6) Adjustment Screw: 316 SS
 - d. Manufacturers:
 - 1) Primary Fluid Systems, Inc.
 - 2) Or equal.
7. Type V732: Pressure Relief Valve, Pressure Sustaining Valve, 1 Inch and Larger
- a. Hydraulically operated, diaphragm, actuated, pilot controlled globe valve, cast iron body, ANSI B16.1 flanged ends, rated 175 psi, stainless steel trim, stainless steel stem, externally mounted strainers with cocks, to open when upstream pressure reaches a maximum set point.
 - b. Manufacturers:

- 1) Cla-Val.
 - 2) Or equal.
8. Type V750: Well Service Air Valve, 1/2 Inch and Larger
- a. Fully automatic float operated valve, suitable for vertical turbine pump discharge service, designed to exhaust air which is present in pump column on pump start-up and allow air to re-enter the column on pump shutdown or should a negative pressure occur.
 - b. Valves used in potable water service shall be NSI/ANSI 61 certified.
 - c. Valves 3" and smaller shall be equipped with a dual port throttling device to provide adjustable control of the exhaust rate and allow free air to flow into the valve through a separate inlet port. Valves 4" larger shall be equipped with a regulated exhaust device, which shall allow free airflow in and out of the valve, close upon rapid air exchange, and control the air exhaust rate to reduce pressure surges.
 - d. Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550.
 - e. Connections:
 - 1) Inlet-Valve sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection. Valve sizes 4 in. and larger shall have bolted flange inlets equal to the valve size. Flanges shall be in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.42 for Class 300 ductile iron flanges.
 - f. Outlets-Valve sizes 6 in. and smaller shall have NPT outlets; Valves 8 in. and larger shall have ANSI B16.1 Class 125 outlet flanges. The valve shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing, and draining.
 - g. Materials: The Well Service Air Valve body, cover, and baffle shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Class 300 ductile iron valves shall be constructed of ASTM A536 Grade 65-45-12 cast ductile iron. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N.
 - h. Manufacturers:
 - 1) Val-Matic.
 - 2) DeZurik.
 - 3) Crispin Valve.
9. Type V752: Wastewater Combination Air Valves, 1 Inch and Larger
- a. Valve shall be automatic float operated valve designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure.
 - b. Valve shall perform functions of both air release and Air/Vacuum valves and be furnished as a single body.
 - c. Valve shall be suitable for use with domestic sewage.
 - d. Valve body and structure shall be constructed of cast iron or ductile iron. Float, guide shafts and bushings shall be stainless steel.
 - e. Manufacturers:
 - 1) Val-Matic.
 - 2) DeZurik.
 - 3) Crispin Valve.
10. Type V755: Clean Water Combination Air Valve, 1 Inch and Larger

- a. Valve shall be automatic float operated valve designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. Valve shall open during draining or if negative pressures occur. Valve shall also release accumulated air from a piping system while system is in operation and under pressure.
 - b. Valve shall perform functions of both air release and Air/Vacuum valves and be furnished as a single body.
 - c. Valves used in potable water shall be NSF/ANSI certified.
 - d. Valve body and structure shall be constructed of cast iron or ductile iron. Float, guide shafts and bushings shall be stainless steel.
 - e. Manufacturers:
 - 1) Val-Matic.
 - 2) DeZurik.
 - 3) Crispin Valve.
11. Type V780: Safety Relief Valve for Air Service, 1-1/2 Inch through 3 Inches
- a. Spring loaded, adjustable pressure relief valve for process air service, with stainless steel trim; seat material suitable for elevated temperatures above 300 °F, test pull ring or lever.
 - b. Manufacturers:
 - 1) Kunkle.
 - 2) Apollo Valve
12. Type V785: Safety Relief Valve for Air Service
- a. Exposed spring, full nozzle with stainless steel trim, cast steel body, seat material suitable for elevated temperatures above 300 °F.
 - b. Manufacturers:
 - 1) Kunkle.
- H. Miscellaneous Valves:
1. Type V901: Diaphragm Valve, 1/2 Inch and Larger
- a. Diaphragm valves shall be weir type with solid CPVC body and bonnet. Provide with Type 316 stainless steel bushing bolts, and other integral metallic components (etc., sleeve and stem). All metallic components shall be isolated for contact with fluid and the surrounding atmosphere. Valves 1/2" through 2" shall have true union socket ends. Valves 2-1/2" and larger shall have ANSI flanged ends. Manual operator shall be indicating, rising stem type with hand wheel. Valve working pressure shall be 100 psig at 120 °F. Valve must also be suitable for testing at elevated pressure per respective flow stream as indicated in Piping Schedule. Diaphragm shall be PTFE or Viton.
 - b. Manufacturers:
 - 1). George Fisher.
 - 2). Asahi/America, Inc.
2. Type V902: Pinch Valve
- a. Iron body, fanged ends, TFE Teflon sleeves, upper and lower pinch bars, and hand wheel operator.
 - b. Manufacturer:
 - 1). Red Valve Co.
3. Type V903: Anti-Siphon/Back Pressure Valves, 2 Inch and Smaller
- a. Spring controlled diaphragm, CPVC body, with a safety vent, to close when upstream pressure reaches a minimum set point and serve as an anti-siphon device. Rated 150 psi. The safety vent shall be connected to a leak containment system which shall include clear polyethylene tubing connecting to a vented, CPVC spill chemical neutralization bucket appropriate for the chemical service.

