SPECIFICATIONS AND CONTRACT DOCUMENTS

FOR THE CONSTRUCTION OF

TOWN OF ADDISON, TX
SURVEYOR CHLORAMINE BOOSTER STATION

CLIENT PROJECT #2021-05-C

PUBLIC WORKS AND ENGINEERING DEPARTMENT
BID NUMBER 21-172

VOLUME 2 OF 2
TECHNICAL SPECIFICATIONS

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ADDISON SURVEYOR CHLORAMINE BOOSTER STATION
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CONTRACT DOCUMENTS

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 improvements at the Surveyor Pump Station. More specifically, the Project includes, but is not limited to, construction of the following:
   1. FRP building and slab for chemical storage and dosing controls
   2. Pavement driveway installation
   3. New electrical connection from existing MCC
   4. Small diameter piping from the new FRP building to the ground storage tank

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.

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 Surveyor Pump Station (15150 Surveyor Blvd).

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 pumping processes.
3. Compliance with Texas Department of Health regulations and requirements, specifically the Town of Addison's permit for potable water production.
4. Work affected by existing site and facility.
5. 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 Surveyor Pump Station in the Town of Addison is an important facility for receiving water from Dallas Water Utilities and distributing water to customers. Impairing the operational capabilities of this facility will result in serious financial damage to the Town and may result in water usage restrictions for the Town's potable water customers.
2. Conduct work in a manner that will not impair the operational capabilities of essential elements.
3. The status of the pump station shall be defined as "operational" throughout the project.

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 TREATMENT 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 of the plant 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 Plant Personnel will evaluate the request based on the plant'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 treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

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

A. Facilities or conditions required to keep the existing pump 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 pump 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 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 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 email.
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 email to Engineer for Owner's signature, or
   b. Return unsigned one electronic copy with written justification via email 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 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.

1.2 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 BID ITEM DESCRIPTIONS

A. The Basis of Payment will be as established in the Contract Documents and as described below:
   1. Bid Item 1: Surveyor Paving and Access Improvements – Payment shall be made at the contract price per square yard. This price shall be full compensation for all excavation, forming, curing, and finishing the concrete, furnishing tools and equipment and other incidentals necessary to perform work to install and/or repair roads, driveways, and parking areas.
   2. Bid Item 2: Surveyor Sitework and Chemical Storage and Dosing Building – Payment shall be made at the lump sum price and shall be full compensation for all work, labor, and materials for construction of the improvements complete and operational as defined in the Contract Documents, including the installation of the storage and dosing building, chemical piping, and associated electrical, civil, and building mechanical improvements. Payment to include O&M manuals.
   3. Bid Item 3: Surveyor Chloramine Residual Control Equipment and Mixer – Payment shall be made at the lump sum price and shall be full compensation for all work, labor, and materials for construction of the improvements complete and operational as defined in the Contract Documents, including the chloramine residual control equipment, pumps, panels, mixer, and associated electrical and civil improvements.
   4. Additive Alternative: Driveway with Porous Pavers – If chosen, payment shall be made at the lump sum price and shall be compensation for all excavation, forming, piping installation, and porous paver installation, furnishing tools and equipment and other incidentals necessary to perform work to install the porous paver driveway and associated drainage piping.
   5. Deductive Alternative: Gravel Driveway – If chosen, payment shall be made at the lump sum price and shall be compensation for all excavation, forming, and gravel installation, furnishing tools and equipment and other incidentals necessary to perform work to install the gravel driveway.

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. Shutdown of Pump Station Operations:
   1. Provide 30 days advance notice to Engineer and Owner of need for any shutdown.
   2. Contractor shall schedule a shutdown coordination meeting with Owner and Engineer one week prior to any shutdown.
   3. 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.

4. 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.

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 REFERENCE POINTS AND SURVEYS

A. 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.

B. 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.

C. Contractor's Responsibilities:
   1. Provide additional survey and layout required to layout the Work.
   2. Locate and protect reference points prior to stating 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 representative.
   3. Subcontractor’s representatives whom Contractor may desire or Engineer may request to attend.
   4. Engineer’s representatives.
   5. Others as appropriate.

C. Upon issuance of Notice to Proceed, or earlier when mutually agreeable, Contractor 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. Engineer 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. Contractor 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 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. 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.

E. Discuss potential problems that may impede scheduled progress and corrective measures.

F. 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, as necessary,

1.7 FACILITY STARTUP MEETINGS

A. Schedule and attend a minimum of 1 facility startup meeting. 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 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.

1.2 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.
   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.

1.3 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.
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.
   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.

1.4 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.

1.5 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.

1.6 ADJUSTMENT OF CONTRACT TIMES

A. Reference the General Conditions and Section 01 26 00.

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 email 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. 8300-1-A, etc.
      b. Sequentially number each submittal.
      c. Resubmission of submittal shall have original number with sequential alphabetic suffix (ie: Resubmittal No. 8300-1-B).
         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 email 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 email 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.
11. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 79 00.

B. Construction Photographs and Video: In accordance with Section 01 31 00, and as may otherwise be required in Contract Documents.

C. Contract Closeout Submittals: In accordance with Section 01 77 00.

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.

G. Schedules:
   1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00.
      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.
   3. Schedule of Estimated Progress Payments: In accordance with Section 01 32 00.
   4. Progress Schedules: In accordance with Section 01 32 00.

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.
   5. Training Data: In accordance with Section 01 79 00.

1.6 FINAL SUBMITTALS

A. Submit final copy of all submitted information to Owner as component of Final Close Out. Prepare final data in electronic media format.

B. Organizational Format:
   1. Identify electronic files with title “FINAL PROJECT SUBMITTALS” and list each submittal with the following information on each file’s cover sheet:
      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.
   2. Provide Title Page file with the following:
      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.
   3. Provide electronic searchable Table of Contents for all files:
      a. 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.
   4. Text: Manufacturer’s printed data, or neatly identified
   5. Material shall be suitable for reproduction, with quality equal to original.
   6. All drawings and oversized figures shall be presented electronically in 11x 17 format.

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, fully viewable and fully searchable in most recent version of Adobe Acrobat.

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), 2012.
   2. International Existing Building Code (IEBC), 2012.
   3. International Energy Conservation Code (IECC), 2012.
   4. International Fire Code (IFC), 2012.
   5. International Mechanical Code (IMC), 2012.
   6. International Plumbing Code (IPC), 2012.

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.	ASAHC	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.	bbl	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.	CO2	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	miixed 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	ortha-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 32 00 – Construction Progress Documentation.
   2. Section 01 33 00 – Submittal Procedures.
   3. 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.
   2. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
   3. Temporary Utility Submittals:
      a. Electric power supply and distribution plans.
      b. Water supply and distribution plans.
      c. Drainage plans.
      d. Sanitary sewer.
   4. 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.
   5. 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.

PART 2 - PRODUCTS (NOT USED)

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. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.

2. Schedule the Work so construction will not interfere with irrigation of cultivated lands or pasturelands. Construction may proceed during irrigation season, provided Contractor constructs temporary irrigation ditches, turnouts, and miscellaneous structures acceptable to property owners.
3. Provide continuous access for livestock through farm areas. Do not cut off ready access to portions of farmlands in which livestock are pastured. Maintain existing fences required to restrain livestock. Keep gates closed and secure.
4. Maintain in continuous service all existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
5. 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.
6. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
7. 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.
8. 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.
9. 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.
10. 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.

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 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.

3.6 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.

3.7 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. 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 Texas 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 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 73 40 – WORK WITHIN PUBLIC RIGHT-OF-WAY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for maintenance, support, protection, relocation, reconstruction and adjusting-to-grade, restoration, construction of temporary and new facilities, and abandonment of existing utilities affected by construction work within the public right-of-way.

1.2 REFERENCES

A. State of Texas, Department of Transportation (TXDOT):
   1. Standard Specifications.

1.3 DEFINITIONS

A. Utility: For purpose of this Section, utility means any public or private service, such as electric light and power systems; gas distribution systems; telephone, telegraph, cable television and other communication services; water distribution; storm drain and sanitary sewer services; police and fire communication systems; street lighting and traffic signs and signals; parking meters; and steam distribution systems.

B. For Trenching:
   1. Open Trench:
      a. General: Includes excavation, pipe laying, backfilling, and pavement replacement.
   2. Any excavated areas shall be considered as "open trench" until all pavement replacement has been made, or until all trenches outside of pavement replacement areas have been backfilled and compacted in accordance with these Contract Documents.

1.4 DESIGN REQUIREMENTS

A. Trenching:
   1. Except where otherwise specified, indicated on the Drawings, or accepted in writing by the Engineer, the maximum length of open trench, where construction is in any stage of completion, shall not exceed the linear footage as set forth below. Descriptions under following area designations are general in nature and may be amended in writing by the Engineer due to particular or peculiar field conditions:
      a. Business District Areas C 100 Linear Feet: Store front areas.
      b. Commercial Areas C 400 Linear Feet: Industrial, shopping centers, churches, schools, hotels, motels, markets, gas stations, government and private office buildings, hospitals, fire and police stations, and nursing homes.
      c. Residential Areas C 1 Block or 600 Linear Feet, Whichever is the Least: Single and multi-family residences, apartments, and condominiums.
      d. Undeveloped Areas C 1,000 Linear Feet: Parks, golf courses, farms, undeveloped subdivided land.
   2. Completely backfill trenches across streets and install temporary or permanent pavement as soon as possible after pipe laying.

B. Site Conditions:
   1. Use substantial steel plates with adequate trench bracing to bridge across trenches at street and alley crossings, commercial driveways, and residential driveways where trench backfill and temporary patch have not been completed during regular working hours.
   2. Provide safe and convenient passage for pedestrians.
   3. Maintain access to fire stations, fire hydrant, and hospitals at all times.

4. Provide traffic control devices, barricades and signage as required by the regulating agency.

1.5 SUBMITTALS

A. Traffic Control Plan: Submit detailed traffic control plan for acceptance by jurisdictional agency.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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.

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

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.

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 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.
   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 email 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 email 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.

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. Chemical pumping skids
   2. Tank mixers
   3. Chloramine residual and dosing control systems

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)

	Installed in accordance with Manufacturer's recommendations.
	Inspected, checked, and adjusted.
	Serviced wit proper initial lubricants.
	Electrical and mechanical connections meet quality and safety standards.
	All applicable safety equipment has been properly installed.
	Functional tests.
	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 ___

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.
   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. Top 6” of backfill to grade shall be select fill conforming to Section 31 23 23.13 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

SECTION 02 80 25 - ORNAMENTAL GATES

PART 1 – GENERAL

1.1 SUMMARY

A. This section specifies the work necessary to furnish and install ornamental security gate system as shown on the Contract Drawings. The system shall include all components required.

B. Related Sections:
   1. 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.
   2. 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 01 11 00, Summary Of Work
      b. Section 31 23 23.13, Fill And Backfill
      c. Division 03, Concrete

1.2 SUBMITTALS

A. Provide the following within two weeks of Contract award:
   1. Manufacturer's information and specifications for materials, finishes, dimensions, and installation instructions.
   2. Manufacturers recommended installation instructions.
   3. Evidence of gate installer qualifications.
   4. Shop drawing showing actuator unit anchorage, specifying type, number, diameter and location of anchoring bolts.

1.3 QUALITY ASSURANCE

A. Gate installation shall be performed by a firm experienced with ornamental fences and gates on projects comparable to this project.

B. Gate installation shall meet the wind loading at the location of installation.

PART 2 – PRODUCTS

2.1 GENERAL

A. Materials shall be new and products of recognized, reputable manufacturers. Used, rerolled, or re-galvanized materials are not acceptable.

B. Manufacturer of components and accessories specified herein shall be as follows:
   1. Ameristar Fence Products, Inc., Echelon II Invincible ¾-Rail
   2. Substitutions: Not permitted.

2.2 CONCRETE

A. Per Division 3 – Concrete.

2.3 ORNAMENTAL FENCE AND GATES

A. Material:
   1. Aluminum material for fence framework shall conform to the requirements of ASTM B221. The aluminum extrusions for posts and rails shall be Allow and Temper designation 6005-T52. The aluminum extrusions for pickets shall be Alloy and Temper Designation 6063-T52.
   2. The manufactured framework shall be subjected to a thermal coating process (high-temperature, in-line, multi-stage, and multi-layer) including, as a minimum, a six-stage pretreatment/wash and an electrostatic spray application of a polyester finish. The topcoat shall be a “no-mar” TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall match the existing fence on-site.
   3. Material for fence pickets shall be 1" square x 0.125” thick extruded tubing. The cross-sectional shape of the rails shall conform to the manufacturer's ForeRunner™ design with outside cross-section dimensions of 1.75" square. The top wall and internal web of the rail shall be 0.070" thick; the sidewalls shall be 0.070" thick for superior vertical load strength.
   4. Bracket to rail attachments shall be made using specially designed one-way tamperproof security nuts and carriage bolt. Bracket to post connections shall be made using self-drilling hex-head screws.
   5. Aluminum castings shall be used for all rings, post caps, finials, and miscellaneous adornments.

B. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.

C. Completed panels shall be capable of supporting a 300 lb. load (applied at midspan) without permanent deformation. Panels shall be biasable to a 25% change in grade.

D. Gates shall be fabricated using 1.75” sq. reinforced rail material, 2” sq. x .250” gate ends, and 1” sq. x .125” pickets. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall be joined by welding.

PART 3 – EXECUTION

3.1 GENERAL

A. Install gates in accordance with ASTM F567 (except as modified in this section) and in accordance with fence and gate manufacturer's recommendations as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete gate installation.

C. For installations that must be raked to follow sloping grades, the post spacing shall be measured along the grade.

3.2 FIELD PREPARATION

A. Establish locations of fence lines, gates, and terminal posts.

3.3 POST SETTING

A. Driven posts are not acceptable.

B. Post Hole Depth: As shown on drawings.

C. Set posts with minimum embedment per the contract drawings.

D. Before concrete sets, crown and finish top of concrete to readily shed water.

3.4 GATES

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper- resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

B. Adjust gate to operate smoothly, easily, quietly free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

C. Lubricate hardware and other moving parts.

D. Installer shall train Owner's personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining installed system(s).

3.5 FINISH GRADE

A. Furnish and install two-inch deep ¾ minus aggregate within six inches of both sides of fence line and gate lines.

3.6 FIELD QUALITY CONTROL

A. Gate Tests: Prior to acceptance of installed gates and gate operator systems, demonstrate proper operation of gates under each possible open and close condition.

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03 11 00 - CONCRETE FORMWORK

PART 1 - GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Concrete Institute (ACI):
      a. 117, Standard Specifications for Tolerances for Concrete Construction and Materials.
      b. 318/318R, Building Code Requirements for Reinforced Concrete.
      c. 347, Formwork for Concrete.

1.2 DESIGN REQUIREMENTS

A. Design formwork in accordance with ACI 301, ACI 347 and ACI 318 to provide concrete finishes specified in Section 03 30 00.

B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.

C. Make joints in forms watertight.

D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Form Ties-Tapered Through-Bolts: Proposed method of sealing form tie hole; coordinate with details shown.
   2. Manufacturer’s Data for the Following Product: Form release agent.

B. Samples: One each as follows:
   1. Form ties.

C. Information Submittals: Statement of qualification for formwork designer.

1.4 QUALIFICATIONS

A. Formwork Designer: Formwork, falsework, and shoring design shall be by an Engineer licensed in the State of the project site.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Wall Forms and Underside of Slabs:
   1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish.
   2. Circular Structures:
      a. Conform forms to circular shape of structure.
      b. Straight panels may be substituted for circular forms provided panels do not exceed 2’ in horizontal width and angular deflection is no greater than 3-1/2° per joint.

B. Painted Surface Forms: High density overlay plywood for flat concrete surfaces to be painted.

C. All Other Forms: Materials as specified for wall forms.

D. Form Release Agent:
   1. Material: Release agent shall not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of concrete surfaces when applied to forms. A “ready to use” water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations and can be used in potable water facilities.
   2. Manufacturers and Products:
      a. Master Builders, Inc.; Rheofinish 211.
      b. Cresset Chemical Company; Crete-Lease 20-VOC.
      c. US Mix Products Company; US SPEC Slickote.

E. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

F. Form Ties:
   1. Material: Steel
   2. Spreader Inserts:
      a. Conical or spherical type.
      b. Design to maintain positive contact with forming material.
      c. Furnish units that will leave no metal closer than 1” to concrete surface when forms, inserts, and tie ends are removed.
   3. Wire ties not permitted.
   4. Flat bar ties for panel forms furnish plastic or rubber inserts with minimum 1” depth and sufficient dimensions to permit patching of tie hole.
   5. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
      a. Integral steel water stop 0.103” thick and 0.625” in diameter tightly and continuously welded to tie.
      b. Neoprene water stop 3/16” thick and 15/16” diameter whose center hole is 1/2-diameter of tie, or molded plastic water stop of comparable size.
      c. Orient water stop perpendicular to tie and symmetrical about center of tie.
      d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
   6. Through-Bolts: Tapered minimum 1” diameter at smallest end.
   7. Elastic Vinyl Plug:
      a. Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming watertight seal.
      b. Manufacturer and Product: Dayton/Richmond Co., Miamisburg, OH; A58 Sure Plug.
      c. Recess plug 1” minimum and grout over hole. See Section 03 60 00 GROUT.

PART 3 - EXECUTION

3.1 FORM SURFACE PREPARATION

A. Thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants prior to coating surface.

B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by the manufacturer.

C. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

3.2 ERECTION

A. General: Unless specified otherwise, follow applicable recommendations of ACI347.

B. Beveled Edges (Chamfer):
   1. Form 3/4” bevels at concrete edges, unless otherwise shown.
   2. Where beveled edges on existing adjacent structures are other than 3/4”, obtain Engineer’s approval of size prior to placement of beveled edge.

C. Wall Forms:
   1. Do not reuse forms with damaged surfaces.
   2. Locate form ties and joints in an uninterrupted uniform pattern.
   3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.

D. Forms for Curbs and Sidewalks:
   1. Provide standard steel or wood forms.
   2. Set forms to true lines and grades, and securely stake in position.

E. Form Tolerances: Provide forms in accordance with ACI 117, 347 and 318 and the following tolerances for finishes specified:
   1. Wall Tolerances:
      a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
      b. Wall Type W-A:
         1). Plumb within 1/4” in 10’ or within 1” from top to bottom for walls over 40 feet high.
         2). Depressions in Wall Surface: Maximum 5/16” when 10’ straightedge is placed on high points in all directions.
      c. Wall Type W-B:
         1). Plumb within 1/8” in 10’ or within 1/2” from top to bottom for walls over 40’ high.
         2). Depressions in Wall Surface: Maximum 1/8” when 10’ straightedge is placed on high points in all directions.
   2. Thickness: Maximum -1/4” or +1/2” from dimension shown.
   3. Form Offset: Between adjacent pieces of form work, facing material shall not exceed 1/8” where exposed to public view and 1/4” maximum for all other conditions.

3.3 ADDITIONAL REQUIREMENTS

A. Construct forms tight enough to prevent loss of concrete mortar.

B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, reglets, recesses and the like for easy removal.
   2. Do not use rust-stained steel form-facing material.
   3. Use only form or form-tying methods which do not cause spalling of the concrete upon form stripping or tie removal.

C. Set edge forms, bulkheads and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

D. Provide temporary 12 inch wide x 18 inch high openings for cleanouts and inspection ports every 7 feet at the bottom of each lift form and where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations, where possible.

E. Chamfer exterior corners and edges of permanently exposed concrete.

F. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds and bulkheads required in the Work.
   1. Determine sizes and locations from trades providing such items.
   2. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and waterstops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.

G. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris just before placing concrete.

H. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

I. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions before placing reinforcement.

J. Embedded Items.
   1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
      a. Install anchor bolts/rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
      b. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles and other conditions.
      c. Check special castings, channels or other metal parts that are to be embedded in the concrete prior to and again after placing the concrete.
      d. Check nailing blocks, plugs and strips necessary for the attachment of trim, finish and similar work prior to placing the concrete.

K. Pipes and wall spools cast in concrete.
   1. Install wall spools, wall flanges, and wall anchors before placing concrete. Do not weld, tie or otherwise connect the wall spools or anchors to the reinforcing steel.
   2. Support pipe and fabricated fittings to be encased in concrete on concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement will occur during construction.
   3. Pipes or spools located below operating water level shall have waterstop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.

L. Removing and reusing forms.
   1. General: Do not remove forms from concrete which has been placed with outside temperature below 50°F without first determining and verifying with Engineer if the

concrete has properly set without regard for time. Do not apply loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.

a. Leave formwork for beam soffits, joists, structural slabs, beams, girders and other structural elements that support weight of concrete in place until concrete has achieved 100 percent its 28-day design compressive strength.
b. Formwork for sides of beams, walls, columns and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50°F (10 deg C) for 48 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
c. Leave bracing for walls until the top or roof slab concrete reaches 100% of its 28-day design compressive strength.
d. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
3. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces.

M. Aluminum surfaces in contact with concrete.
1. Aluminum surfaces in contact with concrete or grout or dissimilar metals shall be protected with a Mylar isolator, bituminous paint or other material approved by Engineer.

N. Shores and reshores.
1. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation and removal of shoring and reshoring.
a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
2. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
3. For multi-storied structures, the shoring and reshoring diagrams and procedures shall be signed and sealed by a Registered Professional Engineer in the state where the construction is being undertaken. These diagrams and procedures shall take into account the effect of the loads on the uncured concrete and the construction load on each floor.
4. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

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 20 00 - CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing steel and related items required for cast-in-place concrete.