- b. Construction Materials:
 - 1) Body: CPVC
 - 2) Diaphragm: PTFE
 - c. Manufacturers:
 - 1) Plast-O-Matic Valves, Inc.
 - 2) Or equal.
4. Type V910 Telescoping Valve, 4 Inches through 36 Inch
- a. Valve configuration shall be as shown on the Drawings and detailed within the Supplements following End of Section.
 - b. Complete assembly consisting of rising stem, slip tube, seal flange, lifting bail, valve stand with indicator and motor, when required, and Type 316 stainless steel anchor bolts and mounting hardware.
 - c. Slip tube shall be Type 304 stainless steel, manufactured from seamless pipe or tube, with a minimum wall thickness of 1/8" and must be of sufficient length to facilitate valve travel and maintain an appropriate insert depth.
 - d. A stainless steel companion flange and neoprene slip seal gasket shall be provided. The gasket shall be a minimum 1/4-inch thick, mounted to allow sliding and shall be watertight throughout the travel of the slip tube.
 - e. Lift shall be handwheel type and stem shall be of the rising type, stainless steel, thrust bearings, automatic self-locking, and provide infinite valve positioning. A clear plastic Butyrate stem cover shall be provided with a mylar strip type position indicator, calibrated in 1/4-inch increments to illustrate valve position.
 - f. Manufacturers and Products:
 - 1) Troy Valve
 - 2) Waterman; TS-2.
 - 3) Golden-Harvest
 - 4) Amwell; Type RP.
5. Type V915: Mud Valve
- a. Cast iron body tapered seat, bronze disc and seat ring, frame flanged, nonrising type stem, bronze extension stem, 2" square operating nut for floor box operation, and stem guides for maximum unsupported stem length of 5 feet.
 - b. Manufacturers and Products:
 - 1) Waterman; MV11.
 - 2) Clow; F-3075.
 - 3) Troy Valve; A25600RB
6. Type V916: Mud Valve
- a. Type 316 stainless steel body tapered seat, disc and seat ring, frame flanged, nonrising type stem, stainless steel extension stem, 2" square operating nut for floor box operation, and stem guides for maximum unsupported stem length of 5 feet.
 - b. Manufacturers and Products:
 - 1) Waterman.
 - 2) Clow.
 - 3) Troy Valve
7. Type V940 Solenoid Valve, 2 Inches and Smaller
- a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA Class A, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized) as indicated.
 - b. Minimum operating pressure differential no less than 5 psig, maximum operating pressure differential no greater than 125 psig.
 - c. Manufacturers and Products:

- 1) ASCO
- 2) Skinner

8. Type V941 Plastic Body Solenoid Valve, 2 Inches and Smaller
 - a. Two-way internal pilot operated diaphragm type, PVC body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA 4X, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized) as indicated.
 - b. Minimum operating pressure differential no less than 5 psig, maximum operating pressure differential no greater than 140 psig.
 - c. Manufacturers and Products:
 - 1) Plast-O-Matic Valves, Inc.
 - 2) Or Equal.

2.6 TAGGING REQUIREMENTS

- A. See Section 22 05 53, MECHANICAL IDENTIFICATION.
- B. The tags shall be attached to the valves by soldered split key rings so that ring and tag cannot be removed. The tag shall bear the 1/4" die-stamped equipment identification number as indicated in the Contract Documents.

2.7 ACCESSORIES

- A. T-Handled Operating Wrench:
 1. 2 each galvanized operating wrenches, 4 feet long.
 2. Manufacturers and Products:
 - a. Mueller; No. A-24610.
 - b. Clow No.; F-2520.
 3. 2 each galvanized operating keys for cross handled valves.
- B. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 6" ID shaft.
 1. Box: Cast iron with minimum depth of 9".
 2. Lid: Cast iron, minimum depth 3", marked for the appropriate service.
 3. Extensions: Cast iron.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

- A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.2 INSTALLATION

- A. Flange Ends:
 1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
 2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
- B. Screwed Ends:
 1. Clean threads by wire brushing or swabbing.
 2. Apply joint compound.
- C. Valve Orientation:

1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4' 6" or less above finished floor, unless otherwise shown.
 2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4' 6" and 6' 9" above finish floor, unless otherwise shown.
 3. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.
 4. If no plug valve seat position is shown, locate as follows:
 - a. Horizontal Flow: The flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve.
 - b. Vertical Flow: Install seat in the highest portion of the valve.
- D. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flow meters, for isolation during maintenance.
- E. Install safety isolation valves on compressed air.
- F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.
- G. Extension Stem for Operator: Where the depth of the valve is such that its centerline is more than 3 feet below grade. Furnish an operating extension stem with 2" operating nut to bring the operating nut to a point 6" below the surface of the ground and/or box cover.
- H. Torque Tube: Where operator for quarter-turn valve is located on floor stand. Furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.
- I. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

3.3 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.
- E. Set, verify, and record set pressures for all relief and regulating valves.
- F. Automatic valve to be tested in conjunction with control system testing.
- G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.4 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified herein shall be present at the jobsite for the minimum person-days listed for the services herein under, travel time excluded:
 1. 2 person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
 2. 2 person-days for functional and performance testing.
 3. 2 person-days for pre-startup classroom or jobsite training of OWNER'S personnel.

B. Training of OWNER'S personnel shall be at such times and at such locations as requested by OWNER.

C. See Section 01 79 00, Demonstration and Training.

3.5 MANUFACTURER'S CERTIFICATE(S)

A. Provide Manufacturer's certificate(s) in accordance with Section 01 79 00.

3.6 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.
1. Power Operated Valve Schedule.

END OF SECTION

SECTION 40 24 00 - PROCESS PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI):
 - a. B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 - b. B16.5, Pipe Flanges and Flanged Fittings.
 2. American Society for Testing and Materials (ASTM):
 - a. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
 3. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.2 SUBMITTALS

- A. Shop Drawings: Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide required piping specialty items, whether shown or not shown on the Drawings, as required by applicable codes and standard industry practice.
- B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded pipe joints are not.

2.2 CONNECTORS

- A. Teflon Bellows Connector:
1. Type: Two convolutions unless otherwise shown, with metal reinforcing bands.
 2. Flanges: Ductile iron, drilled 150 psi ANSI B16.5 standard.
 3. Working Pressure Rating: 140 psi, minimum, at 120 ° F.
 4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.
 5. Manufacturers and Products:
 - a. Garlock; Style 214.
 - b. Resistoflex; No. R6904.
- B. Elastomer Bellows Connector:
1. Type: Fabricated spool, with single filled arch.
 2. Materials: Nitrile tube and neoprene cover.
 3. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard, with full elastomer face and steel retaining rings.
 4. Working Pressure Rating: 140 psig, minimum, at 180° F for sizes 12" and smaller.
 5. Thrust Restraint: Control rods to limit travel of elongation and compression.
 6. Manufacturers and Products:
 - a. Goodall Rubber Co.; Specification E-1462.
 - b. Garlock; Style 204.
- C. Sleeve Type Coupling Manufacturers:

1. Dresser.
2. Rockwell.

D. Closure Collar Concrete: As specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.3 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced, molded wide-arch.
2. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard with split galvanized steel retaining rings.
3. Washers: Over the retaining rings to help provide a leak proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250° F.
7. Rated Deflection and Pressure:
 - a. Lateral Deflection: 3/4" minimum.
 - b. Burst Pressure: Four times the working pressure.
 - c. Compression deflection and minimum working pressure as follows:

Size (inch)	Deflection (inch)	Pressure (psig)
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:
 - a. General Rubber Corp.; Style 1015 Maxijoint.
 - b. Mercer; Flexmore Style 450.
 - c. Goodall Rubber Co.; Specification E-711.

B. Teflon Bellows:

1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ANSI B 16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120° F.
4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.
5. Manufacturers and Products:
 - a. Garlock; Style 215.
 - b. Resistoflex; No. R6905.

C. Copper Pipe Expansion Compensator:

1. Material: All bronze.
2. Working Pressure Rating: 125 psig, minimum.
3. Accessories: Anti-torque device to protect the bellows.
4. Manufacturers and Products:
 - a. Flexonics; Model HB.
 - b. Hyspan; Model 8509 or 8510.

D. Galvanized and Black Steel Pipe Expansion Compensator:

1. Material: Carbon steel with stainless steel bellows.
2. Working Pressure Rating: 150 psig, minimum.
3. Accessories: Anti-torque device to protect the bellows.
4. Manufacturers and Products:
 - a. Flexonics; Model H.
 - b. Hyspan; Model 8503.

- E. Flexible Metal Hose:
 - 1. Type: Close pitch, annular corrugated with single braided jacket.
 - 2. Material: Stainless steel, ASTM A276, Type 321.
 - 3. End Connections:
 - a. 3" and Larger: Shop fabricated flanged ends to match mating flanges.
 - b. 2-1/2" and Smaller: Screwed ends with one union end.
 - 4. Minimum Burst Pressure: 600 psig at 70° F for 12" and smaller.
 - 5. Length: Provide hose live-length equal to the lengths shown on the Drawings.
 - 6. Manufacturers and Products:
 - a. Flexonics; Series 401M.
 - b. Anaconda; BWC21-1.

2.4 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

- A. Manufacturers and Products:
 - 1. Flexonics; Model TCS, with tie bolts.
 - 2. Keflex; Type 152-TR, with tie bolts.

2.5 SERVICE SADDLES

- A. Double-Strap Iron:
 - 1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
 - 2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
 - 3. Taps: Iron pipe threads.
 - 4. Materials:
 - a. Body: Malleable or ductile iron.
 - b. Straps: Galvanized steel.
 - c. Hex Nuts and Washers: Steel.
 - d. Seal: Rubber.
 - 5. Manufacturers and Products:
 - a. Smith-Blair; Series 313 or 366.
 - b. Dresser; Style 91.
- B. Nylon-Coated Iron:
 - 1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
 - 2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
 - 3. Materials:
 - a. Body: Nylon-coated iron.
 - b. Seal: Buna-N.
 - c. Clamps and Nuts: Stainless steel.
 - 4. Manufacturer and Product:
 - a. Smith-Blair; Style 315 or 317.