B. Related Sections:
   1. Section 03 11 00 – Concrete Formwork.
   2. Section 03 30 00 – Cast-In-Place Concrete.

1.2 SUPERVISION

A. Workmanship: Provide qualified supervision at all times reinforcing work is in progress. Workmen shall be experienced iron workers.

B. Codes: Reinforcement placement and detailing shall comply with practice specified in the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" publication ACI 315- latest edition of the American Concrete Institute or its latest revision, unless otherwise specified herein.

1.3 SUBMITTALS

A. Shop drawings: Shop drawings shall be prepared for all reinforcement required by the project. Shop drawings shall be logically and legibly prepared to permit reasonable ease of sorting, selecting, placing reinforcement as well as checking drawings. Preparer and fabricator shall be identified on the drawings.
   1. Reinforcement shall not be fabricated until the shop drawings have been processed, approved and returned.
   2. Check all shop drawings to verify reinforcement dimensions required by drawings are satisfied.
   3. Provide bar sizes, bar lengths, bar material, bar grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and lap lengths, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

B. Reinforcement shop drawings:
   1. Review of reinforcement shop drawings by the Engineer will be limited to general compliance with the Contract Documents.
   2. Submit reinforcement shop drawings in a complete package for each specific structure. Partial submittals will be rejected.

C. Changes to reinforcing steel contract drawing requirements:
   1. Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the Drawings for reinforcing steel.
   2. Such changes will not be acceptable unless the Engineer has accepted such changes in writing.

1.4 PRODUCT HANDLING

A. Protection:
   1. Use all means necessary to protect reinforcement from dirt and other foreign substances before and after placing.
   2. Store in a neat manner in logical order, bundled, tagged, off the ground, and in an area adequately isolated.

3. Re-bundle to maintain identification when placing is interrupted.

B. Replacement: All damaged or improperly fabricated bars shall be replaced at the Contractor's expense.

PART 2 - PRODUCTS

2.1 CONCRETE REINFORCEMENT

A. General: All reinforcement shall be free from rust, loose mill scale, and other contaminants.

B. All bars shall be billet steel bars for concrete reinforcement ASTM A 615 Grade 60.

C. Wire bar supports located between reinforcing bars and face of concrete:
1. Stainless steel. Type 304 stainless steel bar supports.
2. Support reinforcing for concrete placed on ground using bar support chairs with Type 304 stainless steel plates for resting on ground welded to the chairs.

D. Concrete bar supports located between reinforcing bars and face of concrete:
1. Manufactured expressly for supporting reinforcing bars.
2. Manufactured with two annealed steel wires to securely tie concrete bar support to reinforcing steel.
3. Manufactured with minimum f'_c = 5,000 psi concrete.

2.2 WELDED WIRE REINFORCEMENT (WWR):

A. In accordance with ASTM A 185.

B. WWR may not be used in place of reinforcing bars unless accepted in writing by the Engineer.

C. Provide WWR in flat sheet form.

D. If WWR is used, provide WWR having cross-sectional area per linear foot of not less than cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

2.3 ACCESSORIES:

A. General: Accessories shall be subject to Engineer's approval.
1. Tie wire - 18 gauge annealed steel wire.
2. Number of chairs shall be adequate to prevent sag during steel and concrete placement.
3. Wall layer spacers shall be 1/4 inch round "Z" bar.
4. Horizontal layer spacers shall be wire bar supports or reinforcing bars bent to support top layer.
5. Dowel bar splicer:
   a. Dowel bar splicer shall be Richmond or approved equal, manufactured from standard specified rebar material, with NC threads and shop fabricated to specified dowel configurations.
6. Mechanical Connectors:
   a. Approved Manufacturers: 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 manufacturer’s approved procedures.

PART 3 - EXECUTION

3.1 GENERAL

A. Reinforcing bars and welded wire fabric reinforcement: Verify that reinforcement is new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.

B. Other trades: Coordinate all work of other trades to avoid conflict with reinforcement.

C. Shop drawings: Check all shop drawings to verify dimensions required.

3.2 FABRICATING

A. General: Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice." Reinforcement shall be shop fabricated except where straight bars No. 5 or smaller are required.

B. Bending: All bending shall be by using bending jigs and mandrels. All bars shall be bent cold.

C. Cutting: Bars shall be cut by cold shearing. Torch cutting in the field may be permitted in special situations.

3.3 PREPARATION

A. Surface Preparation:
   1. Reinforcing bars: Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars having rust scale, loose mill scale, or thick rust coat.
   2. Cleaning of reinforcement materials: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.4 PLACING

A. General:
   1. Accurately place all bars to meet tolerances as outlined in ACI 318 and tie in place before placing concrete, include dowels. Tie with 18 gauge steel wire.
   2. Corner bars required for horizontal reinforcing. Unless otherwise noted on plans corner bars shall be same size and spacing as horizontal bar.
   3. No field bending of bars will be allowed.

B. Clearance:
   1. Preserve clearance between bars of 1 inch minimum, not less than one bar diameter or 1-1/3 times large aggregate, whichever is larger.
   2. Provide following concrete coverage over reinforcing steel unless otherwise indicated on plans:
      a. Three inches above subgrade - in excavation.
      b. Two inches above subgrade - slab on fill.
      c. Two inches from form - walls exposed to water or earth and for slab over water.
      d. One and one-half inches from form - normal cover interior walls, beams, columns, etc.
      e. Three-fourths inch on top steel - interior slabs.
      f. One and one-half inches on top and bottom - exterior slab.
   3. Lap all reinforcing bars as required by ACI 318-latest edition Class B as indicated on the drawings except where otherwise required by ACI.

4. Stagger splices except where otherwise shown.
5. Lap welded wire reinforcement a minimum of two spaces.

C. Dowels: All dowels shall be placed and securely anchored before placing concrete

D. Supports:
1. Provide a sufficient number to prevent sagging, to prevent shifting, and to support loads during construction; but in no case less than quantities and at locations as indicated in ACI 315.
2. Do not use brick, broken concrete masonry units, spalls, rocks, wood or similar materials for supporting reinforcing steel.
3. Do not use reinforcing bars that have less cover than required by the Contract Documents. Do not adjust location of reinforcement required by the Contract Documents to provide cover to these bars.
4. Wire chairs will not be accepted to hold reinforcing clearance on walls.

E. Tying of bar reinforcement:
1. Fasten bars securely in place with wire ties.
2. Tie bars sufficiently often to prevent shifting.
3. Provide at least 3 ties in each bar length.
4. Do not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity.
5. Tie slab bars at every intersection around periphery of slab.
6. Tie wall bars and slab bar intersections other than around periphery at not less than every fourth intersection, but at not greater than following maximum spacings:

Bar Size	Slab Bar Spacing Inches	Wall Bar Spacing Inches
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

7. After tying wire ties, bend ends of wire ties in towards the center of the concrete section.
   a. The cover for wire ties shall be the same as the cover requirements for reinforcing bars.

F. Openings and obstructions:
1. Place additional reinforcing around openings as shown on the drawings and standard details.
2. Bend reinforcing around obstructions. Place extra reinforcing where cutting is authorized. Engineer's approval required before cutting steel.
3. Consult Engineer on special situations.

G. Welded Wire Reinforcement:
1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
2. Bend fabric as indicated on the Drawings or required to fit work.
3. Unroll or otherwise straighten fabric to make flat sheet before placing in the Work.
4. Lap splice welded wire fabric as indicated on the Drawings.
5. If lap splice length is not indicated on the Drawings, splice fabric in accordance with ACI 318 and ACI 350.

H. Certification: Certify material and type of deformation.

I. Condition: All reinforcement shall be free from loose rust, dirt coating, oil, paint, or any foreign substance.

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 11 00 - Concrete Formwork.
   3. Section 03 15 00 - Concrete Accessories.
   4. Section 03 20 00 - Concrete Reinforcement.
   5. Section 03 41 00 - Precast Concrete.
   6. Section 03 60 00 – Grout.
   7. Section 03 60 01 - Basin Bottom Grout.
   8. Section 03 64 00 - Concrete Repair Crack Injection.

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 that 75-m (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 ¾" 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 ASTM C295*	1 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 ASTM C295**	1.25 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 siliconate 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%, ±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%, ±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 64 00, CONCRETE REPAIR CRACK INJECTION.
   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 SYSTEMS. 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 °F ±3 °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 °F ± 3 °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 °F ±3 °F and 50% ±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 64 00. 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 64 00 - CONCRETE REPAIR CRACK INJECTION

PART 1 - GENERAL

1.1 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): T 237, Standard Method for Testing Epoxy Resin Adhesive.
   2. ASTM International (ASTM):
      a. D 638, Standard Test Method for Tensile Properties of Plastics.
      b. D 648, Standard Test Method for Deflection of Plastics Under Flexural Load.
      c. D 695, Standard Test Method for Compressive Properties of Rigid Plastics.
      d. D 790, Standard Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials.

1.2 DEFINITIONS

A. Large Cracks: Wider than 0.015”.

B. Small Cracks: Width equal to 0.015” or less.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Physical and chemical properties for epoxy adhesives.
   2. Technical data for metering, mixing, and injection equipment.

B. Information Submittals:
   1. Manufacturer’s recommended surface preparation procedures and application instructions for epoxy adhesives.
   2. Installation instructions for repairing core holes with epoxy grout.
   3. Manufacturer’s Certificate of Compliance: Certified test results for each batch of epoxy adhesive.
   4. Statements of Qualification for Epoxy Adhesive:
      a. Manufacturer’s site representative.
      b. Injection applicator.
      c. Injection pump operating technician.
   5. Epoxy adhesive two component ratio and injection pressure test records for concrete crack repair work.

1.4 QUALITY ASSURANCE

A. Qualifications for Epoxy Injection Staff:
   1. Manufacturer’s Site Representative:
      a. Capable of instructing successful methods for restoring concrete structures utilizing epoxy injection process.
      b. Understands and is capable of explaining technical aspects of correct material selection and use.
      c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
   2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
      a. Licensed and certified by epoxy Manufacturer.

b. Minimum 3 years experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection including 2,000 linear feet of wet crack injection to stop water leakage.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Package adhesive material in new sealed containers and label with following information:
1. Manufacturer's name.
2. Product name and lot number.
3. ANSI Hazard Classification (formerly SPI Classification).
4. ANSI recommended precautions for handling.
5. Mix ratio by volume.

B. Storage and Protection: Store adhesive containers at ambient temperatures below 120 °F and above 32 °F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Epoxy Manufacturers and Products:
1. Sika Corp., Lyndhurst, NJ; Sikadur 35 Hi-Mod LVPL.
2. Euclid Chemical Co., Cleveland, OH; Eucopoxy injection resin.

2.2 EPOXY ADHESIVE

A. Two-component A and B structural epoxy adhesive for injection into cracks or other voids in concrete structures for bonding or grouting.

B. Adhesive Properties: When cured for 7 days at 77, ±3 °F and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

	Test Method	**Large Cracks**	**Small Cracks**
Ultimate Tensile Strength, psi	ASTM D638	8,000 min.	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	3.7 max.	3.7 max.
Flexural Strength, psi	ASTM D790	10,000 min.	10,000 min.
Flexural Modulus, psi	ASTM D790	5.5 x10^5 min.	4.5 x10^5 min.
Compressive Yield Strength, psi	ASTM D695*	15,000 min.	12,000 min.
Compressive Modulus, psi	ASTM D695*	3.8 x10^5 min.	3.8 x10^5 min.
Heat Deflection Temperature	ASTM D648*	130 °F min.	140 °F min.
Slant Shear Strength: (5,000 psi Compressive Strength Conc.)	AASHTO T 237**		
Cured 3 days @ 40 °F-Wet Concrete			3,500 psi min
Cured 1 day @ 77 °F-Dry Concrete			5,000 psi min.
Cured 3 days @ 77 °F ±3 °F			5,000 psi min.
* Cure test specimens so that peak exothermic temperature of adhesive does not exceed 100 °F			
**See referenced specifications for preparation method of test specimens			

2.3 SURFACE SEAL

A. Sufficient strength and adhesion for holding injection fittings firmly in-place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection adhesive has cured.

PART 3 - EXECUTION

3.1 GENERAL

A. Structurally repair cracks in structures as specified in Section 03 30 00.

B. Cracks: Repair by injection of epoxy adhesive.

3.2 PREPARATION

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with epoxy adhesive manufacturer's instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system.

D. Do not use acids and corrosives for cleaning, unless neutralized prior to injecting epoxy.

3.3 APPLICATION

A. Sealing: Apply surface seal in accordance with Manufacturer's instructions to designated crack face prior to injection. Seal surface of crack to prevent escape of injection epoxy.

B. Entry Ports:
   1. Establish openings for epoxy entry in surface seal along crack.
   2. Determine space between entry ports equal to thickness of concrete member to allow epoxy to penetrate to the full thickness of the wall.
   3. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.
   4. Space entry ports close together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
      a. Cracks extend entirely through wall.
      b. Backfill of walls on one side.
      c. Difficult to excavate behind wall to seal both crack surfaces.
   5. Core drill to verify epoxy depth where only one side of wall is exposed.

C. Epoxy Injection:
   1. Store epoxy at minimum of 70 °F.
   2. Start injection into each crack at lowest elevation entry port.
   3. Continue injection at first port until adhesive begins to flow out of port at next highest elevation.
   4. Plug first port and start injection at second port until adhesive flows from next port.
   5. Inject entire crack with same sequence.

D. Finishing:
   1. Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without draining or runback of epoxy material from cracks.

2. Remove surface seal from cured injection adhesive.
3. Finish crack face flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports are not acceptable.
5. Remove surface seal material and injection adhesive runs and spills from concrete surfaces.

3.4 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two adhesive components, and inject mixture into crack.

B. Discharge Pressure: Automatic pressure controls capable of discharging mixed adhesive at pressures up to 200 psi, ±5%, and able to maintain pressure.

C. Automatic Shutoff Control: Provide sensors on both Component A and B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

D. Proportioning Ratio Tolerance: Maintain epoxy adhesive Manufacturer's prescribed mix ratio within a tolerance of ±5% by volume at discharge pressure p to 160 psi.

E. Ratio/Pressure Check Device:
1. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
2. Pressure gauge capable of sensing pressure behind each valve.

3.5 FIELD QUALITY CONTROL

A. Epoxy Adhesive Two Component Ratio Tests:
1. Disconnect mixing head and pump two adhesive components simultaneously through ratio check device.
2. Adjust discharge pressure to 160 psi for both adhesive components.
3. Simultaneously discharge both adhesive components into separate calibrated containers.
4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work has stopped for more than 1-hour.
7. Document and maintain complete accurate records of ratios and pressure checks.

B. Injection Pressure Test:
1. Disconnect mixing head of injection equipment and connect two adhesive component delivery lines to pressure check device.
2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure test for each injection equipment unit:
   a. Beginning and end of each injection work day.
   b. When injection work has stopped for more than 45 minutes.

6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Crack Injection Tests:
   1. Initial Cores:
      a. 4” diameter for full crack depth taken from Engineer selected locations.
      b. Take three cores in first 100 lineal feet of crack repaired and one core sample for each 500 lineal feet thereafter.
   2. Provide suitable containers for storage, curing, and transportation of test specimens.
   3. Methods of Testing Cores:
      a. Penetration: Visual examination.
      b. Bond Strength/Compression Test: Concrete failure prior to adhesive failure.
   4. Test Requirements:
      a. Penetration: Minimum of 90% of crack shall be full of epoxy adhesive.
      b. Bond Strength/Compression Test: Concrete failure before adhesive failure, or 6,500 psi with no failure of either concrete or adhesive.
   5. Evaluation and Acceptance of Tests:
      a. If initial cores pass tests as specified, epoxy adhesive injection Work at area represented by cores will be accepted.
      b. If initial cores fail either by lack of penetration or bond strength, crack repair Work shall not proceed further until areas represented by cores are re-injected or repaired and retested for acceptance.
      c. Obtain verifying core samples, number and location as selected by Engineer, after rework of areas represented by failed initial core is complete.
   6. Core Hole Repair:
      a. Correct Work as result of testing upon notification from Engineer.
      b. Refill initial and verifying core holes with an epoxy grout tamped and rodded in-place to form a dense fill.
      c. Finish surface to blend with adjacent concrete.

END OF SECTION

DIVISION 5

METALS

SECTION 05 12 00 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Structural steel.
   2. Grout.

B. Related sections:
   1. Division 1 Section “Quality Requirements” for independent testing agency procedures and administrative requirements.
   2. Section 05 50 00, METAL FABRICATIONS for steel lintels or shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.
   3. Section 09 90 00, PAINTING AND PROTECTIVE COATINGS for surface preparation and priming requirements.
   4. Section 13 34 19, METAL BUILDING SYSTEMS, for structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC “Code of Standard Practice for Steel Buildings and Bridges,” that support design loads.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.

C. Welding certificates.

D. Qualification Data: For Installer and fabricator.

E. Mill Test Reports: Signed by Manufacturers certifying that the following products comply with requirements:
   1. Structural steel including chemical and physical properties.
   2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   3. Shop primers.
   4. Non-shrink grout.

F. Source quality-control test reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who regularly erects structural steel with scope and complexity similar to that of this project.

B. Fabricator Qualifications: A qualified fabricator who regularly fabricates structural steel with scope and complexity similar to that of this project.

C. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code--Steel.”

D. Comply with applicable provisions of the following specifications and documents:
   1. AISC “Code of Standard Practice for Steel Buildings and Bridges.”
   2. AISC “Seismic Provisions for Structural Steel Buildings” and “Supplement No.2.”
   3. AISC “Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design.”
   4. AISC “Specification for the Design of Steel Hollow Structural Sections.”
   5. AISC “Specification for Allowable Stress Design of Single-Angle Members”.
   6. RCSC “Specifications for Structural Joints Using ASTM F 3125 Bolts.

E. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00, PROJECT MANAGEMENT AND COORDINATION and Section 01 12 00 PROJECT MEETINGS.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
   1. Store fasteners in a protected place. Re-lubricate bolts and nuts that become dry.
   2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
   3. Do not clean and use rusty bolts.

1.6 COORDINATION

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992.

B. Channels, Angles, and Shapes: ASTMA A 36 unless otherwise noted.

C. Plate and Bar: ASTM A 36 unless otherwise noted.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B structural tubing.

E. Steel Pipe: ASTM A53, Type E or S, Grade B.
   1. Weight Class: Standard unless otherwise indicated.
   2. Finish: Black, except where indicated to be galvanized.

F. Welding Electrodes: Comply with AWS requirements. Tensile strength should be the same or greater than base metal.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM F 3125 Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Finish: Plain unless noted or indicated otherwise.

B. Un-headed Anchor Rods: ASTM F 1554, Grade 36, unless otherwise indicated.
   1. Configuration: as indicated.
   2. Nuts: ASTM A 563, heavy hex carbon steel.
   3. Plate Washers: ASTM A 36 carbon steel.
   4. Washers: ASTM F 436, hardened carbon steel.
   5. Finish: Plain, unless noted or indicated otherwise.

C. Threaded Rods: ASTM A 36.
   1. Nuts: ASTM A 563 heavy hex carbon steel.
   2. Washers: ASTM F 436 hardened carbon steel.
   3. Finish: Plain, unless noted or indicated otherwise.

D. Clevises or turnbuckles: ASTM A 108, Grade 1035, cold-finished carbon steel.

E. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.

F. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 PRIMER

A. Primer: Fabricator's standard lead and chromate free non-asphaltic rust inhibiting primer.

B. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time and complying with Section 03 60 00 GROUT.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC "Code of Standard Practice for Steel Buildings and Bridges" and AISC "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design".
   1. Camber structural-steel members where indicated.
   2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
   3. Mark and match-mark materials for field assembly.
   4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, “Power Tool Cleaning.”

F. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

G. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10” o.c., unless otherwise indicated.

H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces.
   2. Base-Plate Holes: Cut, drill, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC “Specification for Structural Joints Using ASTM F 3125 Bolts” for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
   2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC “Code of Standard Practice for Steel Buildings and Bridges” for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2”.
   2. Surfaces to be field welded.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials.
   5. Galvanized surfaces.

B. Surface Preparation: Clean the surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 3, “Power Tool Cleaning.”

C. Priming: Immediately after surface preparation, apply primer according to Manufacturer’s written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. Stripe paint comers, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Apply a 1-coat, non-asphaltic primer complying with SSPC-PS Guide 7.00, “Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems,” to provide a dry film thickness of not less than 1.5 mils.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
   1. Fill vent holes and grind smooth after galvanizing.
   2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedment, with steel erector present, for compliance with requirements.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
   1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC “Code of Standard Practice for Steel Buildings and Bridges” and “Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design”.

B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
   1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of base plate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and base or bearing; plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow it to cure. Comply with Manufacturer’s written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC “Code of Standard Practice for Steel Buildings and Bridges.”

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly clean bearing surfaces and other surfaces that will

be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

C. Splice members only where indicated.

D. Do not use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.

E. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC “Specification for Structural Joints Using ASTM F 3125 Bolts” for type of bolt and type of joint specified.

1. Joint Type: Snug tightened, unless noted or indicated otherwise.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC “Code of Standard Practice for Steel Buildings and Bridges” and “Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design”, for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC “Code of Standard Practice for Steel Buildings and Bridges” for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC “Specification for Structural Joints Using ASTM F 3125 Bolts.”

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and Manufacturer’s written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

END OF SECTION

DIVISION 8

OPENINGS

SECTION 08 16 13 – FIBERGLASS REINFORCED PLASTIC DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Fiberglass reinforced plastic (FRP) doors and frames.
      a. Standard doors and frames.
      b. Fire-rated doors and frames.