2.6 INSULATING FLANGES, COUPLINGS, AND UNIONS

- A. Materials:
 - 1. In accordance with the applicable piping material specified in the Pipe Data Sheets.
 - 2. Galvanically compatible with piping.
- B. Union Type:
 - 1. 2" and Smaller: Screwed or solder-joint.
 - 2. 2-1/2" and Larger: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.

- C. Working Pressure Rating: Suitable for specified system working pressure.
- D. Manufacturers and Products:
 - 1. Dielectric Flanges and Unions:
 - a. Epcos Sales, Inc.
 - b. Capitol Insulation Unions.
 - 2. Insulating Couplings:
 - a. Dresser; STAB-39.
 - b. R. H. Baker; Series 216.

2.7 WALL PIPES

- A. Ductile Iron Wall Pipe:
 - 1. For penetrations through concrete walls, floors, slabs, or roofs that are to be watertight.
 - 2. Diameter and Ends: Same as connecting ductile iron pipe.
 - 3. Thickness: Equal to or greater than remainder of pipe in line.
 - 4. Fittings: In accordance with applicable Pipe Data Sheet.
 - 5. Thrust Collars:
 - a. Provide for all wall pipes.
 - b. Rated for thrust load developed at 250 psi.
 - c. Safety Factor: 2, minimum.
 - d. Material and Construction:
 - Ductile iron or cast iron, cast integral with wall pipe wherever possible.
 - Fabricate welded attachment of ductile iron thrust collar to pipe where casting impossible. Perform in pipe manufacturer's shop by qualified welders. Electric arc welds of ductile iron with NI-55 or FC-55 nickel-iron-carbon weld rod. Continuously weld on each side all around.
 - 6. Manufacturers: American Cast Iron Pipe Co.; U.S. Pipe and Foundry Co.
 - 7. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 2
- B. Steel or Stainless Steel Wall Pipe:
 - 1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
 - 2. Lining: Same as connecting pipe.
 - 3. Thrust Collar: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe. Continuously fillet weld on each side all around.
 - 4. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 2
 - 5. Restraint: Provide lugs for use with thrust ties as specified.

2.8 PIPE SLEEVES

- A. Steel Pipe Sleeve:
 - 1. Material: 3/16" minimum thickness steel pipe.
 - 2. Seep Ring:
 - a. 3/16" minimum thickness center steel flange for water stoppage on sleeves in exterior or water-bearing walls.
 - b. Outside Diameter: 3" greater than pipe sleeve outside diameter.
 - c. Continuously fillet weld on each side all around.
 - 3. Factory Finish:
 - a. Galvanizing:
 - Hot-dip applied, meeting requirements of ASTM A153.
 - Electroplated zinc or cadmium plating is unacceptable.
 - b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, PROTECTIVE PAINTING AND COATINGS, System No.2.

- B. Insulated and Encased Pipe Sleeve:
 1. Manufacturer: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.
- C. Modular Mechanical Seal:
 1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
 2. Fabrication: Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts, nuts, and pressure plates.
 3. Size: According to Manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
 4. Manufacturer: Thunderline Link-Seal.

2.9 MISCELLANEOUS SPECIALTIES

- A. Strainers for Process Water Service, 2" and Smaller:
 1. Type: Bronze Body, Y-Pattern, 200 psi non-shock rated, with screwed gasketed bronze cap.
 2. Screen: Heavy gauge Type 304 stainless steel or Monel, 20-mesh
 3. Manufacturers:
 - a. Armstrong International, Inc.; Model F
 - b. Mueller Steam Specialty; Model 351M.
- B. Strainers for CPVC, Plastic Piping Systems, 4" and Smaller:
 1. Type: Y-pattern CPVC body, 150 psi non-shock rated, with screwed CPVC cap; and PTFE Teflon seals as recommended by manufacturer for service.
 2. End Connections: Screwed or solvent weld, 2" and smaller. Class 150 ANSI flanged, 1-1/2" and larger.
 3. Screen: Heavy-gauge CPVC, 1/32" mesh, minimum 2 to 1 screen area to pipe size ratio.
 4. Manufacturers and Products: Hayward; Series 85/80, or equal.
- C. Spray Nozzles:
 1. Scum Spray Nozzle Type 1:
 - a. Spray Pattern: Even
 - b. Spray Angle: 140° at 60 psi
 - c. Material: 316 Stainless Steel
 - d. Deflection Angle: 75°
 - e. Capacity: 8 gpm at 40 psi
 - f. Size: 1/2" NPT
 - g. Provide nozzle with adjustable ball fitting
 - h. Manufacturer and Produce: Spraying System Co., Nozzle Type K; or equal.
 2. Scum Spray Nozzle Type 2:
 - a. Spray Pattern: Solid narrow angle cone-shaped spray pattern with round impact area
 - b. Spray Angle: 15° at 40 psi
 - c. Material: 316 stainless steel
 - d. Capacity: 3 gpm at 40 psi
 - e. Size: 1/4" NPT
 - f. Provide nozzle with adjustable ball fitting
 - g. Manufacturer and Product: Spraying System Co., Nozzle Type G-15; or equal.
 3. Scum Spray Nozzle Type 3:
 - a. Spray Pattern: Deflected flat spray pattern at low pressure
 - b. Counterweight lever which when lifted, allows the solid stream flow to purge nozzle.
 - c. Material: Bronze with neoprene rubber deflector
 - d. Size: 1/4" NPT