B. Related Sections include the following:
   1. Division 8 Section “Door Hardware” for hardware for FRP doors.

1.2 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire-resistance and temperature-rise ratings, and finishes for each type of FRP door and frame specified.
   1. Manufacturers’ printed installation instructions for doors and frames.

B. Shop Drawings: In addition to requirements below, provide a schedule of FRP doors and frames showing size and thickness, and using same reference numbers for details and openings as those on Drawings:
   1. Elevations of each door design.
   2. Details of doors, including vertical and horizontal edge details.
   3. Frame details for each frame type, including dimensioned profiles.
   4. Details and locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, accessories, joints, and connections.
   7. Details of glazing, glazing frames and stops showing glazing.

C. Samples for Initial Selection: Complete set of actual materials in small sections for the following:
   1. FRP Door Faces: Show the full range of finish colors, textures, and patterns available.

D. Samples for Verification: Actual door face materials, approximately 4x4 inches square for each sample selected. Provide samples showing color and texture to be expected in the finished work.

E. Qualification Data: For manufacturer and for Installer.

F. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of FRP door and frame.
   1. Certification: Test report/certification of self-extinguishing capabilities of gel-coat finish.

G. Reinforcement Certification: Test report/certification of anchor holding value of door and frame reinforcement material.
   1. Documentation of anchor holding valves for composite design of doors and frames.

H. Other Action Submittals:
   1. Schedule: Provide a schedule of fiberglass reinforced plastic work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain FRP doors and frames through one source from a single manufacturer (for both standard and fire-rated doors).

B. Manufacturer's Qualifications: A company specializing in the manufacture of FRP doors and frames (standard and fire-rated) with a minimum of five years documented production experience.

C. Installer Qualifications: An experienced installer trained and approved by manufacturer or the supplier, with a minimum of three years experience.

D. Standard FRP Door and Frame Assemblies: Doors and frames shall have a flame-spread rating of 25 or less in accordance with ASTM E 84.
   1. Component Rating: All FRP components, including the gel-coat finish, shall be self-extinguishing per ASTM D 635.

E. Fire-Rated FRP Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated.
   1. All doors and frames shall be certified to meet UL 10B/UL 10C.

F. Core Material Rating: Foam plastic core material for all non-rated insulated doors must be a Class A rated foam.
   1. Frame Spread Index: 75 or less.
   2. Smoke Developed Index: Not more than 450.

G. Pre-installation Conference: Conduct conference at project site.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery doors and frames cardboard wrapped, or crated in wood to provide protection during transit and on-site storage.
   1. Provide foam or corrugated separation between individual units.

B. Store doors and frames under cover (out of the weather) at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber.
   1. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify openings in poured concrete and CMU walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

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

1.7 WARRANTY

A. Warranty: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace doors that are defective in materials or workmanship, or which have damage or have failed due to corrosion.
   1. Ten (10) years for defects in materials and/or workmanship.
   2. Twenty-five (25) years for de-lamination, and/or degradation or failure due to corrosion.

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, but are not limited to, the following:
   1. Chem-Pruf Door Co. Ltd.
   2. Tiger Door, LLC.
   3. Chase Doors; Fib-R-Dor.

2.2 MATERIALS

A. Fiberglass Mat: Random glass fiber mat, minimum 4.5 ounces per square foot weight of glass material.

B. Polyurethane Foam: Minimum density 4 pounds per cubic foot, maximum flame spread 25 in accordance with ASTM E 84.
   1. Class "A" rated to comply with International Building Code requirements.

C. Kraft Honeycomb Material: Phenolic resin impregnated, maximum flame spread 25 in accordance with ASTM E 84.

D. Mineral Core: Manufacturer's standard fire-resistant mineral core materials.

E. Roving: Unidirectional glass fiber mat, minimum 16 ounces per square yard weight.

F. Resins: Formulated for specified environment, maximum flame spread 25 in accordance with ASTM E 84, self-extinguishing in accordance with ASTM D 635.

G. Anchors: Manufacturer's standard stainless steel anchors.

H. Bonding Materials: Manufacturer's standard frame-to-opening bonding system.

I. Joint Sealer: Silicone sealant, specified in Section 07 92 00.

J. Glazing:
   1. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacturer, fabrication or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
   2. Delegated Design: Design glass, including comprehensive engineering analysis according to ICC's 2006 International building code by a qualified professional engineer.
   3. Thermal movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
      a. Temperature Change: 120 deg F (67 deg C), ambient; material surfaces.
   4. Sealants and accessories shall be manufacturer's standards.

2.3 FRP DOORS

A. General: Provide FRP doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated.
   1. Design: Flush panel – seamless design with smooth face.
   2. Finish: Manufacturer's standard gel-coat finish, self-extinguishing type.
      a. Flame Spread Rating: 25 or less.
   3. Size: Width and height as scheduled on Drawings.
      a. Height of doors shall not be altered on-site, unless manufacturer agrees, in writing, to honor the specified warranty(s) after modifications.
   4. Thickness: Nominal 1-3/4 inches.
   5. Foam Core Material: Foam plastic core materials shall conform to the requirements of the International Building Code.
   6. Hardware Provisions: Provide surface recessed areas, cutouts, or hinge pockets, and internal reinforcement for mortised hardware and hinges.

B. Door Construction: Manufacturer's standard construction process, subject to compliance with the following requirements:
   1. Stiles and Rails: Pultruded rectangular (or square) fiberglass tubes, or a molded one-piece U-shaped frame.
      a. Minimum Tube Size: 1-1/2 x 1-1/2 inches.
   2. Standard Core Materials: As indicated below – no wood allowed.
      a. Exterior Doors
         1) Urethane/Polyurethane Core: Class A rated.
            a) R-Value: R-10 to R-12 minimum.
      b. Interior Doors
         1) Honeycomb Core: Phenolic resin impregnated Kraft paper.
            a) Maximum Flame Spread Rating: 25.
            b) R-Value: R-5 to R-8.
   3. Fire-Rated Core Material
      a. Mineral Core: Fire-rated (as scheduled).
         1) Full thickness of door cavity.
   4. Internal Reinforcement: Manufacturer's standard FRP or high-density polymer.
      a. Minimum Screw-Holding Capacity: 650 pounds.
      b. Thru-Bolting: Embed compression members or reinforcement during fabrication where thru-bolting of hardware is required.
   5. Face Sheets: Fiberglass reinforced mats or sheets, saturated with resins.
      a. Fire-Rated Doors: FRP mats or panels made with fire-retardant resins, or with intumescent molded into the door structure.
   6. Finish: Gel-coat finish with integral color.
      a. Minimum Thickness: 25 mil gel-coat.
      b. Surface: Smooth.
         1) Sheen: Gloss or semi-gloss.
   7. Color: Provide custom color. Owner shall select final color.

2.4 DOOR ACCESSORIES

A. Glazed Openings: Cutouts/openings for fixed view panels shall be provided by the FRP door manufacturer at the time the door is fabricated. Openings cut into the door shall be completely sealed by FRP frame members provided as an integral part of the door fabrication.
   1. Glazing Stops/Retainers: Solid FRP or molded resin stops, with a sloped profile that drains away from the glazing.
      a. Type: Removable type, with anchors which do not affect the sealed integrity of the door panel itself.
      b. Finish: Match the color and finish of the door.

2. Louvers: Where required/indicated, louvers shall be fabricated of FRP material of an inverted “v” design, and shall be subject to the same performance requirements and warranty as the door panel. The louver opening will be fabricated into the door in the same method as for glazed openings above.
    a. Finish and Color: To match door and frame.
3. Fasteners: Provide stainless steel fasteners, as required by manufacturer, for installation of stops at glazing openings and louvers.
4. Astragals: Astragals (for pairs of doors) shall be fabricated of FRP material to match door.
    a. Profile: Angle or “z” style astragal.
    b. Finish and Color: To match door.
5. Thresholds: Pultruded or molded FRP with gel-coat finish.
    a. Type and Size: 5 inch wide saddle-type threshold.
    b. Finish and Color: To match door and frame.

2.5 FRP FRAMES

A. General: Provide FRP frames of design indicated herein, and as shown on the Drawings. FRP faced hollow metal or stainless steel frames are not acceptable.
    1. Profile: One-piece frame with integral stop - no joints or screws.
    2. Finish: Gel-coat finish shall match finish for doors.
        a. Gel-coat shall be self-extinguishing.
        b. Flame Spread Rating: 25 or less.
    3. Color: Provide custom color.

B. Frame Construction: Manufacturer’s standard FRP pultrusion or one-piece molded frames.
    1. Opening Size: As scheduled on the Drawings.
    2. Frame Size: As follows unless otherwise shown or noted on the Drawings.
        a. Jamb Depth: 5-3/4 inches standard.
        b. Face Dimensions: Jambs 2 inches standard; head 2 inch or 4 inch as scheduled.
        c. Stop Depth: 5/8 inch minimum.
    3. Standard Core Materials: Full depth FRP or Class A rated plastic foam fill.
    4. Fire-Rated Core Materials: Fire-stop and mineral core, or other fire-resistant composite core formulation, used by manufacturer to achieve UL and ASTM certifications.
    5. Internal reinforcement: Provide solid polymer or FRP reinforcement materials as an integral part of the frame design, for the attachment of mortise and surface-mounted hardware.
    6. Anchors: Manufacturer shall provide the type, number and spacing for anchors as required for adjacent construction.
        a. CMU Walls: “T” strap or heavy gauge wire anchors.
        b. Concrete Walls: Existing opening anchors.
        c. Metal Framing: As recommended by manufacturer.

2.6 HARDWARE/HARDWARE PREPARATIONS

A. General: Hardware for FRP doors and frames is specified in Section 08 71 00 Door Hardware unless otherwise noted.
    1. Hardware Specified in this Section: Provide hardware items as follows:
        a. FRP astragals.
        b. FRP thresholds.
    2. Hardware by Others: FRP door/frame manufacturer shall coordinate the fabrications of the doors and frames to accommodate hardware specified or indicated elsewhere in the contract documents, and as provided by an approved Hardware Schedule.

B. Hardware Preparations: FRP door/frame manufacturer shall provide internal reinforcement blocking for all surface-mounted hardware, and to provide the blocking and cutouts for all mortise hardware.
   1. Surface-Mounted Hardware Items
      a. Closers
      b. Kick plates.
   2. Mortise Hardware items: All doors and frames shall be mortised and reinforced to allow on-site installation of hinges and locks, in accordance with the approved Hardware Schedule and the hardware manufacturer's templates.
      a. Full mortise hinges.
      b. Mortise locksets.
      c. Mortise exit devices.

2.7 FASTENERS

A. General: All fasteners shall by Type 304 CRSS (18-8 series corrosion-resistant stainless steel) - no carbon steel or aluminum components.

2.8 FABRICATION

A. General: Fabricate FRP doors and frames as shown on the Drawings and in accordance with industry practices as required to achieve highest quality of workmanship.
   1. Frames shall be rigid, neat in appearance and free from defects.
   2. Field measurements shall be taken as required for coordination with adjoining work.

B. Quality Standards: Form exposed surfaces free from warp, wave and buckle, with all corners square.
   1. Set each member in proper alignment and relationship to other members with all surfaces straight and in a true plane.

C. Reinforcement: Reinforce members, accessories and joints with plates, tubes or angles for rigidity and strength.

D. Hardware Preparation: Doors and frames shall be mortised and reinforced for hardware in accordance with the hardware manufacturer's instructions and templates. The reinforcing shall be designed to receive hinges, locks, strikes, closures, etc.
   1. Reinforcing for hardware shall be designed by the FRP manufacturer to withstand all imposed loads and repetitions of use for each respective item of hardware.

E. Furnish at least one floor anchor and three jamb anchors in each jamb of frames up to 84 inches high and one additional anchor for each 12 inches in height above 84 inches, in shapes, sizes and spacing shown or as required by manufacturer for anchorage into adjoining wall construction.
   1. Fabricate joint anchor of stainless steel.
   2. Terminate bottom of frames at the indicated finished floor level.

F. Door/Frame Tolerances: Provide clearance for doors of 1/8 inch at jambs and heads; 1/4 inch clearance above threshold.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of FRP doors and frames.
   1. Examine roughing-in for embedded and built-in anchors to verify actual locations of FRP frame connections before frame installation.
   2. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION

A. General: Provide FRP doors and frames of sizes, thicknesses, and designs indicated. Install doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings, approved shop drawings, and manufacturer's written instructions and recommendations.
   1. Field Modifications: On-site alteration or modification of FRP doors and frames to accommodate field conditions is not permitted.
   2. Fire labeled doors and frames must be installed in strict accordance with manufacturer's instructions and the latest revision of NFPA 80.

B. FRP Frames: Install frames for doors (sidelights, transoms and borrowed lights, where applicable) and other openings, of size and profile indicated.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces or spreaders, leaving frame surfaces smooth of undamaged.
      a. Install view or light-opening frames with removable glazing stops located on secure side of opening.
      b. Remove temporary braces necessary for installation only after frames have been properly set and secured.
      c. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
      d. Provide floor anchors for each jamb (and/or mullion) that extends to floor and secure with post-installed expansion anchors.

C. FRP Doors: Fit doors accurately in frames, within clearances specified below.
   1. Non-Fire-Rated Doors:
      a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
      b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
      c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
      d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements and with FRP door and frame manufacturer's written instructions.
   1. Secure stops with countersunk stainless steel flat-head screws/anchors spaced uniformly not more than 9 inches o.c., and not more than 2 inches o.c. from each corner.

3.3 ADJUSTING AND CLEANING

A. Final Adjustments: Leave work in complete and proper operating condition. Remove and replace damaged or defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.
   1. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding and to fit accurately in the frames within the clearances/tolerances specified.
   2. Check and readjust operating hardware items immediately before final inspection.

B. Cleaning: Clean FRP doors and frames immediately after installation using cleaning materials and procedures as recommended by the manufacturer.
   1. Clean with mild, non-abrasive cleaner and water, using soft, non-abrasive cleaning aids.

3.4 PROTECTION

A. General: Protect door/frame opening assemblies and hardware from damage by subsequent construction until time for Substantial Completion.

3.5 SCHEDULE

A. DOOR SCHEDULE

   1. See drawings for schedule.

END OF SECTION

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Commercial door hardware for the following:
      a. Swinging doors.
      b. Hinged metal transom.

B. Related Sections include the following:
   1. Division 8 Section "Standard Steel Doors and Frames".
   2. Division 8 Section “Fiberglass Reinforced Plastic Doors and Frames”.
   3. Division 8 Section “Overhead Coiling Doors” for door hardware provided as part of overhead door assemblies.

C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
   1. Thresholds and weather stripping for locks specified in other Sections.

1.2 SUBMITTALS

A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples for Initial Selection: For each finish, color, and texture required for each type of door hardware indicated.

C. Samples for Verification: Submit minimum 2-by-4-inch plate Samples of each type of finish required, except primed finish.

D. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

E. Warranty: Special warranty specified in this Section.

F. Other Action Submittals:
   1. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
      b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
      c. Content: Include the following information:
         1) Identification number, location, hand, fire rating and material of each door and frame.
         2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
         3) Complete designations of every item required for each door or opening including name and manufacturer.
         4) Fastenings and other pertinent information.

5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
6) Explanation of abbreviations, symbols, and codes contained in schedule.
7) Mounting locations for door hardware.
8) Door and frame sizes and materials.
9) List of related door devices specified in other Sections for each door and frame.

d. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Engineer, and Owner about door hardware and keying.
2. Installer shall have warehousing facilities in Project's vicinity.
3. Scheduling Responsibility: Preparation of door hardware and keying schedules.

B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

D. Pre-installation Conference: Conduct conference at Project site.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.5 COORDINATION

A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of operators and door hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
   2. Warranty Period: Three years from date of Substantial Completion, except as follows:
      a. Exit Devices: Two years from date of Substantial Completion.
      b. Manual Closers: 10 years from date of Substantial Completion.

1.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.
   1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.
   2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:
   1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.

C. In other Part 2 articles where titles below introduce lists, 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 unless noted otherwise in the hardware schedules.

2.2 HINGES, GENERAL

A. Quantity: Provide the following, unless otherwise indicated:
   1. Two Hinges: For doors with heights up to 60 inches.
   2. Three Hinges: For doors with heights 61 to 90 inches.
   3. Four Hinges: For doors with heights 91 to 120 inches.
   4. For doors with heights more than 120 inches provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

B. Template Requirements: Provide only template-produced units.

C. Hinge Weight: Unless otherwise indicated, provide the following:
   1. Exterior Doors and interior metal or FRP doors: Heavy-weight hinges.
   2. Interior Wood Doors: Standard-weight hinges.
   3. Doors with Closers and/or exit devices: Antifriction-bearing hinges – ball bearing.

D. Hinge Base Metal: Unless otherwise indicated, provide the following:
   1. Exterior Hinges: Stainless steel, with stainless-steel pin (630/US32D).
   2. Interior Hinges: Stainless steel, with stainless-steel pin (630/US32D).
   3. Hinges for Fire-Rated Assemblies: Stainless steel, with stainless-steel pin.

E. Hinge Size: 4-1/2-inch x 4-1/2-inch, unless otherwise noted.
   1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors.
   2. Corners: Square.

F. Fasteners: Comply with the following:
   1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
   2. Wood Screws: For wood doors.
   3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
   4. Screws: Phillips flat-head. Finish screw heads to match surface of hinges.
      a. Fasteners for FRP doors and frame hardware are specified in Division 8, “FRP Doors and Frames.”

2.3 HINGES

A. Butts and Hinges: BHMA A156.1. Listed under Category A in BHMA’s “Certified Product Directory.”

B. Template Hinge Dimensions: BHMA A156.7.

C. Available Manufacturers:
   1. Hager Companies (HAG).
   2. Lawrence Brothers, Inc. (LB).
   3. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

2.4 PIVOTS AND PIVOT HINGES

A. Pivots: BHMA A156.4. Listed under Category C in BHMA’s “Certified Product Directory.:

B. Available Manufacturers:
   1. DORMA Architectural Hardware; Member of The DORMA Group North America.
   2. IVES Hardware; an Ingersoll-Rand Company.
   3. Rixson Specialty Door Controls; an ASSA ABLOY Group company.

2.5 LOCKS AND LATCHES, GENERAL

A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board’s “Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)” and ANSI A117.1.
   1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

C. Lock Trim
   1. Levers: Cast.
   2. Escutcheons (Roses): Forged or Cast.
   3. Dummy Trim: Match lever lock trim and escutcheons.
   4. Lockset Designs: Provide lockset design(s) indicated by hardware sets or, if locksets are provided by another manufacturer, provide designs that match those designated.
      a. Corbin Russwin: ML 2000 Series with Citation CSB (lever) trim.

D. Lock Throw: Comply with testing requirements for lengths of bolts required for labeled fire doors, and as follows:
   1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
   2. Deadbolts: Minimum 1-inch bolt throw.
      a. Bored Locks: Minimum 1/2-inch latchbolt throw.

E. Backset: 2-3/4 inches, unless otherwise indicated.

F. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:

2.6 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
   1. Mortise Locks: BHMA A156.13.
   2. Bored Locks: BHMA A156.2.

B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13, Grade 1; Series 1000.
   1. Available Manufacturers:
      a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
      b. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
      c. Yale Commercial Locks and Hardware: an ASSA ABLOY Group Company.
   2. Product Reference Standard: Corbin Russwin: ML 2000 Series: 3600 Series (heavy-duty lever locksets).

C. Bored Locks: BHMA A156.2, Grade 1, Series 4000.
   1. Available Manufacturers:
      a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
      b. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
      c. Yale Commercial Locks and Hardware: an ASSA ABLOY Group Company.
   2. Product Reference Standard: Corbin Russwin: ML 2000 Series: 3600 Series (heavy-duty lever locksets).

2.7 AUXILIARY LOCKS AND LATCHES

A. Auxiliary Locks: BHMA A156.5, Grade 1.
   1. Available Manufacturers:
      a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
      b. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
      c. Yale Commercial Locks and Hardware: an ASSA ABLOY Group Company.

2.8 DOOR BOLTS

A. Bolt Throws: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   1. Mortise Flush Bolts: Minimum 3/4-inch (19 mm) throw.
   2. Surface Bolts: Minimum 7/8-inch (22 mm) throw.
   3. Fire-Rated Surface Bolts: Minimum 1-inch (25 mm) throw.

B. Dustproof Strikes: BHMA A156.16, Grade 1.

C. Surface Bolts: BHMA A156.16, Grade 1.
   1. Flush Bolt Heads: Minimum of 1/2-inch (13 mm) diameter rods of stainless steel with minimum 12-inch heads (305 mm) long rods for doors up to 84 inches (2134 mm) in height. Provide longer rods as necessary for doors exceeding 84 inches (2134 mm).
   2. Available Manufacturers:
      a. IVES Hardware, an Ingersoll-Rand Company.
      b. Other approved equal.

D. Manual Flush Bolts: BHMA A156.16, Grade 1, designed for mortising into door edge.
   1. Available Manufacturers:
      a. IVES Hardware; an Ingersoll-Rand Company.
      b. Stanley Commercial Hardware; Div. of The Stanley Works.
      c. Trimco.
   2. Product Reference Standard: Ives No. 457-1/2 x 12 inches with top and bottom plates for rod retention.

2.9 EXIT DEVICES

A. Exit Devices: BHMA A156.3, Grade 1.

B. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.
   1. Provide operating devices that do not require tight grasping, pinching or twisting of the wrist and that operate with a force of not more than 5 lbf.

C. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

E. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

F. Exit Device Design: Push Bar type equal to Corbin Russwin ED 5000 Series.
   1. Mortise lock exit devices: Corbin Russwin Series ED 5600L, with Citation C7M Lever handle) trim.
   2. Rim exit device: Corbin Russwin Series ED 5200 Series with Citation C7M trim.

G. Outside Trim: Lever, Lever with Mortise cylinder or Pull with Mortise cylinder; material and finish to match locksets, unless otherwise indicated.

1. Match design for locksets and latchsets, unless otherwise indicated.

H. Dogging: One point dogging with 1/4-turn maximum to activate.

2.10 LOCK CYLINDERS

A. Standard Lock Cylinders: BHMA A156.5, Grade 1.
   1. Key Control Level: Category A.
   2. Destructive Test Level: Category A.
   3. Surreptitious Entry Resistance Level: Category A.

B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
   1. Number of Pins: Six.
   2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
   3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
   4. Bored-Lock Type: Cylinders with tailpieces to suit locks.

C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
   1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.

D. Construction Keying: Comply with the following:
   1. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.
      a. Replace construction cores with permanent cores as indicated in keying schedule.

E. Manufacturer: Same manufacturer as for locks and latches.

F. Available Manufacturers
   1. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).

2.11 CLOSERS

A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.
   1. Comply with the following maximum opening-force requirements:
      a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
      b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

C. Overhead Closers: Closers shall have high-strength cast-iron body with rectangular covers, adjustable spring power and back-check, and full rack and pinion action. All closers shall have adjustable back-check intensity valves and separate adjustment screws for closing and latching speeds.
   1. Closers for doors over 7-feet in height, or more than 3-feet wide, shall have heavy duty arms.

2. Closers at exterior doors shall include positive stop arms unless otherwise indicated.
3. Door closer covers and arms shall be spray pained to match door hardware.
4. Closers shall be provided with hex bolts for fastening through doors, frames and transoms.

D. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

E. Surface Closers: BHMA A156.4, Grade 1. Listed under Category C in BHMA's "Certified Product Directory." Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.

F. Closer Design/Type: Closer type as follows:
1. Regular Arm: Corbin Russwin DC 2200 Series
2. Parallel Arm: Corbin Russwin DC 2200 Series
3. Parallel Arm with Positive Stop: Corbin Russwin DC 2210
   a. Multi-size application

2.12 PROTECTIVE DOOR PLATES

A. Size: 1-1/2 inches (38 mm) less than door width on push side and 1/2 inch (13 mm) less than door width on pull side, by height specified below.

B. Fasteners: Manufacturer's standard machine or self-tapping screws.

C. Metal Protective Kick Plates: BHMA A156.6; beveled top and 2 sides; fabricated from the following material:
1. Material: 0.050-inch- (1.3 mm) thick stainless steel.
2. Product References Standard: Rockwood No. 1050; 16 inches high.

D. Metal Protective Armor Plates: Beveled top and two sides.
1. Material: 0.062 inch thick stainless steel.
2. Product Reference Standard: Rockwood No. 1050; 30 inches high.

2.13 STOPS AND HOLDERS

A. Stops and Bumpers: General: BHMA A156.16, Grade 1.
1. Provide wall stops for doors unless other type stops are scheduled or indicated. Do not mount floor stops were they will impede pedestrian or vehicular traffic. Where floor or wall stops are not appropriate, provide overhead holders.

B. Door Stops: Door stops shall be of the type specified in the hardware sets or in this schedule, and shall be provided with the proper fasteners.
1. Door Stop Schedule

	Floor Stop w/Holder	Floor Stop Dome	Wall Stop w/Holder	Wall Stop	Kick Stop (4" Arm)
IVES	446/450	438	445/449	407-1/2	452

2. Fasteners/Anchors: Stops shall be provided with machine screws and anchors at concrete and masonry conditions, and toggle bolts at plaster, gypsum board, and wood conditions.

C. Overhead Holders: Overhead type door holders shall be concealed type of correct size for door, 90 degrees openable, unless 120 degree opening shown, and allowing for checkmating. Interior doors shall be provided with overhead stops if wall type stops cannot be used and floor stops create a tripping hazard. Finish shall be chrome plated bronze with satin finish, US 26D, unless otherwise specified.
   1. Holders Design: Door holders shall be Russwin Corbin, DH 5000 Series, Holder No. DH5400, or equal.

D. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame.

2.14 THRESHOLDS

A. Standard: BHMA A156.21. Listed under Category J in BHMA's "Certified Product Directory."

B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.
   1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2-inch.

C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2-inch (13 mm) high.

D. Threshold Design: All exterior doors shall receive a panic style (offset) aluminum threshold unless otherwise indicated:
   1. Accessible Entry: National Guard No. 896N (neoprene gasket).
   2. Non-Accessible Entry: National Guard No. 884N (neoprene gasket).
   3. Receiving Entry: National Guard No. 513, Saddle/flat style threshold.

2.15 MISCELLANEOUS DOOR HARDWARE/ACCESSORIES

A. Push Plates and Pulls: 4-inch by 16-inch by 0.050 thick, stainless steel: Rockwood #70 or equal. Pulls shall be 3/4" diameter thru-bolted with 4-inch x 16-inch stainless steel plate, Rockwood No. 105 X 70, or equal.

B. Astragal: "T" Astragal No. 158NA, National Guard Products.

C. Coordinator: Frame mounted, non-handed coordinator and filler piece; Rockwood No. 1600 Series x US26D.
Provide Rockwood No. 1100 carry bars at openings with astragals.

D. Drip Cap: Door Top: National Guard No. 16AD x door width plus 2 inches. Mount head to hollow metal frame.

E. Bottom Sweep: National Guard No. 201NA x door width.

F. Weatherstrip: National Guard No. 135N; install at each jamb and at head.

G. Cane Bolt: Heavy-duty cane bolt, Hager No. 1408; 18 inches long x 5/8-inch diameter x US32D (with bolt guides, keeper, and surface strikeplate).
   1. Finish: Galvanized or factory paint finish.

H. Exit Devices: Sargent 8800 (Rim) Series with maximum corrosion-resistant design and finishes, i.e., US32D x CPC. Provide fire-rated devices as noted on Door Schedules. All devices must be keyed to Corbin Russwin system.

I. Closers: LCN 4041-EDA-SRI-ALXTB; provide with standard color powder coat paint finish.

J. Push-Pulls: Rockwood No. 107 x 70 x US32D.

K. Kick Plates: Rockwood No. 1050; 16 inches high x 2 inches less than door width x 0.050 inch thick x US32D.

L. Armor Plates: Rockwood No. 1050; 30 inches high x 2 inches less than door width x 0.062 inch thick x US32D (with bevel at three sides).

M. Cane Bolt: Heavy-duty cane bolt, Hager No. 1408; 18 inches long x 5/8-inch diameter x US32D (with bolt guides, keeper, and surface strikeplate).
   1. Finish: Galvanized or custom applied powder coat paint.

N. Astragal: FRP astragal by door manufacturer; furnish with neoprene weatherstrip seal.

O. Threshold: FRP offset threshold by door manufacturer; furnish with neoprene weatherstripping at offset face to form a “weatherseal.”

P. Panic Exit Devices: Devices complying with NFPA 80 and as further specified in Section 2.9.

2.16 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A.
   1. Existing System: Master key locks to Owner’s existing system.

B. Keys: Nickel silver.
   1. Quantity: In addition to one extra key blank for each lock, provide the following:
      a. Master Keys: Five.

2.17 FABRICATION

A. Manufacturer’s Nameplate: Do not provide products that have manufacturer’s name or trade name displayed in a visible location.
   1. Manufacturer’s identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer’s standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer’s standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
   1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only

means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Steel Machine or Wood Screws: For the following fire-rated applications:
   a. Mortise hinges to doors.
   b. Strike plates to frames.
   c. Closers to doors and frames.
3. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:
   a. Surface hinges to doors.
   b. Closers to doors and frames.
   c. Surface-mounted exit devices.
4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
5. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, “Recommended Fasteners for Wood Doors.”

2.18 FINISHES

A. Standard: BHMA A156.18, as indicated in door hardware sets.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable temporary protective cover before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.19 MANUFACTURERS

A. Product numbers listed in the following specifications are taken from catalogs of manufacturers listed as follows:
   1. ST Stanley Hardware
   2. S Sargent & Company
   3. NG National Guard Products
   4. R Russwin
   5. Mc McKinney
   6. N Norton
   7. H Hager
   8. RO Rockwood Mfg.
   9. I Ives
   10. GJ Glynn Johnson
   11. Sch Schlage
   12. VD Von Duprin

B. Products of the following manufacturers will be considered acceptable provided products are of equivalent weight, function, materials and design:
   1. Hinges: Hager, Mc Kinney
   2. Locks: Russwin, Sargent, Schlage
   3. Closers: Russwin, Norton, Sargent
   4. Holders and Stops: Sargent
   5. Door Trim: Glynn Johnson, Ives
   6. Thresholds & Weatherstripping National Guard

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, wall and floor construction, and other conditions affecting performance.

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

3.2 PREPARATION

A. Steel Doors and Frames: Comply with DHI A115 Series.
   1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
   1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
   1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
   2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Thresholds: Set thresholds for exterior doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DOOR HARDWARE SETS

A. In addition to miscellaneous hardware per section 2.15 provide:

HARDWARE SET 1 (HW-1) EACH TO HAVE		
Mc	3 Hinges	TB 2714 4 ½ X 4 ½ US26D NRP
VD	Rim Exit	98L X US26D W/Schlage 20-022X26D 35-101-C
S	Closer	1431-OU EN
RO	Kickplate	10” X 34” K1050F US32D
RO	Kick Down Door Stop	461L US26D
NG	1 Threshold	884V x Length Required
NG	1 Seal	5050B-17 x Length Required
	Lock	

END OF SECTION

SECTION 08 90 00 - LOUVERS AND VENTS

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. Section Includes:
   1. Combination, Drainable extruded-aluminum louvers.
   2. Stationary, Drainable extruded-aluminum louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft. acting inward or outward.

B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

A. Product Data: For each type of louver indicated.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

2. AWS D1.3, "Structural Welding Code - Sheet Steel."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

D. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.7 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.

B. Fasteners: Use types and sizes to suit unit installation conditions.
1. Use screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For fastening stainless steel, use 300 series stainless-steel fasteners.
4. For color-finished louvers, use fasteners with heads that match color of louvers.

C. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern.
2. Horizontal Mullions: Provide horizontal mullions at joints.

C. Maintain equal louver blade spacing to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

G. Provide subsills made of same material as louvers or extended for recessed louvers.

H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 COMBINATION, DRAINABLE EXTRUDED-ALUMINUM LOUVERS

A. Louver Construction and Operation: Provide operable louvers with extruded-aluminum frames and blades not less than 0.080-inch (2.03-mm) nominal thickness, and with operating mechanisms to suit louver sizes.
   1. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch.

B. Dual-Blade, Drainable-Blade, combination Louver: Fixed drainable blades and adjustable plain blades combined in single frame.
   1. Louver Depth 6 inches overall.
   2. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 STATIONARY, DRAINABLE EXTRUDED-ALUMINUM LOUVER

A. Louver Construction: Provide stationary louver with extruded-aluminum frame and blades not less than 0.080 inch (2.0-mm) nominal thickness. Frame shall be integral flange type.
   1. Hinged frame: Continuous piano hinge
   2. Louver Depth: 4 inches (100 mm)

2.5 LOUVER SCREENS

A. General: Provide screen at each exterior louver
   1. Screening Type: Insect screening.

2.6 EXTENDED SILLS

A. General: Provide extended sills at each louver
   1. Extended Sills: Extruded aluminum, Alloy 6063-T5. Minimum nominal wall thickness 0.060 inch (1.5 mm).

2.7 INSTALLATION ANGLES

A. General: Provide manufacturer’s installation angles and fasteners for each louver.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.9 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Kynar 500 Fluoropolymer Coating:
   1. Conform to AAMA 605.2.
   2. Apply coating following cleaning and pretreatment.
   3. Cleaning: AA-C12C42R1X.
   4. Dry louvers before final finish application.
   5. Total Dry Film Thickness: Approximately 1.2 mils (0.03 mm), when baked at 450 degrees F (232 degrees C) for 10 minutes.
   6. Color and Gloss: Match Architect's sample building color.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

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 water treatment and storage facilities.

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) Site electrical power: Not available for CONTRACTOR’s use.
      2) 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.]
      3) 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.
      4) 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 RESTRICTTIONS.

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. Alkali resistant bitumastic: As manufactured by one of the following or equal:
1. Refer to Coal Tar Epoxy Substitute.

B. Wax coating: As manufactured by the following or equal:
1. Sanchem: No-Ox-Id A special.

C. 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.

D. 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).

E. 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

F. 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.

G. 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.

H. High temperature coating up to 1,400 degrees Fahrenheit: As manufactured by the following or equal:
   1. Dampney: Thermalox 240 Silicone Ceramix.

I. Asphalt varnish: AWWA C 500.

J. 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.

K. Coal tar epoxy substitute: As manufactured by one of the following or equal:
   1. Devoe: Devtar 5A HS.
   2. S-W: Macropoxy 646 Black.

L. 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.

M. 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.

N. 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.

O. Waterborne acrylic emulsion: As manufactured by one of the following or equal:
   1. S-W: DTM Acrylic B66W1.
   2. Tnemec: Tneme-Cryl Series 6.

P. 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. 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.
   3. 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.
   4. 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, convector 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, convector 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 insure set time is complete prior to each application. Hardness testing shall be preformed 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 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.

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14 CONCRETE FLOOR COATINGS

A. Preparation:
1. Prepare surfaces in accordance with general application requirements and in strict a 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.

3.15 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.

3.16 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.

3.17 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 – Potable 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	3 coats, 3 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. Al.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 (150º - 350º):

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 150º - 350º	1 coat, 2 MDFT

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

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 400º - 1000º	1 coat, 2 MDFT 1 coat, 1.5 MDFT

H. System No. 8 High Temperature (1000º - 1400º):

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 1400º	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.

3.18 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. Galvanized steel wall framing, galvanized roof decking, galvanized electrical conduits, galvanized pipe trays, galvanized cable trays, and other galvanized items:
    a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired as follows:
        1) Clean damaged areas by SSPC SP-1, SP-2, SP-3, or SP-7 as required.
        2) Apply 2 coats of a Galvanizing Zinc Compound in strict accordance with manufacturer's instructions.
7. Grease fittings.
8. Fiberglass ducting or tanks in concealed locations.
9. Steel to be encased in concrete or masonry.

3.19 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.

B. Following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.

C. Metal:
    1. System 2 – Submerged Metal – Potable
        a. Above grade piping, wall pipes, and pipe sleeves.
        b. Structural Steel.
    2. System 12 - Skid-Resistant Aluminum and FRP
        a. Aluminum checker plate in all exterior locations, and in wet interior locations.
    3. System 15 - Aluminum and Dissimilar Metal Insulation
        a. Aluminum surfaces embedded or in contact with concrete, masonry, and other metals.
        b. Stainless steel embedded in concrete.
        c. Dissimilar metals for electrical insulation.

D. Other Materials
    1. System 14 - Exposed PVC
        a. All exterior exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV resistant gel coat.

E. Concrete:
    1. System 17 – New Concrete/CMU Exterior
        a. Safety markings

END OF SECTION

DIVISION 11

EQUIPMENT

SECTION 11 20 00 – GST RESIDUAL CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: All work necessary to furnish, install, and place into operation the chloramine residual control system (RCS). This section includes the chemical feed skids, water quality station, smart controller, and accessories as specified herein.

B. The RCS Supplier shall furnish an entire Residual Control System consisting of the following major components:

1. Smart Control Center (SCC) – Integrated control panel with Human Machine Interface and data acquisition system.
2. Water Quality Station (WQS) – Reagentless, amperometric probe type analyzer to be used in continuous measurement of Total Chlorine, pH, Temperature, and ORP simultaneously.
3. Chemical Feed Skids (CFS) – Two skid mounted systems, one each for injecting ammonia as liquid ammonium sulfate (typical concentration of 38%-40%) and chlorine as liquid sodium hypochlorite (typical concentration of 12.5%) in potable water.

C. Related sections

1. Section 01 33 00 – Submittal Procedures.
2. Section 01 60 00 – Product Requirements.
3. Section 01 78 23 – Operations and Maintenance Data.
4. Section 01 79 00 – Demonstration and Training.
5. Section 11 30 00 – Spill Containment IBC Tote Scale.
6. Division 26 – Electrical.
7. Section 40 23 39 – Process Piping.

D. Codes and standards

1. American National Standards Institute (ANSI).
2. Underwriter Laboratory (UL): UL 508A- Industrial Control Panel
3. Occupational Safety and Health Administration (OSHA)
4. National Electrical Manufacturers Association (NEMA)
5. National Electrical Code (NEC)

E. System Description

1. The RCS is an automated system designed to continuously monitor the disinfectant level and precisely dose chemicals in order to control and maintain a disinfectant concentration target.
2. The RCS shall improve water quality through multiple processes:
   a. The RCS shall allow for optimization of the chloramine residual curve by continuously monitoring water quality parameters and controlling doses of ammonia and chlorine.
3. The system shall be designed for the following operating conditions:
   a. Ambient Temperature: 0°C to 35 °C (33°F to 90 °F).
   b. Relative humidity: 0% to 95%, non-condensing.
4. The system must maintain the incoming disinfectant residual within ± 0.2 ppm of the desired set point within 48-hours after initial system start-up.

1.2 GENERAL

A. Like items of equipment provided hereunder shall be the end products of one Manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and Manufacturer's service.

1.3 SUBMITTALS

A. Submittals shall be as required in Section 01 33 00, Submittal Procedures. The following specific information shall be provided:

1. Shop Drawings: Shop drawings shall include descriptive information as required to fully describe the Pumps, Panels, and overall performance and shall identify any deviations from the specified requirements.
2. Product data sheets.
3. Special handling instructions, in accordance with Section 01 60 00, Product Requirements.
4. Requirements for storage and protection prior to installation, in accordance with Section 01 60 00, Product Requirements.
5. Installation, start-up, operation and maintenance instructions.
6. Diagram indicating the electrical wiring to be installed by Supplier.
7. List of all requested exceptions to the Contract Documents.
8. Panel information to be submitted in accordance with Division 26, Electrical.
9. Quality control submittals as listed in Section 01 33 00, Submittal Procedures.
10. Instrumentation and control submittals as listed in Division 26, Electrical.

1.4 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing manual as specified in 01 78 23, Operation and Maintenance Data.

B. Detailed operation and maintenance (O&M) manuals for the RCS shall be provided by the Supplier to the Engineer for review and approval. At a minimum, the following shall be included:

1. Required Operation Data.
   a. Complete, detailed operating instructions for each piece of equipment.
   b. Explanations for all safety considerations relating to operations.
   c. Recommended spare parts lists.
2. Required Maintenance Data.
   a. All information and instructions required by plant personnel to keep equipment properly cleaned, lubricated, and adjusted so that it functions economically throughout its full design life.
   b. Maintenance summary forms.
   c. Explanation with illustrations as necessary for each maintenance task
   d. Recommended schedule of maintenance tasks.
   e. Lubrication charts and table of alternate lubricants
   f. Troubleshooting instructions.
   g. List of maintenance tools and equipment.
   h. Name, address, and phone number of manufacturer and manufacturer's local service representative for major system components.

1.5 EXPERIENCE REQUIREMENTS

A. All equipment utilized in the RCS shall be the product of a manufacturer having at least five (5) Texas installations of the type being proposed or 50 installations in the U.S.

B. A list of similar installations shall be furnished with the shop drawing submittal, including names and telephone numbers of contacts, upon request.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chemical feed pump systems, Water Quality Station, or Smart Control Center that fails in materials or workmanship within specified warranty period.

B. Warranty Period: All system components: One (1) year from date of Equipment Commissioning.

C. Cost for the removal, shipment, repair or replacement, and installation of components, and correction of defective work by CONTRACTOR shall be included in warranty.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment including controls and drives specified herein shall be specifically designed for the service environment encountered in this installation. The environment may be moist and corrosive.

B. Equipment shall be designed and capable of either continuous or intermittent operation.

C. All equipment, supports, anchors, and fasteners shall be of adequate strength to withstand loads associated with starting/stopping, turbulence, thrusts from liquid movement, thermal expansion, and contraction and other loads encountered under normal operating conditions.

D. The equipment shall be chemically compatible with and capable of dosing the chemical solutions specified herein.

2.2 MANUFACTURERS

A. 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.

B. Manufacturer of components and accessories specified herein shall be as follows:

1. PSI Water Technologies
2. Or approved equal

2.3 WATER QUALITY SYSTEM

A. Water Quality Station (WQS): Consists of a reagentless amperometric probe type analyzer that utilizes a set of sensors that measure the temperature, pH, Oxidation-Reduction Potential (ORP), total chlorine, and chloramine. WQS measures the weight that represents the chemical volume or level in the storage unit. These measurements are displayed in real time on the Human-Machine Interface (HMI) display and are continuously logged onto a USB flash drive for analysis. The analyzer is designed for continuous measurement of the sample stream without the need for reagent addition.