- e. Manufacturer and Product: Spraying System Co., 22561 Foam Control Spray Nozzles; or equal.
- D. Quick Couplings:
- 1. Provide female NPT by male quick-connect hose adaptors. All adapters and couplers shall satisfy dimensional requirements of MIL-C-27487E and shall be cast iron and sized shown on the Drawings.
 - 2. Manufacturers and Products: Swagelock; Series QH.
- E. Quick Disconnect Cam Operating Couplings for Chemical Service:
- 1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
 - 2. Material: Glass-filled polypropylene and PVDF with Teflon gaskets and as recommended for the service by Manufacturer.
 - 3. End Connections: NPT threaded or flanged to match piping connections.
 - 4. Hose shanks for chemical installations.
 - 5. Plugs and Caps: Female dust cap for each male end, male dust plug for each female end.
 - 6. Pressure Rating: 125 psi, minimum at 70° F.
 - 7. Manufacturers:
 - a. OPW; Kamlock
 - b. Ryan Herco; 1300 Series
 - c. Goodall; Basic Eight
- F. Chemical Injection Quills:
- 1. Retractable injection quill, service rated for 250 psi, including stainless steel check valve, ball valve, solution tube adaptor, packing nut, restraint system, and limit chains, and 300 Series O-ring gaskets.
 - 2. Manufacturer and Products: SAF-T-FLO; or equal.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

- A. As specified in Section 01 60 00, PRODUCT REQUIREMENT.
- B. Install process piping specialties in accordance with manufacturer's directions, as shown on the Drawings, and as specified herein.

3.2 PIPING FLEXIBILITY PROVISIONS

- A. General:
 - 1. Install thrust protection.
 - 2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.
- B. Flexible Joints at Concrete Backfill or Encasement: Install within 18" or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.
- C. Flexible Joints at Concrete Structures:
 - 1. Install 18" or less from the face of structures; joint may be flush with face.
 - 2. Install a second flexible joint, whether or not shown.
 - a. Pipe Diameter 18" and smaller: Within 18" of the first joint.
 - b. Pipe Diameter Larger than 18": Within one pipe diameter of the first joint.

3.3 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipes where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling Manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
 - a. Locate away from structures so that there are at least two flexible joints between the closure and pipe entering the structure.
 - b. Clean pipe surface before closure collars are placed.
 - c. Wet non-metallic pipe thoroughly prior to pouring collars.
 - d. Prevent concrete from entering pipe.
 - e. Extend collar a minimum of 12" on each side of joint with minimum thickness of 6" around outside diameter of pipe.
 - f. Make entire collar in one placement.
 - g. After concrete has reached initial set, cure by covering with well moistened earth.

3.4 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer Bellows Expansion Joint.
2. Nonmetallic Pipe: Teflon Bellows Expansion Joint.
3. Screwed and Soldered Piping Systems: Copper or Galvanized and Black Steel Pipe Expansion Compensator, as applicable.
4. Pipe Run Offset: Flexible Metal Hose.

C. Anchors and Anchor Walls: Install as specified in Section 22 05 29, PROCESS SUPPORTS AND ANCHORS, to withstand expansion thrust loads and to direct and control thermal expansion.

3.5 SERVICE SADDLES AND THRUST TIES

A. Service Saddles:

1. Ferrous Metal Piping (except stainless steel): Double-strap iron.
2. Plastic Piping: Nylon-coated iron.

B. Thrust Ties:

1. Install where shown and where required to restrain the force developed by the specified test pressure.
2. Steel Pipe: Attach with fabricated lugs.
3. Ductile Iron Pipe: Attach with socket clamps against a grooved joint coupling or flange.
4. Flanged Coupling Adapters: For exposed installations, install Manufacturer's anchor studs through the coupling sleeve.

- C. Installation: Install in accordance with Manufacturer's written instructions.
 - 1. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
 - 2. Remove pipe coating if necessary to present smooth surface.

3.6 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

- A. Tie Bolts: Tighten snug prior to applying any pressure to the system.

3.7 INSULATING FLANGES, COUPLINGS, AND UNIONS

- A. Applications:
 - 1. Copper to ferrous metal piping connections.
 - 2. Cathodically protected piping penetration to buildings and watertight structures.
 - 3. Submerged to un-submerged metallic piping connections.
 - 4. Where required for electrically insulated connection.
- B. Installation of Insulating Kits: Drill oversize to accommodate insulating sleeves through the bolt holes, assuming standard bolt sizes.
- C. Pipe Installation:
 - 1. Insulating joints connecting immersed piping to non-immersed piping shall be installed above maximum water surface elevation.
 - 2. All submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete basins shall be isolated from the concrete reinforcement steel.