B. At a minimum, the Water Quality Station shall have the following features, components, and functionality:

1. Materials
    a. Housing: Powder coated steel
    b. Enclosure Rating: NEMA 3R
2. Power Requirements: 115 VAC, 60 Hz
3. Sampling and discharge flow rate: 10 GPH
4. Maximum inlet pressure of flow cell: 30 PSI
5. HMI: 3.8“ LCD Touch Screen
6. SCC Communication: Modbus RS-485
7. SCADA Communication: 8 analog outputs
8. Real-time data acquisition on USB Flash Drive.
9. Sensors
    a. Total Chlorine Sensors
        1). Dual probe configuration.
        2). Type: 3-electrode amperometric.
        3). Measuring Range: 0 - 20 mg/L.
        4). Resolution: 0.01 mg/L.
    b. pH Sensor
        1). Type: Combined 2-electrode type pH probe.
        2). Measuring Range: 0 – 14.
        3). Resolution: 0.01.
    c. ORP Sensor
        1). Type: Single Junction.
        2). Measuring Range: +/-2000mV or range of ORP meter.
        3). Measuring surface: Platinum Extended Tip.

C. Submersible Driven Sample Pump

1. General Requirements
    a. Furnish and install corrosion resistant submersible sample pumps.
    b. The use of a Manufacturer’s name and model or catalog number is for the purpose of establishing a standard of quality and general configuration, but modifications shall be made to ensure all requirements specified herein are met. Specific pump models are suggested and other pump models meeting the service and duty requirements will be considered.
2. Manufacturers
    a. Where a manufacturer’s standard equipment name and/or model number is listed, the equipment shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.
    b. Materials, equipment, components, and accessories specified in this section shall be products of:
        1). Micropump I-Drive IEG with Series GJ Pumphead.
        2). Or equal.
3. Motor Requirements
    a. Motor shall be selected in accordance with the pump’s non-overloading performance characteristics.
    b. Brushless DC motor
    c. The motor shall be mounted with the pump at the pump manufacturer’s plant and shipped as one unit.
4. Shipping, Storage, Handling, and Protection
    a. As specified in section 01 60 00.
5. Installation
    a. Work shall be done as specified in section 01 60 00.
6. Factory Tests
    a. Motor Tests and Test reports: As specified in Division 26, Electrical.
    b. Perform factory pump performance test with results plotted on a curve showing at a minimum flow, head, efficiency, and horsepower, as requested by engineer.

c. All factory tests shall have a certified test report submitted to the Engineer. Notify Owner and Engineer minimum of two weeks prior to testing. See Section 01 75 60 for additional witness testing requirements.
d. Upon request, a written quality assurance record confirming testing/inspections shall be supplied with each pump at the time of shipment.
e. Each pump (when specified) shall be tested in accordance with the latest test code of the Hydraulic Institute (H.I.) at the manufacturer to determine head vs. capacity and kilowatt draw required. Witness tests shall be available at the factory upon request.
f. The pump(s) shall be rejected if the requirements stated herein are not satisfied.

7. Manufacturer's Services
   a. Provide representative for one (1) day on-site to verify correct installation, equipment testing, equipment certification, and personnel training.
   b. The equipment manufacturer shall furnish the services of a qualified factory trained field service engineer for 8-hour working day(s) at the site to inspect the installation and instruct the owner's personnel on operation and maintenance of the pumping units.
8. Manufacturer's Certificate(s)
   a. Provide Manufacturer's certificate(s). In accordance with Section 01 79 00.

2.4 SMART CONTROL CENTER

A. The Smart Control Center (SCC) shall continuously monitor the water quality data from the WQS and issue dosing commands to the Chemical Feed Skids (CFS) to maintain residual levels at a predetermined set-point. The control panel shall house the operator interface terminal (OIT), PLC, and terminal strips to fully support the functions of water quality monitoring and chemical feed skid dosing to precisely add disinfectant chemicals.

B. The control panel shall display all relevant operating parameters and/or alarm conditions. The OIT will serve as the operator interface, data input screen, and alarm log.

C. At a minimum, the Smart Control Center shall have the following features, components, and functionality:

1. Materials
   a. Housing: Powder coated steel
   b. Enclosure Rating: NEMA 4
2. Power Requirements: 115 VAC, 60 Hz
3. Allen Bradley MicroLogix 1400 programmable logic controller (PLC) with Ethernet communication protocol.
4. Human-machine interface (HMI): Magelis DT351 7.4" LCD touch screen
5. Ethernet based access to HMI software from computer or smartphone within same network
6. SCADA Communication:
   a. Modbus TCP/IP (Standard)
   b. 2 Analog Output (0-10 V)
   c. 6 Digital Outputs ("Dry-Contact")
7. Chemical feed skid controls.
8. Alarm Management System will produce an automated alert on the HMI if monitored parameters fall out of range of set-point values.
9. Remote Monitoring System (RMS) provides real-time access to water quality data and automated alerts and alarms via SMS.
10. Real-time data acquisition on USB Flash Drive.
11. Three different levels of access: Viewer, Operator or Administrator.
12. Three operating modes: Off, Manual and Auto.

D. The SCC is integrated with a real-time clock.

E. The SCC is supplied with a USB in the back of the Human-Machine Interface (HMI) for data download.

F. The SCC is integrated with one-way wireless transmitter.

G. The SCC has the option of graphical measurement that tracks measurement values over time.

2.5 CHEMICAL FEED SKIDS

A. Chemical Feed Skids contain chemical dosing controllers which provide feedback to and receives commands from the Smart Control Center and transmits signals to the chemical dosing pumps. One (1) chlorine feed skid and one (1) ammonia feed skid will be provided per Residual Control System.

B. Chemical Dosing Controller

1. Pump Control Options: Digital relay, analog (4-20mA), or power switch
2. Power Requirements: 115 VAC, 60 Hz
3. SCC Communication: Modbus RS-485
4. Housing: Black Polycarbonate
5. Enclosure Rating: NEMA 3R
6. Dimensions: 10.0” x 8.0” x 6.0”

C. Chemical Feed Skid:

1. General:
   a. Overall skid dimensions shall not exceed the maximum dimensions shown on the Drawings.
   b. Placement of commonly accessed or maintained pump accessories (valves, instruments, electrical, etc.) are not to exceed 4.5 feet in height above the finished floor.
   c. Provide easy access for any normal replacement parts on skid, including ability to switch out replacement parts without disconnecting hard piping.
2. Containment:
   a. Chemical resistant, UV protected black polypropylene
   b. 9 Gallons secondary containment
3. Peristaltic Pump:
   a. Metering pump is a positive displacement, peristaltic type tubing pump with a brushless variable speed motor, non-spring loaded roller assembly located in the pump head, integral leak detection system, and flexible tubing with attached connection fittings.
   b. Pump head is a single, unbroken track which requires no-tools maintenance and can be mounted on the left or right of the pump.
   c. Pump provides front panel user touchpad controls for stop/start and configuration menu access and navigation, operating mode selection, and priming.
   d. Pump is equipped with a 3.5" TFT color display for menu driven configuration settings, pump output value, service alerts, leak detection system alarms status, and remote input signal values.
   e. Pump provides the manual control of pump output volume via flowrate setpoint.
   f. Pump is used to remote control of pump output volume via 4-20mA signal.
   g. Enclosure Rating: NEMA 3R
   h. Metering pumps shall be a Watson-Marlow Qdos Universal+ Peristaltic Pump or equal.
   i. Each chemical feed skid shall be equipped with one (1) duty and one (1) stand-by pump. An individual pump must be capable of meeting the range of specified feed rates.

1). Chemical feed rates:

Location	Sodium Hypochlorite		Liquid Ammonium Sulfate	
	Min Feed Rate (gph)	Max Feed Rate (gph)	Min Feed Rate (gph)	Max Feed Rate (gph)
Surveyor Pump Station	1.0	4.0	0.1	1.0

4. Piping/Unions: PVC Schedule 80
   a. The internal piping of the skid shall be sized as indicated in the following table:

Design Flow of individual pump	**Suction Pipe Size**	**Discharge Pipe Size**
0-10 GPH	1/2”	1/2”
10-25 GPH	3/4”	1/2”

5. Seals: Viton or EPDM
6. Tubing:
   a. Sodium Hypochlorite: 3/8” I.D. reinforced PVC tubing.
   b. Ammonia: 3/8” O.D. flexible polyethylene tubing.
   c. NSF-61 Approved.
7. Pump skid accessories:
   a. PVC calibration column.
   b. PVC backpressure relief valve.
   c. PVC pressure relief valve.
   d. Wye strainer.
   e. Pressure transmitter
   f. Operating pressure: 0-100 PSI (+/- 0.5% Accuracy)
   g. 4-20mA output
   h. Digital display
8. Mounting:
   a. Mounting Clips: Chemical resistant, UV protected black polypropylene
   b. Pump Mounting Brackets: 316 Stainless Steel
   c. Mounting Hardware: 316 Stainless Steel

2.6 SPARE PARTS

A. Spare parts provided shall include:

1. Spare parts for each pump provided
2. Spare parts kit for water quality station
3. Spare parts kit for smart control center

PART 3 - EXECUTION

3.1 INSTALLATION

A. The equipment shall be installed per the contract documents and manufacturer’s recommendations.

B. The Supplier or a contractor authorized by the supplier will complete the Installation Activity Report, which certifies the equipment installation has been completed in accordance with Manufacturer's specification

C. The RCS, along with all applicable components, shall be marked and identified for all health, flammability, and reactivity of hazardous materials as required by all applicable jurisdictional building codes, statutes, standards, regulations, and laws.

3.2 STARTUP AND TRAINING

A. A factory technician from the RCS Supplier shall be present at the jobsite for initial system start-up and commission of equipment. Factory technician will ensure that the system is properly installed, start-up the system, and train the Owner's personnel.

B. Contractor and RCS Supplier shall make equipment adjustments required to place system in proper operating condition.

C. The RCS Supplier shall coordinate the residual control system installation and testing with the Control System Specialist responsible for connection of the system to the Owner's existing SCADA system for remote monitoring and control. The supplier shall provide support to the Control System Specialist as required to ensure proper communication of data between the systems.

D. Supplier staff (or their representatives) will instruct designated UTILITY personnel in the safe and proper operation of the Mixer System. This training will reference the operations manual provided with equipment and show how to check for proper functioning of the equipment.

END OF SECTION

SECTION 11 22 10 – GST SUBMERSIBLE MIXING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers submersible tank mixing systems up to 3.0 HP in size intended for continuous use while submersed in potable water storage tanks. Each mixer shall have the ability to function continuously on a year-round basis, regardless of drain and fill cycles. Each mixer shall consist of a water-filled submersible motor, an impeller, chemical dosing nozzles, and a non-submersible control center that houses all control electronics.

B. CONTRACTOR shall furnish an in-tank mixer with control panel that is compatible with the Residual Control System (RCS), as specified in section 11 20 00, GST Residual Control System, and install the submersible mixing system together with controls and accessories necessary for a complete and operable system.

C. Contractor shall furnish electrical conduit with 230VAC Single Phase voltage based on System configuration, a Safety disconnect switch and a 20 Amp non-GFCI circuit breaker up to the point of installation of the mixing system control center.

D. Contractor shall also provide tubing and conduit from RCS to mixer location in ground storage tank (GST), as shown on the drawings and recommended by the manufacturer.

E. Related sections
1. Section 01 33 00 – Submittal Procedures.
2. Section 01 60 00 – Product Requirements.
3. Section 01 78 23 – Operations and Maintenance Data.
4. Section 01 79 00 – Demonstration and Training.
5. Section 11 20 00 – Residual Control System.
6. Division 26 – Electrical.
7. Section 40 23 39 – Process Piping.

F. Codes and standards
1. NSF / ANSI Standard 61
2. Underwriter Laboratory (UL): UL 508
3. Occupational Safety and Health Administration (OSHA)

G. System Description
1. Mixing system consists of an impeller mounted on a submersible motor and supported approximately from the tank floor. The mixer shall operate such that it conveys water from the bottom of the tank up towards the water surface. Mixer control and operation shall be independent of tank drain and fill cycles to ensure constant mixing. Wet-side of Mixer shall weigh less than 75 pounds (~34 kg) and dry-side shall weigh less than 50 pounds (~22 kg). Both wet-side and dry-side shall be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.
2. Mixing system active components shall be elevated at a minimum of 18 inches above tank floor to avoid disturbing accumulated tank sediment or entraining particles and causing accelerated wear of moving parts.
3. Power source for mixer shall be 230VAC single phase grid power to allow unit to continue around the clock operation where necessary.
4. Mixer shall have integrated chemical injector nozzles to immediately mix liquid ammonium sulfate and liquid sodium hypochlorite in the ground storage tank.

5. Mixer and accessories shall be able to withstand monochloramine, LAS, and sodium hypochlorite.
6. Power source for mixer shall be 230VAC single phase grid power to allow unit to continue 24/7 operation where necessary.

1.2 SUBMITTALS

A. Submittals shall be as required in Section 01 33 00, Submittal Procedures. The following specific information shall be provided:
1. Shop Drawings: Shop drawings shall include descriptive information as required to fully describe the mixing system and overall performance and shall identify any deviations from the specified requirements.
2. Product data sheets.
3. Special handling instructions, in accordance with Section 01 60 00, Product Requirements.
4. Requirements for storage and protection prior to installation, in accordance with Section 01 60 00, Product Requirements.
5. Installation, start-up, operation and maintenance manuals.
6. Diagram indicating the electrical wiring to be installed by Supplier.
7. List of all requested exceptions to the Contract Documents.
8. Panel information to be submitted in accordance with Division 26, Electrical.
9. Quality control submittals as listed in Section 01 33 00, Submittal Procedures.

1.3 QUALITY ASSURANCE

A. Each mixing system shall be tested prior to deployment according to standard engineering practices at the factory testing facilities.

1.4 EXPERIENCE REQUIREMENTS

A. All equipment utilized in the mixer system shall be the product of a manufacturer having at least five (5) Texas installations of the type being proposed or 50 installations in the U.S.

B. A list of similar installations shall be furnished with the shop drawing submittal, including names and telephone numbers of contacts, upon request.

1.5 WARRANTY

A. Special Warranty: The Product is warranted to be substantially free from defects in material and workmanship and to conform to Seller’s specifications applicable to the Product within specified warranty period.

B. Warranty Period: All system components: One (1) year from date of Equipment Commissioning.

C. Cost for the removal, shipment, repair or replacement, and installation of components, and correction of defective work by CONTRACTOR shall be included in warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 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.

B. Manufacturer of components and accessories specified herein shall be as follows:

1. PAX Water Technologies (Richmond, California).
2. Or approved equal.

2.2 GENERAL REQUIREMENTS

A. All equipment including controls and drives specified herein shall be specifically designed for the service environment encountered in this installation. The environment may be moist and corrosive.

B. Equipment shall be designed and capable of continuous operation.

C. The equipment shall be chemically compatible with and capable of dosing the chemical solutions specified herein.

D. Mixers shall have no oil-filled parts

E. All wet-side mixer components shall be certified by NSF to the NSF/ANSI Standard 61

F. Dry-side mixer components shall include sine filter to prolong motor life and reduce noise level.

G. No maintenance required on the wet-side components in typical potable water application.

H. No passive mixing system allowed.

I. Mixers using submersible pump with slit or “water sheet” or horizontal motor mounting designs are not acceptable.

J. A single mixer shall be capable of completely mixing the GSTs located at the Surveyor Pump Station. The information provided herein is intended for information purposes only. It is the manufacturers responsibility to review record drawings of the facilities and design the mixer for each tank to accommodate field conditions such as columns, inlet and outlet pipe locations, hatch locations, etc.

Location	**Volume (MG)**	**Diameter (ft)**	**Height (ft)**	**Max Side Water Depth (ft)**
Surveyor Ground Storage Tank	2.0	120.0	26.0	25.0

2.3 PERFORMANCE

A. The mixing system shall completely mix the GST according to the following minimum performance requirements. These requirements can be measured and validated after installation by operators with readily-available tools such as temperature probes and total chlorine grab samplers.
   1. Temperature Uniformity
      a. All temperatures shall converge to within 0.50°C (0.9°F) within 24 hours after mixer is installed and activated.
   2. Disinfectant Residual Uniformity
      a. Disinfectant residual within top five feet of tank and bottom five feet of tank will converge to within 0.20 ppm within 3 days after mixer is installed and activated. During continuous operation of the mixer, under normal disinfectant dosing parameters, disinfectant residual will converge to within 0.20 ppm at least once every 24 hours.

B. Supplier will provide required temperature sensors and total chlorine grab sampling equipment as required to prove temperature and disinfectant residual uniformity during testing.

2.4 MIXING SYSTEM CONSTRUCTION

A. Components – wet-side: shall be NSF/ANSI Standard 61 certified.

B. Equipment entering tank shall not adhere to, scratch or otherwise cause damage to internal tank coating or put undue stress on the materials of the tank construction. Equipment shall fit through a standard hatch of size 18-inches by 18-inches or larger.

C. Each submersible mixer shall consist of the following components, regardless of the power source selected:
   1. Impeller
      a. AISI Type 316 Stainless Steel
      b. Balanced to within 0.5 gram-inches
      c. Passivated per ASTM A380 to minimize corrosion
      d. Not more than 8 inches in overall height
      e. Not more than 4.5 inches in diameter
      f. Not more than 2.4 lbs. in weight
      g. Shall not create cavitation at any rotational speed up to 2500 RPM
   2. Motor
      a. AISI Type 304 Stainless Steel body
      b. Chlorine/Chloramine resistant rubber seals
      c. Fully submersible
      d. Low power (3.0 HP maximum)
      e. Water-filled motor
      f. Water-lubricated motor
   3. Mounting
      a. AISI Type 316 Stainless Steel
      b. Three detachable legs or pedestal mount
      c. NSF/ANSI Standard 61 certified EPDM rubber, non-skid, non-scratch feet or insulating pad
      d. Attachments secure motor cable away from impeller
      e. Overall weight of wet-side unit not to exceed 75 lbs. to avoid damaging tank floor
      f. Overall height of unit not to exceed 5 ft

D. Components – dry-side: 230VAC control center shall consist of the following components:
   1. Enclosure
      a. Type 4 (NEMA 4) Lockable
      b. Weather Resistant
      c. Overall weight of control center not to exceed 50 lbs.
      d. Green and Red LED Indicator lights show motor status
      e. White Power Indicator LED
      f. Cooling Fan
   2. Motor Controller/VFD
      a. Rated to 3.0 HP
      b. Operating temperature range -4 ºF to 129 ºF (-20 ºC to 55 ºC)
      c. HOA Switch
      d. Manual speed control
      e. Thermal shut-off protection built-in
      f. Current overload protection built-in
      g. SCADA outputs included:
         1). Digital Output signal indicating motor running
         2). Digital Output signal indicating fault
         3). Digital Input/output signal allowing remote motor on/off

4). RS-485 or Dry Contact connections
5). 4-20mA Signal

3. GFCI-protection
   a. 230VAC, single-phase, with a 300mA trip level GFCI included inside control center
4. Panel quipped with a 230VAC 20-AMP main breaker
5. Sine filter

2.5 CONTROLS

A. Each unit shall be equipped with all necessary controls, inter-wired, to provide the following minimum functions:
   1. On / Off switch to control power to mixer.
   2. Automatically-activated motor shut-off if water level drops below motor height in tank.
   3. Sine filter
   4. Any other controls shown on electrical and instrumentation drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall furnish services of a factory-trained installation contractor or crew having experience with installation procedures and operation and maintenance requirements for the type of equipment installed under these specifications. Mixer must be able to be installed through an 18-inch by18-inch hatch. Mixer must be able to be installed without draining tank or taking tank out of service. Wet-side of Mixer shall weigh less than 75 pounds (~34 kg) and dry-side shall weigh less than 50 pounds (~22 kg). Both wet-side and dry-side shall able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.

B. Tank penetration, if determined by the manufacturer to be required or as shown in the drawings, is recommended to be above tank water line, typically through the hatch side-wall.
   1. Fitting will prevent moisture intrusion into tank and ideally be horizontally oriented.
   2. Fitting shall be 1 inch diameter to allow cable to pass through.
   3. Strain relief for power cable shall be part of the contractor-supplied fitting for tanks more than 30 feet in depth.
   4. For tanks more than 70 feet in depth, or at customer’s discretion, a water-tight penetration may be installed under the water-line.

C. Installation of the in-tank (“wet-side”) components may be performed in any of the following ways:
   1. Installation by a factory-trained and drinking-water-certified potable water tank diver.
   2. Installation by personnel with confined space training while the tank is drained and empty.
   3. Installation by tank manufacturer personnel during tank manufacture.
   4. Installation below a hatch opening in a full tank utilizing a chain.

D. Installation of the outside-of-tank (“dry-side”) components may be performed by:
   1. Third party representatives or Contractors according to the manual provided.
   2. UTILITY personnel according to the manual provided

E. The mixer and control center shall be installed in accordance with approved procedures submitted and as shown, unless otherwise approved in writing from the Factory.

3.2 STARTUP AND TRAINING

A. A factory technician from the mixer system supplier shall be present at the jobsite for initial system start-up and commissioning of equipment. Factory technician will ensure that the system is properly installed, start-up the system, and train the Owner's personnel.

B. Contractor and mixer Supplier shall make equipment adjustments required to place system in proper operating condition.

C. Supplier staff (or their representatives) will instruct designated UTILITY personnel in the safe and proper operation of the Mixer System. This training will reference the operations manual provided with equipment, and show how to check for proper functioning of the equipment.

END OF SECTION

SECTION 11 30 00 – SPILL CONTAINMENT IBC TOTE SCALE

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the spill containment tote scale specifications including size, capacity, power, and materials as specified herein.

B. CONTRACTOR shall provide and install a spill containment scale and indicator that is necessary for a complete and operable system as specified in this section.

C. Related Sections
1. Section 01 33 00 – Submittal Procedures.
2. Section 01 60 00 – Product Requirements.
3. Section 01 78 23 – Operations and Maintenance Data.
4. Section 01 79 00 – Demonstration and Training.
5. Division 26 – Electrical.