3.8 WALL PIPES

- A. Applications:
 - 1. As specified in Section 40 23 39, PROCESS PIPING - GENERAL
 - 2. Watertight and Below Ground Penetrations:
 - a. Wall pipes with thrust collars.
 - b. Provide taps for stud bolts in flanges to be set flush with wall face.
 - c. Existing Walls: Rotary drilled holes.
 - 3. Wall Pipe Installation:
 - a. Isolate embedded metallic piping from concrete reinforcement.
 - b. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.9 PIPE SLEEVES

- A. Application:
 - 1. As specified in Section 40 23 39, PROCESS PIPING - GENERAL.
 - 2. Above Grade in Non-submerged Areas: Hot-dip galvanized after fabrication.
 - 3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
- B. Installation:
 - 1. Support non-insulating type securely in form work to prevent contact with reinforcing steel and tie-wires.
 - 2. Caulk joint with rubber sealant or seal with wall penetration seal.

3.10 MISCELLANEOUS SPECIALTIES

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

DIVISION 44
POLLUTION CONTROL EQUIPMENT

SECTION 44 42 56.46 – VERTICAL CLOSE-COUPLED SOLIDS-HANDLING PUMP

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Vertical close-coupled solids-handling pumps and components to be supplied by the Contractor.
- B. Related Sections:
 - 1. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
 - a. Section 26 05 00: Common Work Results for Electrical

1.2 QUALITY ASSURANCE

- A. Qualifications of manufacturer:
 - 1. The proposed manufacturer of equipment shall have been successfully engaged in the manufacture of similar equipment for at least 5 years prior to the start of this work and shall have a record of installations acceptable to the Engineer.
 - 2. Pump(s) are to be engineered and manufactured under the certification of ISO-9001:2000.
- B. Qualifications of installer:
 - 1. Use only skilled and experienced workmen who are thoroughly trained in the fabrication and installation of the selected equipment.
- C. Unit Responsibility: Pump(s), complete with motor, coupling, necessary guards and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to insure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- D. Codes and standards:
 - 1. Materials shall be suitable for service conditions. Iron castings shall be tough, close grained gray cast iron free from blowholes, flaws, or excessive shrinkage and shall conform to ASTM A48. Structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads.
 - 2. Electric motors shall be designed and applied in compliance with NEMA, ANSI, IEEE, and AFBMA standards and the NEC for the specific duty imposed by the driven equipment.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Within 30 days after award of Contract, and before any of the materials of this Section are delivered to the job site, submit complete Shop Drawings and catalog cuts to the Engineer in accordance with the provisions of Section 01 33 00, SUBMITTAL PROCEDURES of these Specifications, showing details of all equipment of this Section.
- B. Manufacturer's recommendations:
 - 1. Accompanying the Shop Drawings, submit two copies of the manufacturer's current recommended method of installation.

1.4 PRODUCT HANDLING

A. Protection:

1. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times. Pumps, motors, electrical equipment, and other equipment having antifriction or sleeve bearings shall be stored in weather tight warehouses which are maintained at a temperature at least 60 degrees F.
2. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of the Engineer.
3. Electrical equipment, controls, and insulation shall be protected against moisture or water damage. All space heaters provided in the equipment shall be kept connected and operating at all times until equipment is placed in service.

B. Replacements:

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. The vertical close-coupled dry-pit solids-handling pump specified in this section shall be furnished by and be the product of one manufacturer.
- B. Where a Manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features, and materials of construction as specified herein.
- C. Manufacturer of components and accessories specified herein shall be as follows:
 1. Fairbanks Nijhuis
 2. Or approved equal

2.2 PUMP CONSTRUCTION

- A. General: Major components shall be of gray cast iron, ASTM A-48, Class 30, with smooth surfaces devoid of blowholes or other casting irregularities.
- B. Type: vertical wet-pit centrifugal pump, driven by a vertical, submersible squirrel cage induction motor
- C. Volute/Casing
 1. The pump casing shall be ASTM 48, Class 30, cast-iron capable of hydrostatic test @150% of maximum discharge pressure and have a register fit to ensure alignments. The volute is to be of one piece circular constant flow, equalizing pressure design with smooth fluid passages large enough to pass any size solid that can pass through the impeller. Tapping openings provided for priming, venting, draining and suction and discharge gauge connections. Piping connection to be as shown per pump data sheet.
 2. The volute shall be side flanged tangential discharge and capable of rotation in 45 degree increments to accommodate piping orientation. Diffusion vanes are not permitted.
 3. The volute shall be furnished with large cleanout openings located at the impeller centerline, to allow access to the impeller. Volute priming, drain and 1/2" minimum gauge connections shall be provided. Flanges shall be 125 lbs. (250 lb. discharge flange on 6" C5446) flat faced flanges per ANSI drilling.

4. The casing shall be designed to permit the removal of the rotating assembly without disturbing the suction or discharge piping. The casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head whichever is greater.

D. Shaft Assembly

1. The pump shaft shall be constructed of high-strength 400 Series stainless steel with a minimum 100,000 PSI tensile strength and 75,000 PSI yield strength of sufficient diameter to carry the maximum loads imposed and to prevent vibration and fatigue.
2. The shaft shall be accurately machined along its entire length and precision ground at bearing locations. Keyways shall be provided at both ends.
3. A renewable straight shaft sleeve, positive adhesive sealed to prevent leakage between the shaft and the sleeve, shall protect the shaft through the sealing box area.
4. The shaft sleeve shall be stainless steel with a Brinell hardness of 300 to 350.
5. Radial inboard bearings shall be single-row grease lubricated ball bearings designed to carry the hydraulic radial loads encountered in the service conditions. Thrust outboard bearings shall be single-row designed to carry the pump hydraulic axial and dead load thrust. Bearing shall be designed for a nominal L10 life of 100,000 hours per AFBMA at best efficiency point.