D. Codes and standards
1. UL approved.
2. NEMA 4X.
3. CSA certified.

E. System Description
1. The spill containment and scale system determines the available chemical volume as well as provides spill containment.

1.2 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract close-out submittals shall conform to the requirements of Section 01 30 00- Submittal Procedures.

B. In addition to the general requirements, the following shall be provided:
1. Shop Drawings
   a. Model.
   b. Weight.
   c. Capacity.
   d. Accuracy.
   e. Power Required.
2. Standard Indicator description.

1.3 QUALITY ASSURANCE

A. The scale is calibrated at the factory with certified test weights prior to deployment according to standard engineering practices at the factory testing facilities.

1.4 WARRANTY

A. Special Warranty: The Product is warranted to be substantially free from defects in material and workmanship and to conform to Seller’s specifications applicable to the Product within specified warranty period.

B. Warranty Period: All system components: Five (5) years from the date of shipment from factory.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 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.

B. Manufacturers of products specified herein shall be as follows:
   1. Spill Containment IBC Tote Scale
      a. Scaletron Industries Ltd., Plumsteadville, PA, Model 4042- 63 IBC™.
      b. Or equal.
   2. Spill Containment Dual Drum Scale
      a. Scaletron Industries Ltd., Plumsteadville, PA, Model 4042- 26x52™.
      b. Or equal.

2.2 GENERAL REQUIREMENTS

A. Spill Containment IBC Tote Scale
   1. Materials
      a. A steel frame that is zinc oxide primed and dry powder epoxy coated.
      b. Containment deck and basin shall be polyethylene.
      c. Scale must have four (4) NTEP stainless steel shear beam load cells with stainless steel leveling feet.
   2. Dimensions
      a. Scale frame height shall not exceed 5.65 inches.
      b. Total height with containment deck shall not exceed 30 inches.

B. Spill Containment Dual Drum Scale
   1. Materials
      a. A steel frame that is zinc oxide primed and dry powder epoxy coated.
      b. Containment deck and basin shall be polyethylene.
      c. Scale must have four (4) NTEP stainless steel shear beam load cells with stainless steel leveling feet.
   2. Dimensions
      a. Scale frame height shall not exceed 1.5 inches.
      b. Total height with containment deck shall not exceed 7.5 inches.

C. Load Cells
      a. Shall be located outside the chemical containment basin to eliminate damage due to chemical spills.

D. Hardware
   1. Materials
      a. Stainless Steel.

E. Standard Indicator for Tote Containment Scale
   1. Requirements
      a. 4-1/2 Digit LED indicator.
         1) Shall be electronic with digital display with characters 0.56 in high and housed in a NEMA 4X, UL approved enclosure.
      b. Display shall be housed in a NEMA 4X, UL approved enclosure.
      c. A knob to set tare weights.
      d. Two low level relay contacts.
      e. Must be capable of 0.1 lb. or 0.1 kg up to 1000.0 lbs. or kg.

f. Accuracy is 0.5% of full scale or better.

2. Selectable Output Options
   a. 4-20 mA.
   b. 0-20 mA.
   c. Or -8 to + 12 mA.
   d. Selectable as scale or loop powered to provide versatility to interface with related equipment.

F. Standard Indicator for Drum Containment Scale

1. Requirements
   a. 3-1/2 Digit LED indicator.
      1) Shall be electronic with digital display with characters 0.5 in high and housed in a NEMA 4X, UL approved enclosure.
   b. Display shall be housed in a NEMA 4X, UL approved enclosure.
   c. A knob to set tare weights.
   d. Two low level relay contacts.
   e. Must be capable of 0.1 lb. or 0.1 kg up to 1000.0 lbs. or kg.
   f. Accuracy is 0.5% of full scale or better.
2. Selectable Output Options
   a. 4-20 mA.
   b. 0-20 mA.
   c. Or -8 to + 12 mA.
   d. Selectable as scale or loop powered to provide versatility to interface with related equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate a solid, relatively level spot on the floor to install scale platform.

B. Clean all debris that may interfere with scale clearance.

C. Mount digital indicator to the wall, as indicated on the drawings, or as directed by the Engineer and/or Owner. Attach conduit for load cell cable and output signals as required.

D. Connect load cell cable from load cell, or junction box, to TB-1 as follows:
1. Low Level set pt. 1 (REED relay, contact closure to pin 2: common).
2. Common.
3. Low Level set pt.2 (REED relay, contact closure to pin 2: common).
4. 4-20 LOOP Powered (4 is common and 5 is supply).
5. 4-20 SCALE Powered (5 is common and 6 is supply).
6. – Sense (optional).
7. – Excitation (BLACK).
8. + Sense (optional).
9. + Excitation (RED).
10. – Signal (WHITE).
11. + Signal (GREEN).

3.2 O&M

A. Manufacturer will provide the operation and maintenance requirements.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13 34 23.13 –ONE PIECE FIBERGLASS COMPOSITE MOLDED SHELTER

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

A. This section includes the work necessary to completely furnish and install the one piece fiberglass composite molded shelter including all related equipment, material, and appurtenances.

1.2 GENERAL

A. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.

B. Unit Responsibility: The Work requires that the one piece fiberglass composite molded shelter complete with all accessories be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

C. 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.

D. The equipment specified herein is included in the Manufacturer/Subcontractor Form. Refer to the Bid Form and the Instructions to Bidders for additional requirements.

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. Shop Drawings:
      a. Make, model, and weight of each assembly.
      b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
      c. Detailed mechanical, structural and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
      d. Complete installation instructions.
      e. Complete description of materials and resins used, including physical properties and methods of manufacture for the fiberglass enclosure.
      f. Certify that materials of fiberglass reinforced polyester are resistant to chemical attack from sewage and chemicals.
      g. Statement that fabrication is in accordance with these Specifications. h. Complete bill of materials.
   2. Quality Control Submittals:

a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
b. Special shipping, storage and protection, and handling instructions.
c. Test results, reports, and certifications.
d. Manufacturer's Certificate of Proper Installation.

3. Contract Closeout Submittals: Service records for maintenance performed during construction.

1.4 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, form and schedule for providing as specified in Section 01 78 23.

B. Maintenance Summary Forms: As specified in Section 01 78 23.

1.5 WARRANTY

A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein and as shown on the drawings.

B. Materials, equipment, components, and accessories specified in this section shall be, products of:

1. Jacobs Manufacturing Corp.
2. Warminster Fiberglass
3. Or Approved Equal

2.2 GENERAL REQUIREMENTS

A. Shelter shall withstand 125 miles per hour wind load and 30 pounds per square foot snow load.

B. Fiberglass reinforced plastic shelter shall be of one piece molded construction with composite walls and roof.

C. The molding shall be continuous forming a one piece molded composite shelter with an integral 4-inch wide internal mounting flange around the perimeter.

D. The flange shall be pre-drilled on 12-inch centers with 5/8-inch diameter holes for bolting to a structural fiberglass floor or a concrete pad.

E. Refer to drawings for building dimensions, partition location, and door locations and sizes.

F. The FRP building shall be a wood free structure. Wood will not be permitted for use in reinforcement or structural support.

2.3 MATERIALS

A. Molded composite: Exterior and interior resin-fiberglass laminate with foam core.
   1. Laminate
      a. The laminate consisting of polyester resin and chopped strand fiberglass shall have a minimum glass content of 30%.
      b. The exterior surface shall be white or tan gelcoat with a smooth finish and free from fiber pattern, roughness or other irregularities.
      c. The exterior laminate shall be chemically bonded with the gelcoat and shall be a minimum of 1/8-inch thick.
      d. Minimum physical properties for the laminate shall be as follows:
         1). Tensile Strength; 19,900 psi.
         2). Flexural Strength; 32,100 psi.
         3). Shear Strength; 12,000 psi.
         4). Barcol Hardness minimum; 60.
         5). Impact; 12 ft lbs/inch.
         6). Density/Specific Gravity; 93.6 PCF/1.5.
   2. Core
      a. The core material shall be rigid closed cell, self-extinguishing polyisocyanurate foam with a density of 2.0 pounds per cubic foot.
      b. The center core shall be 1-inch thick with a minimum insulating value of R-6.06.
      c. Procedure to be used in determining the properties listed below shall be in accordance with the following ASTM Standards: ASTM D638, ASTM D790, ASTM 732, ASTM D2583, ASTM D256, ASTM D384, and ASTM D792. Minimum physical properties for the core shall be as follows:
         1). Thermal Conductivity: 0.13 BTU Inch/Hr. SF F.
         2). Density/Specific Gravity: 2.0 PCF/0.3.
         3). Surface Burning Characteristics: Flame Spread, < 150; smoke density, <1000.

B. Components
   1. Doors shall be one piece, molded fiberglass composite and typical to material construction of the walls.
      a. The doors shall be mounted using a continuous stainless-steel hinge.
      b. The doors shall be provided with a one point keyed stainless steel latch
      c. The doors shall have one (12-inch by 12-inch) Lexan window.
      d. The door gasket shall be neoprene sponge rubber bulb type gasket with flexible lock to retain permanent grip.
   2. The base mounting flange gasket shall be extruded closed cell neoprene rubber bulb and provide a weather tight seal.
   3. A minimum of two lifting eye bolts in the roof shall be cadmium plated and removable after installation.

2.4 TOOLS AND SPARE PARTS

A. Tools: The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:

1. All equipment shall be furnished with the specified manufacturers spare parts, as indicated in the individual equipment sections.
2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.
3. Provide, at a minimum, the spare parts for the equipment as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

C. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

D. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

E. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times.

3.3 INSTALLATION

A. Verify that concrete is level and true to plane and of correct dimensions to receive structure. Correct any deficiencies before proceeding.

B. Install in strict accordance with manufacturer’s directions and recommendations.

END OF SECTION

DIVISION 22

PLUMBING

SECTION 22 05 00 - PLUMBING GENERAL

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 DESCRIPTION OF WORK:

A. Provide equipment, labor, material, etc., required to make a complete working installation as shown or as specified.

B. Equipment and materials used in the work shall be:
   1. In accordance with the contract documents.
   2. The best quality and grade for the use intended.
   3. New and unused.
   4. The manufacturer's latest standard or current model.

C. All equipment and method shall be installed and connected in accordance with the best engineering practices and in accordance with the manufacturer's recommendations.

D. Mechanical work includes, but is not limited to:
   1. Make arrangements with local utility company for services as shown or specified.
   2. Obtain all permits and inspections including: Building permits, health department permits and sewer tap permits.
   3. Disconnect, remove and re-install mechanical services located on or crossing through contract limits, above or below grade, obstructing construction of project or conflicting with completed project or any applicable codes.
   4. Modify, extend or tie-into existing mechanical services or systems.
   5. Complete alterations and additions to the domestic water distribution system.
   6. Provide cutting of pavement, sidewalks, driveways, etc., excavating, trenching, shoring and de-watering. Provide backfill material and perform backfilling.
   7. Restore site to original condition or new final grades. Provide paving, concrete, seed, or sod.
   8. Complete alterations and additions to the domestic hot and cold water system. Provide sanitary rinse and flush.
   9. Complete alterations and additions to the interior sanitary sewer.
   10. Provide roofing including flashing, and counter flashing for roof mounted equipment; roof penetrations and supports for work in this Division, unless noted otherwise.

1.3 UTILITY CONNECTIONS:

A. Arrange with local utility companies for utility service connections, taps, meters and installation. Pay all fees and charges (if any) necessary for the utility services shown on the drawings or listed in the specifications.

B. It is the responsibility of the Contractor to re-confirm with the Utility Companies, prior to bidding, that locations, arrangements, line sizes, pressures, interruptions, shut downs, etc. are in accordance with their regulations and requirements.

C. If the utility company requirements are at variance with these drawings and specifications, this Contractor shall include the utility company requirements in his work without additional cost to the Owner.

D. Obtain from Utility Company any additional charges for service of type, size and location called for. Include charges in bid to be paid by Contractor to appropriate party. Provide payment of these charges so as to allow logical progression of construction and avoid delay of completion.

E. Should cost above not be available prior to bid, submit with bid a letter signed by responsible Utility Company personnel stating that cost is not available. Prime Contractor shall submit letter with his bid to Owner. Cost will then be omitted from contract and become responsibility of Owner.

F. Furnish with shop drawings a signed document from each utility company describing location and type of service to be supplied and requirements for service. Document shall be signed by the appropriate responsible representative of the respective utility company.

1.4 WORK NOT INCLUDED:

A. Electrical wiring and conduits shown on the electrical drawings.

B. Asbestos removal.

1.5 RELATED WORK SPECIFIED ELSEWHERE:

A. Electrical: Division 26.

1.6 REQUIREMENTS OF REGULATORY AGENCIES:

A. Obtain and pay for all permits required for the work. Comply with all ordinances pertaining to work described herein.

B. Install the work under this Division in accordance with drawings and specifications and the standards and codes (latest edition) that apply to this work. In the event of a conflict, install work in accordance with the most stringent code requirements determined by Engineer.

C. Arrange, pay for and complete work to pass required tests by agencies having authority over work. Deliver to Engineer Certificates of Inspection and approval issued by authorities.

1.7 QUALIFICATION OF CONTRACTOR:

A. Has completed minimum two projects same size and scope in past five (5) years.

B. This qualification applies to Sub-Contractors.

C. Use workmen experienced in their respective trade. Submit qualifications of Superintendent for review.

D. Owner reserves right to reject bid of any Contractor failing to meet these qualifications.

1.8 GENERAL JOB REQUIREMENTS:

A. Drawings and Specifications:
   1. Drawings and specifications are complementary. Work called for by one is binding as if called for by both.
   2. Drawings are drawn to a small scale and are diagrammatic only. The drawings indicate size and general arrangement of equipment.
   3. Do not scale drawings for exact locations. Refer to dimensional plans. Field measurements take precedence.

B. Provide all necessary offsets, elbows and fittings in piping as required to avoid conflict with work of other trades. Maintain proper headroom and clear passageways to allow adequate access and working clearances for equipment dampers, valves, etc. This shall be done at no additional cost to the Owner.

C. Visit to Site/Work in other Division:
1. Examine not only the plans and specifications for this Division, but plans and specifications of the other Divisions of work and visit the site to become acquainted with existing conditions. Execution of Contract is evidence that Contractor has examined all drawings and specifications, and that all conditions which have a bearing in any way on the manner of installing the work in this Division are known. Later claims for labor and materials required due to difficulties encountered will not be recognized.

D. Underground Utilities/Concealed Utilities:
1. All utilities and services, whether shown on the drawings or not, shall be suitably protected and maintained, and any damages thereto shall be promptly repaired. Owner shall be advised immediately of any damages sustained. If any extra expense is incurred due to the existence of buried utilities not shown on the drawings, or the location of which is not made known to the Contractor, the contract price shall be adjusted in accordance with the General Conditions. The Contractor shall advise the Owner three (3) days in advance of any operation which could possibly disrupt any underground utility. The Contractor shall utilize locator services to mark any underground utilities in the area he is working in, and shall make any other measure deemed necessary to avoid utility disruption.

E. Definitions:
1. Concealed: Materials or systems not visible. Work installed above a ceiling, furred behind a wall or enclosed in a chase.
2. Exposed: Materials or systems that is visible. Work installed in a room without a ceiling. Work not enclosed by walls.
3. Provide: Furnish, install and make complete.
4. Install: Receive, unload, move into place, and make connections.
5. Work: Materials completely installed and connected.
6. ADC: Air Diffusion Council.
7. AGA: American Gas Association.
8. AMCA: Air Movement and Control Association.
9. ANSI: American National Standard Institute.
10. API: American Petroleum Institute.
11. ARI: American Refrigeration Institute.
12. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
13. ASME: American Society of Mechanical Engineers.
14. ASTM: American Society of Testing Materials.
15. AWS: American Welding Society.
16. FM: Association of Factory Mutual Fire Insurance Company.
17. International: Building Code, Gas Code, Mechanical Code, Plumbing Code.
18. MSS: Manufacturer's Standard Society of the Valve and Fittings Industry, Inc.
19. NEC: National Electrical Code.
20. NEMA: National Electrical Manufacturer's Association.
21. NFPA: National Fire Protection Association.
22. NRCA: National Roofing Contractors Association.
23. NSF: National Sanitation Foundation.
24. OSHA: Occupational Safety and Health Act.
25. PDI: Plumbing Drainage Institute.
26. PFMA: Power Fan Manufactures Association.
27. SMACNA: Sheet Metal and Air Conditioning Contractors National Association.

28. International: Building Code, Gas Code, Mechanical Code, Plumbing Code.
29. UL: Underwriters Laboratories.

F. Workmanship, Warranty and Acceptance:
1. Work under this Division shall be first class with emphasis on neatness and workmanship.
2. Install work using competent mechanics, under supervision of foreman, all duly certified by local authorities. Installation subject to Engineer's observation, final approval, and acceptance. Engineer may reject unsuitable work.
3. Furnish Engineer written warranty, stating that if workmanship and/or materials executed under this Division are proven defective within one (1) year after final acceptance, such defects and other work damaged will be repaired and/or replaced.
4. In event that project is occupied or system placed in operation in several phases at Owner's request, warranty will begin on date each system or item of equipment is accepted by Owner.

G. Observations of Work and Demonstration of Operation:
1. When observations are scheduled, provide sufficient personnel to expedite removal of access doors, cover plates, manholes covers, etc.
2. Contractor to assist Engineer in demonstration of operation of new systems to satisfaction of Owner. Contractor to have manpower available for demonstration of systems where requested by Owner.

H. Materials and Substitutions:
1. All materials shall be new. All materials and equipment, for which a UL Standard, an AGA approval, an AWWA standard, FM listing or ASME requirements is established, shall be so approved and labeled or stamped.
2. Wherever in these specifications products are specified by manufacturer's name, bids shall be based on the named products. Where more than one manufacturer's name is mentioned, the one first listed establishes the standard for that product. If the bidder desires to submit a product of a manufacturer other that listed first, it must be the equivalent of the one listed first.
3. The drawings are based on the use of products specified and listed first. If any revision in piping, ductwork, conduit work, foundations, anchor bolts, connections, etc., is required by other named products or approved substitutions, it shall be the Contractor's responsibility to make such revisions at no additional expense to the Owner.
4. If any bidder desires to submit products of manufacturers not listed, he may submit a request for prior approval to the Engineer no later than 10 days prior to the bid date. If the Engineer decides to accept the manufacturers, they will be listed as "Approved" by written addendum.
5. If the manufacturers are not listed as approved either by addendum or in the specifications, they will not be accepted.

I. Shop and Erection Drawings:
1. Shop drawings shall be submitted on a timely basis to allow adequate lead time for review, resubmission if necessary, manufacture and delivery to allow access of material to project at correct time based on schedule established by Engineer/Contractor. On each shop drawing include the specification section that applies to that submittal. Include complete descriptive data with dimensions, operating data and weight for each item of equipment. Carefully examine shop drawings to assure compliance with drawings and specifications prior to submittal to Engineer. Shop drawings and submittals shall bear the stamp of approval of the Contractor as evidence that the drawings have been checked by him. Drawing submitted without this stamp of approval will not be considered and will be returned for proper resubmission.

2. Drawings larger than 8-1/2" x 11", submit three (3) copies and one (1) reproducible of each drawing. Engineer will retain two (2) copies and return one (1) reproduction and one (1) copy to Contractor. Contractor is responsible for copying for distribution.
3. 8-1/2" x 11" drawings in brochure: Submit six (6) original copies for review. Engineer (and) Engineer will retain two (2) copies and return four (4) copies to Contractor. Division 01 "General Conditions" take precedence over this specification.
4. Review of shop drawings does not relieve Contractor of responsibility for errors and omissions in shop drawings. Contractor's responsible for meeting the requirements of the contract documents.
5. Contractor is responsible for dimensions and sizes of equipment. Inform Engineer in writing of equipment differing from that shown.
6. Prepare erection drawings when required by Engineer. Investigate thoroughly all conditions affecting work and indicate on drawing. Engineer will review erection drawings before work commences.

J. Operating and Maintenance Manuals:
1. Provide maintenance and operating manuals bound in 8-1/2" x 11" hardback, three-post binders. Manuals shall contain written instructions for each system, shop drawings, schematic drawings, equipment catalog cuts, manufacturer's instructions, manufacturer's warranties, and valve tag list.
2. Arrange information in the following sequence: title of job, Owner, address, date of submittal, name of Contractor, name of Engineer, index, shop drawings, operating instruction, Contractor's purchase order numbers, supplier's name and address, date of start-up of each piece of equipment and valve tag list.
3. Submit one (1) copy for review. Make required corrections, and submit two (2) record copies.

K. Record Drawings:
1. Contractor shall maintain at the site one (1) copy of the drawings in good order and marked to record all changes made during construction.
2. Contractor shall update all drawings to incorporate all changes and deliver one (1) set of reproducible plans and one (1) electronic copy of the project in the latest "AutoCAD" version to the Owner upon completion of the work.

1.9 PROTECTION AND STORAGE:

A. Provide warning lights, bracing, shoring, rails, guards and covers necessary to prevent damage or injury.

B. Protect all equipment and materials, from damage by weather, entrance of water or dirt. Cap open piping, use plastic covers made for that purpose. Do not use rags or construction debris.

C. Avoid damage to materials and equipment in place. Repair, or remove and replace damaged work and materials.

D. Protect all surfaces from weld spatter, solder and cutting oil.

E. Deliver equipment and materials to job site in original, unopened, labeled container. Store to prevent damage and injury. Store ferrous materials to prevent rusting. Store finished materials and equipment to prevent staining and discoloring. Store materials affected by condensation in warm dry areas. Provide heaters. Storage space on site and in building designated by Owner/Engineer.

END OF SECTION

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.
   2. Section 23 31 13, METAL DUCTS for duct hangers and supports.

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; IBC Seismic Site Class D 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 2-1/2-inch	8 feet	1/4-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 & 20-inch	14 feet	3/4-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-joist 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

SECTION 22 11 16 - PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. The work required under this section includes all work necessary for a complete installation of domestic water piping inside the building to 5 feet outside the building, and sanitary waste piping to a point as indicated on the drawings.

B. The work of this section is subject to the requirements of the Plumbing General Section.

1.2 SUBMITTALS:

A. Submit schedule of pipe and fittings for each service.

1.3 CODES AND STANDARDS:

A. International Plumbing Code, 2012

PART 2 - PRODUCTS

2.1 GENERAL:

A. Refer to design drawings for approximate locations of pipe and for pipe size.

B. Domestic Water Piping:
   1. Water piping within building:
      a. 3 inch and smaller shall be copper tube, type "L" hard temper, ASTM.
   2. Piping below ground:
      a. 2 inch and smaller type "K" soft temper; ASTM B-88.

C. Sanitary Waste and Vent Piping:
   1. Schedule 40 PVC-DWV ASTM D-2665 using solvent cement ASTM D2564, for below slab only.
   2. No-Hub Cast Iron meeting CISPI Standards for all above slab piping.

D. Fittings - Domestic Water Piping:
   1. Wrought copper, solder type, ASTM B-75, ANSI B16.22

E. Fittings - Sanitary Waste and Vent Piping:
   1. Below ground:
      a. Schedule 40 PVC-DWV, ASTM D-2855 using solvent cement ASTM D-2564

F. Unions:
   1. Solder unions shall be wrought copper, with copper ground joint. ASTM B75, ANSI B16.22.
   2. Di-electric, EPSO, 250 lb. WOG.

G. Solder:
   1. Solder Metal shall conform to ASTM B32-alloy grade 95TA: 95 percent tin, 5 percent antimony. Joints shall be made with approved solder containing not more than 0.2 percent lead.

H. Valves:

1. Approved Domestic manufacturers: Hammond, Kitz, Nibco, Apollo, Milwaukee, or approved equal.
2. Valves should be installed according to manufacturer's recommendations.
3. Valves 2-1/2" inches and smaller shall be equal to Nibco T-585-70, full port ball type with bronze body, chrome plated ball and bronze threaded ends, 600 psi WOG or Nibco S-585-70 in copper lines.

PART 3 - EXECUTION

3.1 GENERAL:

A. All piping shall be routed to conserve building space, be coordinated with items installed by other trades and not interfere with access to or operation of the facility.

B. Provide roof flashings for pipe penetrations through roof, to be installed by roofing contractor. Install roof drains as recommended by manufacturer and such that piping does not carry weight of roof drain.

C. Water piping within building shall be size indicated on plans and risers. In the event no size is shown, pipe size or size required by the Plumbing Code. Piping shall be sloped toward a system drain and toward outlets, to provide for system drain-down. Install piping to prevent direct contact between ferrous and non-ferrous materials. Allow flexibility for expansion in piping.

D. All water piping within building shall be installed on the interior side of building envelope insulation, except where installed underslab. Where installed in attic locations piping shall be insulated and installed low to trusses/structure with the envelope insulation installed on top of the piping. A poly vapor barrier shall be secured over the piping and under the building insulation. Where it is not physically possible to install the piping within the building thermal envelope, the piping shall be fitted with electric heat tracing for freeze protection. If heat tracing is utilized, heat trace and insulate all exposed piping, water lines, and valves less than 8" diameter and all equipment where water may collect. Where exact sizes, panels, boxes, conduit, circuitry 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 as needed to provide freeze protection requirements as though shown in detail on the Drawings. The Contractor shall be responsible for supplying all items as required for complete heat tracing systems regardless of the level of detail shown on the Drawings.

E. Domestic water piping system shall be tested with potable water at a pressure of 125 psig or 25 psig above design working pressure, whichever is greater for 12 hours. Test shall be conducted with plumbing inspector unless approved otherwise in writing.

F. Water distribution piping shall be disinfected prior to occupancy or system start-up with a chlorine solution 50 ppm. Allow system to stand for six hours minimum; then exercise all valves to ensure treatment of all branches and components. System shall be flushed with potable water after disinfection and prior to placement into service.

G. Sanitary waste and vent piping shall be tested in accordance with water and air tests as specified in the International Plumbing Code, in addition to any tests required by the local plumbing official. (10 feet of head with no apparent leaks. Hold for 30 minutes minimum). Flush all gravity piping including floor drains and roof drains prior to turning over to the Owner.

3.2 PREPARATION:

A. All pipe shall be cut square. Ream pipe and tube ends and remove burrs. Clean the ends of pipes to remove oil, grease and oxides.

B. Prepare piping connections to equipment with flanges or unions.

C. All soldered piping and equipment connections shall be properly prepared in accordance with good piping practice. Apply a thin layer of flux to only the male tubing. Rotate into the fitting with one or two revolutions.

D. Where PVC is connected to hubless cast iron the connection must be made with special coupling press to compensate for differences in outside diameters of the two materials.

3.3 INSTALLATION:

A. Domestic Water Piping:
1. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
2. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
3. Provide clearance for installation of insulation and access to valves and fittings.
4. Provide access where valves and fittings are not exposed.
5. Install valves with stems upright or horizontal. Provide drain valves at low points in systems.
6. Test cold water piping before being insulated, or concealed in walls or ceiling.

B. Sanitary Waste and Vent Piping:
1. Horizontal soil, waste and drainage lines within building shall have a minimum uniform slope of 1/8 inch per foot on 4 inch and larger, and 1/4 inch per foot on lines 3 inch and smaller.
2. Turns in sanitary, soil, and drain piping shall be made using 45 degree elbows, wyes, quarter-, eighth-, or sixteenth bends, or other bends approved by the Plumbing Code.
3. Do not use sanitary tees or crosses except where discharging from horizontal to vertical.
4. Make changes in pipe sizes with reducing fittings and recessed reducers. Do not reduce line size in direction of flow.
5. Provide cleanouts in all horizontal turns in waste piping greater than 45 degrees.
6. Provide deep seal traps on all floor drains, and trap primers where required by code or as indicated on drawings.
7. Indirect waste lines dumping into floor or hub drains shall maintain a 2-inch air gap between the end of the waste line and the rim of the floor or hub drain.

3.4 APPLICATION:

A. Install unions downstream of valves and at equipment or apparatus connections. Install dielectric unions where joining dissimilar materials.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install brackets at cast iron no hub cleanouts to protect the integrity of the joint.

END OF SECTION

DIVISION 23

HVAC

SECTION 23 05 00 - COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   6. Escutcheons.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   9. Painting and finishing.
   10. Concrete bases.
   11. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. PE: Polyethylene plastic.
   2. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Electrical Characteristics for mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 40 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 33 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions: MSS SP-107, Four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Hart Industries, International, Inc.
      f. Watts Industries, Inc.; Water Products Div.
      g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Co., Inc.
      d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. PSI – Thunderline / Link-Seal®
   2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Provide silicone (ASTM D 2000 MI GE505) for fire seal applications. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Reinforced nylon polymer. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 33 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations: One-piece, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations: One-piece cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
         1). Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealers" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and weatherproof sealant. Select sleeve size to allow proper clear space between pipe and sleeve for.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Verify final equipment locations for roughing-in.

Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 33 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.6 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Warning tags.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing ceilings or other concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch, Stainless steel, 0.025-inch, Aluminum, 0.032-inch, or anodized aluminum, 0.032-inch 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.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, 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.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules).

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 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.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:
   1. Refrigerant Piping:
      a. Background Color: Blue.
      b. Letter Color: White.

3.4 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

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 control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Written description of sequence of operation.
   6. Schedule of dampers including size, leakage, and flow characteristics.
   7. Schedule of valves including flow characteristics.

C. Qualification Data: For Installer and manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
   4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   5. Calibration records and list of set points.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

1.6 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

C. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 THERMOSTATS

A. Manufacturers:
1. Erie Controls.
2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
3. Heat-Timer Corporation.
4. Sauter Controls Corporation.
5. tekmar Control Systems, Inc.
6. Theben AG - Lumilite Control Technology, Inc.

B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
1. Label switches "FAN ON/OFF/AUTO"
2. Mount on single electric switch box.

C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical

rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

2.3 HUMIDISTATS

A. Manufacturers:
   1. MAMAC Systems, Inc.
   2. ROTRONIC Instrument Corp.

B. Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.4 HVAC CONTROL DESCRIPTIONS

A. General: Provide control systems that will maintain room or area comfort under changing ambient conditions and varying use; descriptions in this Section are general in nature and do not cover every mode of operation.

B. Facility 20 Chemical Storage and Feed HVAC Control Description:
   1. References:
      a. Process area: 20 (Sodium Hypochlorite and LAS Rooms at the Surveyor Pump Station)
      b. HVAC drawings: 20-M101 & 20-M501.
   2. Mechanical equipment:

Tag Number	Equipment Name
20EF01	LAS Room Exhaust Fan
20EF02	Sodium Hypo Room Exhaust Fan
20LV01	LAS Room Louver
20LV02	Sodium Hypo Room Louver
20UH01	LAS Room Unit Heater
20UH02	Sodium Hypo Room Unit Heater

   3. Controls at equipment:
      a. Exhaust Fans 20EF01 and 20EF02:
         1). Provide disconnect switch for exhaust fan.
      b. Unit Heaters 20UH01 and 20UH02:
         1). Provide disconnect kit for unit heaters.
   4. Zone controls:
      a. Exhaust Fans 20EF01 and 20EF02:
         1). 20EF01 operates based on room temperature and is interlocked with 20LV01. Fan operates based on room temperature to provide summer ventilation cooling. Exhaust fan to run when temperature exceeds 85 degrees Fahrenheit (adjustable).
         2). 20EF02 operates based on room temperature and is interlocked with 20LV02. Fan operates based on room temperature to provide summer ventilation cooling. Exhaust fan to run when temperature exceeds 85 degrees Fahrenheit (adjustable).

b. Unit heaters 20UH01 and 20UH02:
   1). 20UH01 to maintain room temperature at 50 degrees Fahrenheit (adjustable). Heater operation shall be in accordance with heater manufacturer's recommendations.
   2). 20UH02 to maintain room temperature at 50 degrees Fahrenheit (adjustable). Heater operation shall be in accordance with heater manufacturer's recommendations
   3). Room mounted type T-1 thermostat for each heater.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices as shown on Drawings.

D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

G. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test each point through its full operating range to verify that safety and operating control set points are as required.
   4. Test each system for compliance with sequence of operation.
   5. Test interlocks.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Stroke and adjust dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
   5. Provide diagnostic and test instruments for calibration and adjustment of system.
   6. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 34 23 – FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Type 1 - Down-blast centrifugal roof exhausters.
2. Type 2 - Up-blast centrifugal roof exhausters.
3. Type 3 - Filtered centrifugal roof supply fans.
4. Type 4 - Sidewall propeller fans.
5. Type 5 - Centrifugal ceiling exhaust fans.
6. Type 6 - Centrifugal in-line cabinet fans.
7. Type 7 - Square in-line centrifugal fans.
8. Type 8 - Laboratory fume hood exhaust fans.
9. Type 9 - Hooded axial roof ventilators.
10. Type 10 - Circular hood axial supply fans.
11. Type 11 - Tube in-line, centrifugal fans.
12. Type 12 - Fiberglass reinforced plastic centrifugal fans.
13. Type 13 - Industrial duty centrifugal fans.
14. Type 14 - Centrifugal sidewall exhaust fans.
15. Type 15 - Filtered side intake centrifugal roof supply fans.

1.2 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
1. 9, Load Ratings and Fatigue Life for Ball Bearings.
2. 11, Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc. (AMCA):
1. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
2. 211, Certified Rating Program- Product Rating Manual for Fan Air Performance.
3. 300, Reverberant Room Method for Sound Testing of Fan.
4. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
1. 52.1 - Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particle Matter.
2. 68 - Laboratory Methods of Testing to Determine Sound Power in a Duct.

D. ASTM International (ASTM):
1. A 108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
2. D 4167 - Standard Specification for Fiber Reinforced Plastic Fans and Blowers.
3. E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. National Electrical Code (NEC).

F. National Electrical Manufacturers Association (NEMA):
1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

G. National Fire Protection Association (NFPA):
1. 90A - Standard for Installation of Air Conditioning and Ventilating Systems.
2. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

H. National Roofing Contractors Association (NRCA).

I. Occupational Safety and Health Administration (OSHA).

J. Underwriters' Laboratories, Inc. (UL).

1.3 SYSTEM DESCRIPTION

A. Design requirements:
1. Provide fans that have sharply rising pressure characteristics which extend throughout the operating range and continue to rise beyond the efficiency peak.
2. Provide fans that peak as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.
3. When scheduled, provide guided vibration isolator for fans, so that not more than 10 percent of the vibration amplitude of the fan and motor is transmitted to the supporting structure.
4. Design fan inner scroll and air stream surfaces to maintain smoothness for entire fan service life.
5. Seismic supports: Seismic design criteria as specified in Section 01 81 02.
6. Wind supports for exterior units: Wind design criteria as specified in Section 01 81 04.
7. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
8. Motors supplied with fans: Manufacturer’s standard when type not scheduled; provide motor voltage phases and speed as scheduled; motor not to be overloaded at any point on the fan curve including belt losses.
9. Roof curbs: Designed in accordance with NRCA standards.
10. Insulation and adhesives: Meet NFPA 90A requirements for flame spread and smoke generation.
11. Belt drive systems: Adjustable for minimum within 5 percent speed change, rated for 1.5 times maximum horsepower motor available for the scheduled fan size or model.
12. Screens: Provide bird or insect screen as specified with the fan type or as listed on the Fan Schedule:
13. Bird screen: Stainless steel; 0.5-inch mesh 18 gauge.
14. Insect screen: Stainless steel mesh and frame.
15. Finishes: When not specified with fan type, coat ferrous metals as specified in Section 09 90 00.
16. Accessories: Provide accessories specified and those scheduled.
17. Provide fans with fire/smoke control system as specified under paragraph Fire/Smoke Control System Design Requirements.

B. Performance requirements:
1. Performance requirements are included in the Fan Schedule.
2. Fan performance: Rated and licensed to bear the AMCA label in accordance with AMCA 210 and AMCA 211.
3. Total sound power levels in the 8 octave band range as measured in accordance with ASHRAE 68, AMCA 301, or AMCA 300 as appropriate for each fan: Not to exceed the lesser of the following or the Sones levels on the Fan Schedule.

Sound Power Level, decibel levels referenced to 10-12 watts								
Frequency, Hz	63	125	250	500	1,000	2,000	4,000	8,000
General	100	98	94	88	84	84	78	75

4. Air filters supplied with fans: 25 to 30 percent dust spot efficiency when rated per ASHRAE Testing Standard 52.1.
5. Bearings: Rated per ABMA 9 or 11 for a L10 life rating of not less than 50,000 hours; provide greater life when specified with each fan type.

C. Electrical and control system design:
1. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system. Design to perform the system ventilating functions with the control systems.
2. Comply with requirements as specified in Division 26.

D. Fire control system design requirements:
1. Provide all supply, exhaust, and odor control fans greater than or equal to 2,000 cubic feet per minute with smoke control system including the following minimum components.
   a. Duct or fan mounted smoke detector.
   b. Fan interlock to shut down fan upon smoke detection.
   c. Signals for fans and smoke detectors to and from local fire alarm control panel if a fire alarm control panel is part of project design.
   d. Provide all wire, conduit, end of line resistors, and other electrical equipment for complete functioning smoke control system. Provide in conformance with the electrical, mechanical, and instrumentation Drawings. When no electrical design for smoke control system is indicated, CONTRACTOR shall provide design and installation of the smoke control system.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators used for restaurant kitchen exhaust shall also comply with UL 762.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

C. Coordinate sizes and locations of wall openings and equipment supports with actual equipment provided.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set(s) for each belt-driven unit.

   2. Provide two (2) extra sets (3 total) of filters per installed fan for fans specified with filters.

PART 2 - PRODUCTS

2.1 TYPE 14, CENTRIFUGAL SIDEWALL EXHAUST FANS

A. Manufacturers: One of the following or equal:
   1. Greenheck, Model CUBE.
   2. Loren Cook, Model ACWB.
   3. Penn Ventilator.

B. Characteristics:
   1. Wall-mounted, upblast circular exhaust fan unit.
   2. Backward inclined centrifugal fan wheel with Venturi inlet; performance as scheduled.
   3. Materials: Aluminum fan, housing, and accessories.
   4. Fan bearings: Permanently lubricated ball bearing type.
   5. Adjustable belt drive rated for 150 percent of motor horsepower.
   6. Motor characteristics: As scheduled.
   7. Finishes: Provide Kynar paint coating over compatible primer on all steel surfaces.
   8. Provide duct adapter.
   9. Provide other accessories as scheduled.

C. Accessories:
   1. Mounting brackets: Necessary for installation.
   2. Bird screen: Provide bird screen if no screen is listed on the Fan Schedule.

2.2 SILICON CONTROLLED RECTIFIER (SCR):

A. Manufacturers: One of the following or equal:
   1. GreenHeck, Model 10W.
   2. Penn Ventilator Lek-Trol Series.

B. Characteristics:
   1. Solid-state controller for use with 115 volt single phase shaded pole and open permanent split capacitor motors.
   2. Minimum 10 amp rating.
   3. Provide all necessary mounting boxes and hardware.
   4. Provide with manual speed adjustment knob and on/off control.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 26 Sections.
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine and verify that Work is in condition to receive installation specified in this Section.

B. Take measurements and verify dimensions to ascertain fit of installation.

C. Ascertain support and openings are correctly located.

3.2 PREPARATION

A. Before installation, remove dust and debris from equipment and ducts.

B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.3 INSTALLATION

A. Observe applicable installation requirements as specified.

B. Anchoring and support:
1. Provide anchoring and support for fans and appurtenances.
2. Provide anchoring to sustain seismic and wind forces as specified in Sections 01 81 02 and 01 81 04.

C. Adjust alignment of ducts where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

D. Install flexible connections to fans.

E. Install roof curb and fan as recommended by fan manufacturer.

F. For fan housings with threaded water trap drain, provide drain piped from fan housing to the nearest drain channel, floor drain, or sump.

G. Install fans level and plumb.

H. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

I. Install units with clearances for service and maintenance.

J. Label units with permanent labels.

3.4 CONNECTIONS

A. Ground equipment according to Division 26.

B. Connect wiring according to Division 26.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION

SECTION 23 83 01 – HEATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Gas unit heaters.
2. Electric unit heaters.
3. Electric unit heaters corrosion resistant.
4. Electric unit heaters explosion proof.
5. Gas-fired infrared radiant heaters.
6. Sill, wall, and floor electric convection heaters.
7. Electric duct heaters.
8. Hot water or steam propeller unit heaters.
9. Hot water or steam fin tube convection heaters.
10. Electric make-up air unit.
11. Gas fired make-up air unit.
12. Thermostats for unit heater.

B. Related 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.
3. 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 01 41 00 - Regulatory Requirements.
b. Section 01 81 00 - Project Design Criteria.
c. Section 01 81 02 - Seismic Design Criteria.
d. Section 01 81 04 - Wind Design Criteria.
e. Section 23 09 00 – Instrumentation and Control for HVAC.
f. Section 23 05 93 - Testing, Adjusting, and Balancing.
g. Section 26 05 15 – Electric Motors.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):
1. 302 - Application of Sone Ratings for Non-Ducted Air Moving Devices.

B. American Gas Association (AGA).

C. National Electric Code (NEC).

D. National Fire Protection Association (NFPA):
1. 54 - National Fuel Gas Code.

E. National Electrical Manufacturers Association (NEMA):
1. 250 - Enclosures for Electrical Equipment (100 V Maximum).

F. Underwriters' Laboratories, Inc. (UL).

G. International Fuel and Gas Code (IFGC).

H. International Mechanical Code (IMC).

1.3 DEFINITIONS

A. NEMA Type 3R enclosure in accordance with NEMA 250.

1.4 SYSTEM DESCRIPTION

A. Design requirements:
   1. Provide seismic and wind supports meeting the seismic design criteria as specified in Section 01 81 02 and wind design criteria for exterior units as specified in Section 01 81 04.
   2. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
   3. Hot water piping, gas piping, drains, venting, and other appurtenances of unit heaters: Install in accordance with building code, mechanical code, and plumbing code as specified in Section 01 41 00, and the NFPA.
   4. Noise levels for unit heaters installed in offices, hallways, or entry areas: Not to exceed 10 Sones as measured in accordance with AMCA Publication 302.
   5. Motors supplied with heating units: As specified in Section 26 05 15.

B. Performance requirements are included in the Heating Unit Schedules in the drawings.

C. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system.
   1. Comply with referenced electrical Sections and design to perform system heating functions as specified in Section 23 09 13.

1.5 SUBMITTALS

A. Shop drawings:
   1. System layout, mechanical, electrical power, and control diagrams.
   2. Materials.
   3. Supports and seismic bracing calculations and details.
   4. Cut sheets on primary and ancillary equipment.
   5. Sound ratings of fans in Sones in accordance with AMCA Publication 302.

B. Certificates: Successful testing of burners used in gas unit heaters.

C. Operation and Maintenance Data.

D. Warranties.

1.6 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Provide heating units and controls that are listed by UL.