E. Rotation

1. The pump will have clockwise rotation when viewed from the driver end looking at the pump.

F. Impeller

1. The impeller shall contain a stainless steel A743 GR CA-40 300 BHN wear ring.
2. The impeller shall be of one-piece construction, single suction, two-vane, enclosed, radial flow design with well-rounded leading vanes and then tapered toward the trailing edge for a circular flow pattern. Impellers shall be dynamically balanced and secured to the shaft by means of a bolt, washer, and key. The arrangement shall be such that the impeller cannot be loosened from torque in either forward or reverse rotation.
3. All impellers are to be statically balanced to insure smooth operation, also hydraulically balanced except in some small sizes where end thrust is but a minor factor.
4. The clearance between the impeller outside diameter and cutwater shall be capable of passing a 3.5" sphere.
5. The arrangement shall be such that the impeller cannot be loosened from torque in either forward or reverse rotation.

G. Fronthead

1. The fronthead shall be made of close-grained cast iron conforming to ASTM A48 CL30. It shall be cast separately (integrally on B5441) to the volute and connected to the (suction elbow)(combination base elbow).

H. Backhead

1. A separately cast close-grained cast iron backhead with large access openings and integral sealing box conforming to ASTM A48 Class 30 shall be provided.
2. The sealing box shall be designed for use with conventional packing and mechanical seal without requiring re-machining.
3. The sealing box shall be furnished with a 1/4" injection and vent tap for a clear water or grease connection to a water seal ring to prevent air from entering the pump through the sealing box.
4. A 3/4" minimum sealing box drain tap shall be provided. Sealing box leakage will be collected by the packing box drain trough and piped directly to drain, eliminating any drippage to the floor.
5. A minimum of 5 rings of graphite impregnated synthetic packing and a split PTFE Coating water seal ring shall be furnished. Glands shall be two-piece split interlocking made of bronze held in place by studs and nuts.

- I. Base and Elbow
 - 1. A rugged heavy duty fabricated steel base, with openings large enough to permit access to the suction elbow and cleanout, bolted directly to the volute shall be provided.
 - 2. The base shall be designed to support the assembled weight of the pump and driver. A cast iron 5" x 6" suction elbow, contoured handhole cleanout, and 125 lb flat-faced flange conforming to ANSI drilling shall be furnished.
 - 3. A heavy duty integrally cast one-piece base and elbow made of cast iron conforming to ASTM A48 Class 30 shall be provided. Base elbow is to be furnished with gauge connections to handhole cleanout located 180 degrees from the suction flange. Suction flange will be 6" 125 lb flat-faced flange conforming to ANSI drilling.

- J. Frame
 - 1. The bearing frame shall be close-grained cast iron conforming to ASTM A48 Class 30 and of heavy, rugged design for carrying the bearings and machined for accurate and permanent bearing alignment completely enclosing the shaft between the bearings.
 - 2. The bearing housing shall be of dust proof design incorporating lip type grease seals in contact with the shaft to prevent the entrance of contaminants.
 - 3. Jacking bolts for external impeller adjustment are required. Zerk-type grease fittings for bearing lubrication shall be supplied at the bearing housings.

- K. Hardware
 - 1. All machine bolts, nuts, and capscrews shall be of the hex head type and will not require the use of any special tools.

- L. Shop painting:
 - 1. See structural steel and miscellaneous metal for non-submerged metals.

- M. Vibration Limitations
 - 1. The limits of vibration as set forth in the standards of the Hydraulic Institute shall govern.

- N. Balance:
 - 1. All rotating parts shall be accurately machined and shall be in as rotational balance as is possible. Excessive vibration shall be cause for rejection of equipment. Resonance shall be avoided at operating speeds.
 - 2. Vibration displacement (peak to peak) as measured at any point on the machine shall not exceed requirements of the Hydraulic Institute at any operating speed.
 - 3. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components shall be less than 0.8 or more than 1.3.
 - 4. Contractor shall provide the services of an independent testing company to check the balance of the installed pump at operating conditions and submit a report to the Engineer at no additional cost to the Owner. Tests shall include displacement, velocity, and critical speed of vibrations with certified test results. Testing services shall be Cullum-Brown Company, ABC (American Bearing Co.), Douglas Pump Co, or approved equal.

PART 3 - EXECUTION

3.1 TESTING

- A. The pump(s) shall be performance tested for flow, head, and efficiency, and hydrostatic tested and the manufacturer's plant prior to shipment, in accordance with Hydraulic Institute '1U' Test Standards. Certified copies of the test curves and hydrostatic test results shall be submitted to the engineer for approval.

3.2 SURFACE CONDITIONS

A. Inspection:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that all equipment may be properly installed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.

B. Discrepancies:

1. In the event of discrepancies, immediately notify the Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 INSTALLATION

3.4 SHIPPING, STORAGE, HANDLING, AND PROTECTION

- A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.5 INSTALLATION

- A. Work shall be as specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.6 PAINTING AND COATING

- A. Shop prime and field finish paint ferrous metal in accordance with and as specified in Section 09 90 00 PAINTING AND PROTECTIVE COATINGS Division 09, FINISHES, System No. 2 for all submerged metal surfaces and System No.4 for all non submerged metal surfaces.
- B. Exposed metal surfaces of motors, gear reducers, and drive assemblies shall be factory prepared and primed and field finish coated in accordance with Section 09 90 00 PAINTING AND PROTECTIVE COATINGS Division 09, FINISHES, System No. 4.

3.7 FACTORY TESTS

- A. Motor Tests and Test Reports: As specified in Division 26, ELECTRICAL.
- B. Balance of Vibration: The rotating parts of each pump and its driving unit shall be dynamically balanced before final assembly. The driving unit alone shall operate without vibration in excess of the limits stated in the latest revision of NEMA MG 1.

3.8 FIELD TESTS

- A. Functional Test: Prior to plant startup, all equipment described herein and in the Submersible Pump Data Sheets following shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.
- B. Vibration Test: The complete assembly, consisting of the driving unit and pump, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by the current edition of Hydraulic Institute Standards. If directed by Engineer, vibration tests shall be conducted at Contractor's sole expense to determine amplitude of vibration, and Contractor shall make any corrections necessary to meet these requirements. If corrections are made, a second vibration test shall be done following corrections.

3.9 MANUFACTURER'S SERVICES

- A. Provide representative for three (3) days on-site to verify correct installation, equipment testing, equipment certification, and personnel training.

3.10 MANUFACTURER'S CERTIFICATE(S)

- A. Provide Manufacturer's certificate(s). In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

END OF SECTION

Section 44 42 56.46.1 – VERTICAL CLOSE-COUPLED SOLIDS-HANDLING PUMP(S)

PROJECT: Addison Kellway By-Pass
 OWNER: Town of Addison
 EQUIPMENT NAME(S): Lift Station Pump No. 3
 EQUIPMENT TAG NUMBER(S): Pump No. 3
 CONTROL PANEL(S): Pump Controller MCCA
 TOTAL PUMPS REQUIRED: 1

MANUFACTURERS

MODEL

Fairbanks Nijhuis 5" Discharge x 6" Suction Model 5443
 Or approved equal

SERVICE CONDITIONS

PERFORMANCE REQUIREMENTS

Liquid Pumped:	<u>Wastewater</u>	Capacity (US gpm): Primary (Secondary):	<u>910</u> <u>(1650)</u>
Specific Gravity at 60 deg F:	<u>62.36</u> lb/cf	Total Dynamic Head (ft) Primary (Secondary):	<u>90</u> <u>(60)</u>
Largest dia. Solid pump shall be capable of passing:	<u>3.5</u> in	Min Shutoff Head (ft):	<u>116</u>
Explosion Proof (Y/N)	<u>Y</u>	Max Shutoff Head (ft):	<u>120</u>
Pumping Temperature (°F)	<u>65</u> °F	NPSH Required (ft) Primary (Secondary):	<u>24</u> <u>(26)</u>
Max pump speed at rated capacity	<u>1780</u> rpm	Efficiency (%) Primary (Secondary)	<u>70</u> <u>(74)</u>

EQUIPMENT DESCRIPTION

Casing Material:	<u>Cast Iron, ASTM A48 Class 30</u>	Impeller Shaft Material:	<u>400 Series</u> <u>Stainless Steel</u>
Casing Wear Ring Material:	<u>Stainless Steel 410</u>	Suction Flange:	<u>6 inch</u>
Impeller Type:	<u>Single suction, enclosed two vane</u>	Discharge Flange:	<u>5 inch</u>
Impeller Material:	<u>Cast Iron, ASTM A48 Class 30</u>		
Impeller Wear Ring (Y/N):	<u>Y</u>	Packing (Y/N):	<u>Y</u>
Impeller Wear Ring Material:	<u>Stainless Steel A743 GR CA-40</u>	Double Mechanical Seal (Y/N):	<u>N</u>

MOTOR DATA

Type: Vertical Solid Shaft, Premium Efficiency
 Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.
 Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking

Motor Horsepower: <u>50</u>	Mounting Type: <input type="checkbox"/> Horizontal <input checked="" type="checkbox"/> Vertical
Voltage: <u>460</u>	Enclosure Type: <u>WPI</u>
Phase: <u>3</u>	Material: <u>Cast Iron, A48 Class 35B</u>
Frequency: <u>60</u> Hz	Load Class: <input type="checkbox"/> Multispeed, Two speed: _____ rpm
Synchronous Speed: <u>1800</u> rpm	
Service Factor: <input type="checkbox"/> 1.0 <input checked="" type="checkbox"/> 1.15	

Adjustable Speed Drive: See Division 26, ELECTRIC. Provide Inverter Duty Rated Motors.
 Windings: One Two Thermal protection embedded in windings.
 Motor nameplate horsepower shall not be exceeded at any operational point.
 Provide Space Heater Oversize main terminal (conduit) box for motors Moisture detection switches.

SPECIAL FEATURES / NOTES

See Division 26 for general instrumentation and control requirements.