1.7 WARRANTY

A. Extend warranty from the date of Project Acceptance or the date of first beneficial use of the equipment.

B. Two-year manufacturer's warranty on all components, except heating elements and coils.

C. Heating elements and coils: 10-year warranty.

PART 2 - PRODUCTS

2.1 GAS UNIT HEATERS

A. Manufacturers: One of the following or equal:
1. Trane Company, Type GBND.
2. Sterling, Model QVEF.
3. Jackson and Church; Series MU.

B. Fan type: Aluminum non-surging propeller:
1. Including fan guards.
2. Dynamically balanced.
3. Permanently lubricated ball bearings.
4. Automatic reset thermal overload protection.

C. Heat exchanger characteristics:
1. Seam welded minimum 20-gauge aluminized steel tubes with minimum 18-gauge aluminized steel headers; provide non prorated 10-year exchanger warranty.
    a. Provide stainless steel heat exchangers when indicated in the Heating Unit Schedules.

D. Features:
1. Provide unit including casing, integral draft diverter, heat exchanger, horizontal adjustable louvers with stops to prevent full closure, motor and propeller fan assembly, burners, flue vent fan, controls, and suspension mounting.
2. Burners, universal type manufactured of die-formed, aluminized steel with stainless burner port protectors.
    a. Provide stainless steel burner when indicated in the Heating Unit Schedules.
3. Burner orifices suitable for elevation as specified in Section 01 81 00.
4. Intermittent solid-state ignition control system with pilot burner, made of stainless steel.
5. Flue pipes, 16-gauge, or heavier, galvanized steel, double walled, certified for zero clearance installation.
6. Gas piping, black steel with unions to simplify assembly and disassembly.
7. Bronze shutoff cocks.
8. Cabinet manufactured of minimum 20-gauge galvanized steel.
9. Controls:
    a. Pressure regulators.
    b. Diaphragm gas valve; on units over 100 MBH input, provide 2-stage gas valve (50 percent and 100 percent fire) and 2-stage thermostat.
    c. Safety pilot switch with 100 percent gas shutoff.
    d. High temperature limit switch.

e. Fan time delay.
f. Hand shutoff valves for main burner and for pilot burner.
g. Provide thermostat as specified in this Section.
h. Provide control transformer suitable for 24 volt or 120-volt control as indicated in the Heating Unit Schedules.

E. Finishes:
1. Casing finish backed enamel in manufacturer's standard color.

F. Source quality control: Flame test burners.
1. Provide proof of test upon delivery.

2.2 ELECTRIC UNIT HEATERS

A. Manufacturers: One of the following or equal.
1. Trane, Type UHEC.
2. Markel, Series 5100.
3. Chromalox, Type LUH or VUH.

B. Fan type: Aluminum axial flow:
1. Provide fan guards.
2. Dynamically balance.
3. Fan designed for quiet operation.
4. Permanently lubricated ball bearings.
5. Automatic reset thermal overload protection.

C. Heating element characteristics:
1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
2. Fin type, steel plated heater elements, with elements brazed to common fins, designed for maximum strength and maximum heat transfer.
3. 3-phase designed for balanced phases.
4. Over temperature cutout with automatic reset.

D. Features:
1. Built-in magnetic contactors.
2. Control transformer for 24 or 120-volt control as indicated in the Heating Unit Schedules.
3. Required mounting brackets.
4. Individually adjustable outlet louvers.
5. Cabinet formed of minimum thickness 18-gauge steel with steel stiffeners.
6. Controls:
a. Provide thermostat as specified in this Section.
b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

E. Finishes:
1. Casing finish backed enamel in manufacturer's standard color.

2.3 ELECTRIC UNIT HEATERS CORROSION RESISTENT

A. Manufacturers: One of the following.
1. Chromalox, Type HD3D.
2. QMark, Series JUH.
3. Markel, Series 5500.
4. King, KBS Series.

B. Fan type: Aluminum axial flow:
   1. Provide fan guards.
   2. Dynamically balance.
   3. Fan designed for quiet operation.
   4. Permanently lubricated ball bearings.
   5. Automatic reset thermal overload protection.
   6. Epoxy coated.
   7. Motor: Totally enclosed, permanently lubricated ball bearing type with epoxy coating. Factory wired to Nema 4X enclosure.

C. Heating element characteristics:
   1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
   2. Fin type, Stainless Steel Fintube, designed for maximum resistance to corrosion.
   3. 3-phase designed for balanced phases.
   4. Over temperature cutout with automatic reset.

D. Features:
   1. Built-in magnetic contactors.
   2. Control transformer for 24 or 120-volt control as indicated in the Heating Unit Schedules.
   3. Required mounting brackets.
   4. Individually adjustable outlet louvers.
   5. Cabinet formed of minimum thickness 20-gauge stainless steel type 304.
   6. Controls:
      a. Provide thermostat as specified in this Section.
      b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

2.4 ELECTRIC UNIT HEATERS, EXPLOSION PROOF

A. Manufacturers: One of the following:
   1. Chromolox, Type CHX-A
   2. QMark, Series GUX
   3. Markel, Series HLA

B. Fan Type: Aluminum axial flow.
   1. Provide fan guards.
   2. Dynamically balance.
   3. Fan designed for quiet operation.
   4. Permanently lubricated ball bearings.
   5. Automatic reset thermal overload protection.
   6. Epoxy coated.
   7. Motor: Totally enclosed, explosion proof suitable for Class I, Division I and II areas.
   8. Prewired explosion proof control center with magnetic contactor and control circuit transformer.

C. Heating Element Characteristics:
   1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
   2. Seamless copper heating element. Immersed in sealed liquid to air heat exchanger.
   3. Glycol-water heat transfer fluid.
   4. 3-Phase designed for balanced phases.
   5. Over temperature cutout with automatic reset.
   6. Built-in magnetic contactors.
   7. Control transformer for 24 or 120-volt control as indicated in the Heating Unit Schedules.
   8. Required mounting brackets.
   9. Individually adjustable outlet louvers.
   10. Cabinet formed of minimum thickness 20-gauge stainless steel type 304.

11. Controls:
    a. Provide thermostat as specified in this Section.
    b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

D. Features:
1. Built-in magnetic contactors.
2. Control transformer for 24 or 120-volt control as indicated in the Heating Unit Schedules.
3. Required mounting brackets.
4. Individually adjustable outlet louvers.
5. 14 gauge steel construction with polyester powder coat finish.
6. Controls:
    a. Provide thermostat as specified in this Section.
    b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

2.5 GAS-FIRED INFRARED RADIANT HEATERS

A. Manufacturers: One of the following or equal.
1. EcoSchwank.
2. Thomas and Betts Reznor, Type RIVH.

B. Combustion surface:
1. Material: Ceramic tile.
2. Modular perforated construction suitable for sustaining 1,650 degrees Fahrenheit surface temperature.

C. Main burner characteristics:
1. Die formed aluminized steel with Venturi construction.
2. Direct spark ignited.

D. Features:
1. Aluminum housing and reflector.
2. Control transformer for 24- or 120-volt control as indicated in the Heating Unit Schedules.
3. Required mounting brackets. Threaded hanger type suitable for wall or ceiling mounting.
4. Stainless steel hardware.
5. Design certified by AGA.
6. Controls:
    a. Provide thermostat as specified in this Section.
    b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.
    c. Single-stage combination gas value.
    d. Provide control transformer suitable for 24-volt control as indicated in the heating unit schedules.

2.6 SILL, WALL, OR FLOOR MOUNTED ELECTRIC CONVECTION HEATERS

A. Manufacturers: One of the following or equal:
1. Markel Products, Company, Series 8100.
2. Trane Company, Type EAK, EAG, EAW, or ERG.

B. Heating element characteristics:
1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
2. Heating element high quality nickel chromium alloy resistance wire embedded and completely surrounded by magnesium oxide, enclosed and swaged in aluminum sheath.

3. Heating element locked to support member for quiet operation.
4. Aluminum fins mechanically locked to sheath.
5. Automatic reset thermal cutout extending the full length of the element.
6. 3-phase designed for balanced phases.
7. Power per unit length as indicated in the Heating Unit Schedules.

C. Features:
1. Top air exit.
2. Designed for mounting as indicated in Heating Unit Schedules on wall or at floor level with 0 clearance at bottom.
3. Junction boxes at ends with control and power wiring knockouts, factory mounted and wired, including specified controls:
   a. Wiring diagram affixed to inside of junction box covers.
4. Enclosure front and air exit grille fabricated from 16-gauge aluminum extrusions designed to prevent entrance of small objects.
   a. Enclosure accessories, include adjustable aluminum end caps.
   b. Aluminum, natural anodized.
5. Controls:
   a. Provide thermostat as specified in this Section.
   b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.
6. Built in magnetic contactors.
7. Required mounting brackets.

D. Finishes:
1. Fin tube cabinet finish, baked enamel, color selected by ENGINEER from submitted samples.

2.7 ELECTRIC DUCT HEATERS

A. Manufacturers: One of the following or equal:
1. Markel Products, Company, Type CHMS.
2. Chromalox, Type DH.
3. Indeeco, Type HC.

B. Heating element characteristics:
1. Entering air temperature: 65 degrees Fahrenheit.
2. Heating element, nickel chromium resistant coils, imbedded in high-grade refractory material and compressed rock hard and surrounded with a steel sheath.
3. Automatic reset thermal cutout for primary over temperature protection.
4. Load carrying manual reset thermal cutout factory wired in series with each heater stage for secondary protection, circuit breakers.
5. Equal, balanced, 3-phase stages, except, heaters rated less than 10 kilowatts, 1-stage control.

C. Features:
1. Heater terminal boxes, provided with overhang to suit particular case and allow duct heater installation in accordance with manufacturer's recommendations.
2. Heaters and terminal boxes:
   a. Listed by UL for installation with 0 clearance to combustible surfaces.
3. Terminal box, control cabinet, and element housing to be made of minimum 18-gauge aluminized steel.
4. Terminal box coating to be manufacturer's standard.
5. Built in magnetic contactors.
6. Controls:
   a. Provide thermostat as specified in this Section.

b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.
c. Controls supplied and built into heater terminal box.

7. Required mounting brackets.

2.8 HOT WATER OR STEAM PROPELLER UNIT HEATERS

A. Manufacturers: One of the following or equal:
1. Trane Company, Model P or S.
2. Modine, Model V or HS.
3. McQuay, Model UHH, UDH.

B. Fan type: Aluminum non-surging propeller:
1. Including fan guards.
2. Motor removable from bottom on horizontal models and from the back on vertical models.
3. Dynamically balanced.
4. Permanently lubricated ball bearings.
5. Automatic reset thermal overload protection.

C. Coil characteristics:
1. Entering hot water temperature: 180 degrees Fahrenheit.
2. Hot water temperature drop: 20 degrees Fahrenheit.
3. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
4. Rectangular draw through for horizontal units or 1 row serpentine for vertical units.
5. Seamless copper tubing suitable for a minimum of 150 pounds per square inch gauge hot water or 75 pounds per square inch gauge steam service.
6. Aluminum fins mechanically bonded to tubing.

D. Features:
1. Adjustable horizontal and vertical louvers.
2. Casing fabricated of minimum 20-gauge, rigid steel.
3. Controls:
a. Provide thermostat as specified in this Section.
b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.
4. Required mounting brackets.

E. Finishes:
1. Casing finish: Backed enamel in manufacturer's standard color.

2.9 HOT WATER OR STEAM FIN TUBE CONVECTION HEATERS (FTH)

A. Manufacturers: One of the following or equal:
1. Trane Company, Type AW, AG, AK, RG.
2. Modine, Model TA, RF, F.
3. Vulcan.

B. Coil characteristics:
1. Entering hot water temperature: 180 degrees Fahrenheit.
2. Hot water temperature drop: 20 degrees Fahrenheit.
3. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
4. Manufactured of single tier, 3/4-inch copper tubes with aluminum fins.
5. Integral fin collars to space fins.
6. Fins mechanically bonded to tubes.

7. Suitable for 200 pounds per square inch gauge hot water service or 75 pounds per square inch gauge steam service.

C. Features:
1. Provide positive temperature control with a modulating damper controller to reduce heating capacity when closed by as much as 70 percent.
2. Provide balancing and shutoff cock with access panel.
3. Dampers, factory mounted on element or unit housing.
4. Cabinet recessed, floor mounted, or wall mounted as scheduled.
   a. Manufacture with 16-gauge, or thicker, steel sheet reinforced with channel stiffeners.
      1) Front secured in place with quick opening fasteners.
5. Required mounting brackets.
6. Outlet grille linear extruded anodized aluminum.

D. Finishes:
1. Fin tube cabinet finish, baked enamel, in manufacturer's standard color unless otherwise specified.

2.10 ELECTRIC MAKE-UP AIR UNIT

A. Manufacturers: One of the following or equal.
1. Greenheck, Model MSX.
2. Trane, T Series (for outdoor units), M Series (for indoor units).

B. Features:
1. General: Provide make-up air fan and electric heating unit in a packaged unit suitable for mounting as scheduled with air inlet and outlet oriented as scheduled.
2. Power supply:
   a. Design unit for power voltage and phases as scheduled.
   b. Provide disconnect switch at unit; mount in NEMA 3R enclosure; when explosion proof construction is scheduled, provide disconnect suitable for Group D, Class I, Division 1 location.
   c. Provide built-in magnetic contactors.
3. Fan type: Aluminum axial flow or centrifugal as required to meet scheduled cfm and external static pressure (ESP):
   a. Provide fan guards for fan intake if exposed; provide fan power disconnect switch on unit access door, fan automatically disconnected when door opened.
   b. Dynamically balance.
   c. Fan designed for quiet operation.
   d. Permanently lubricated ball bearings.
   e. Automatic reset thermal overload protection.
   f. When explosion proof scheduled, provide antistatic, nonsparking materials.
   g. Fan shaft designed so that first critical speed is 25 percent above manufacturer's maximum cataloged fan revolutions per minute.
   h. Provide fan vibration isolators between fan and casing.
4. Heating element characteristics:
   a. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
   b. Fin type, steel-plated heater elements, with elements brazed to common fins, designed for maximum strength and maximum heat transfer.
   c. 3-phase designed for balanced phases.
   d. Over temperature cutout with automatic reset.
5. Cabinet:
   a. Formed of minimum thickness 18-gauge galvanized steel with steel stiffeners.

b. Provide roof curb and weatherproof flashing around duct penetrations in accordance with building code and mechanical code as specified in Section 01 41 00.
c. Provide galvanized steel mounting rails or base for roof top mounting.
d. Filter section:
1) Provide filter housing for 2-inch deep filter on fan inlet; provide filter with minimum 80 percent dust removal efficiency; provide 2 spare filters.
e. Provide hinged access doors for fan servicing and electric heater servicing; provide gasketing around doors.
f. Finish interior and exterior components with backed enamel in manufacturer's standard color.
g. Provide minimum of 1-inch thermal insulation.
h. Provide inlet weather hood with same material as casing.

6. Controls:
a. Provide discharge duct mounted temperature-sensing element and thermostat with proportional output to maintain a constant furnace outlet temperature at varying ambient temperature; provide setpoint adjustment from 40 to 90 degrees Fahrenheit.
b. Provide proportioning power controllers SCR or other type controller to operate electric heating units at varying loads to maintain thermostat setpoint.
c. Provide control transformer suitable for 24-volt or 120-volt control and the input power supply as scheduled in the Electric Furnace Schedule.
d. Provide power and control wiring for a complete and functional unit.
e. Provide control interlocks as indicated on the Drawings.
f. When explosion proof construction is scheduled, provide enclosures suitable for NEC Group D, Class I, Division 1.

2.11 GAS FIRED MAKE-UP AIR UNIT

A. Manufacturers: One of the following.
1. Greenheck, DGX Series
2. Hastings, EBD Series
3. Trane, DFOA Series
4. CaptiveAire, Modular Direct Series

B. Features:
1. General: Provide make-up air fan and gas heating section in a packaged unit suitable for mounting as scheduled with air inlet and outlet oriented as scheduled. Unit with integral heating shall be fully assembled at the factory and consist of insulated cabinet, outdoor intake weather hood, aluminum mesh filter with bird screen, mounting bars, supply air blower, and control center.
2. Power supply:
a. Design unit for power voltage and phases as scheduled.
b. Provide disconnect switch at unit; mount in NEMA 3R enclosure; when explosion proof construction is scheduled, provide disconnect suitable for Group D, Class I, Division 1 location.
c. Provide built-in magnetic contactors.
3. Fan type: Aluminum axial flow or centrifugal as required to meet scheduled cfm and external static pressure (ESP):
a. Provide fan guards for fan intake if exposed; provide fan power disconnect switch on unit access door, fan automatically disconnected when door opened.
b. Dynamically balance.
c. Fan designed for quiet operation.
d. Permanently lubricated ball bearings.
e. Automatic reset thermal overload protection.
f. When explosion proof scheduled, provide antistatic, nonsparking materials.

g. Fan shaft designed so that first critical speed is 25 percent above manufacturer's maximum cataloged fan revolutions per minute.
h. Provide fan vibration isolators between fan and casing.

4. Direct gas fired furnace characteristics:
   a. Shall be factory assembled, piped and wired direct gas-fired system of 92% efficiency with a draw through design and field adjustable burner baffles with a direct spark ignition system.
   b. Shall have a cast aluminum burner manifold and stainless steel mixing plates. No air from the inside space shall be allowed to pass across the burner at any time. Flame rectification shall be provided by a flame rod. Burner control shall have a digital coded fault indicator capable of storing the last five faults.
   c. Shall be equipped for operation on natural gas with a maximum rated inlet gas pressure of 1/2 psi..
   d. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.
   e. Shall have temperature control provided by an electronic 25:1 turndown-ratio modulating discharge air sensor.
   f. Shall include the following safety controls:
      1) Manual Reset, High Limit Switch: Main gas valve closes if high-limit temperature is exceeded.
      2) Dual safety shutoff valves shall be provided that do not exceed 120 VAC control signals.
      3) High and low Gas Pressure Switch: Main gas valve closes if high or low pressure switch faults.
      4) A gas vent line shall be included that vents gas from between the safety shutoff valves.
      5) Visual indication: Clear visual signal demonstrating the position of the main gas safety shutoff valves.

5. Cabinet:
   a. Formed of minimum thickness 18-gauge galvanized steel with steel stiffeners. Provide polyester urethane powder coat finish.
   b. Provide roof curb and weatherproof flashing around duct penetrations in accordance with building code and mechanical code as specified in Section 01 41 00.
   c. Provide galvanized steel mounting rails or base for roof top mounting.
   d. Filter section:
      1) Provide filter housing for 2-inch deep filter on fan inlet; provide filter with minimum 80 percent dust removal efficiency; provide 2 spare filters.
      2) Provide filter with at least a MERV 8 rating.
   e. Provide hinged access doors for fan servicing and heater servicing; provide gasketing around doors.
   f. Finish interior and exterior components with baked enamel in manufacturer's standard color.
   g. Provide minimum of 1-inch thermal insulation.
   h. Provide inlet weather hood with same material as casing.

6. Controls:
   a. The unit shall be constructed so that it can function as a stand-alone heating system controlled by factory-supplied controllers, thermostats and sensors.
   b. Remote Interface: Contractor shall provide and install a Remote Interface that functions as a remote indicator of owner-selected operating parameters and also permits remote inputting of new operating parameters. Control panel shall be a stainless steel enclosure. Panel shall include modes for operations of on/off/automatic with lighted indicators. Panel shall include contacts for space thermostat to be remote mounted outside of control panel (see plans for location). Panel shall include contacts for interlocking exhaust fan. Each remote panel shall

have a large LCD user interface screen similar in form and function to the screen on the DDC. Installed location of room display shall be as indicated on the plans.

c. Sensors to be provided with the unit
   1) Room / Space Temperature Sensors (remote mounted separate from panel)
   2) Heating Inlet Air Sensor
   3) Dirty Filter Sensor
   4) Fire Stat Type III
   5) 120V/24V Smoke Detector

2.12 THERMOSTATS FOR UNIT HEATERS

A. Type: Wall mounted, heat only with fan AUTO-ON selector switch when fan part of unit and separate system ON-OFF selector switch.

B. Dial or lever temperature setpoint adjustment with 45 to 90 degrees Fahrenheit setpoint range.

C. Setpoint and temperature indication.

D. Control voltage as indicated in the attached Heating Unit Schedules.

E. Bi-metallic contacts suitable for 1- or 2-stage unit heater control as specified for the heater size or as scheduled. The use of mercury within the thermostat is not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine and verify that Work is in condition to receive installation specified in this Section.
   1. Take measurements and verify dimensions to ascertain fit of installation.
   2. Verify structural sufficiency to support installation.
   3. Verify that chassis, shafts, and openings are correctly located.
      a. Otherwise cut new openings where required.
   4. Confirm specified thermostat and other controls are compatible with specified equipment.

B. Examine and verify structural details and sections indicated on the Drawings, ascertain adequacy, and determine possible conflicts in dimensions and clearances.

3.2 PREPARATION

A. Before installation, remove dust and debris from equipment and ducts.

B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.3 INSTALLATION

A. Anchoring and support: Install anchoring for seismic and wind forces to meet the design criteria specified in Sections 01 81 02 and 01 81 04.

B. Alignment: Adjust ductwork alignment when necessary to resolve conflicts with architectural and structural features or to resolve conflicts with work of other trades.

C. Install and wire heating units and thermostats in accordance with manufacturer's recommendations.

1. Provide disconnect switches at the heating units wherever indicated on the Drawings, specified in this Section, scheduled and wherever required by code.

D. Adjust heater units with louvers for optimum air circulation.

E. Provide gas unit heater venting in accordance with mechanical code and plumbing code as specified in Section 01 41 00 and in accordance with NFPA 54.

3.4 FIELD QUALITY CONTROL

A. Test equipment and installation to verify operation is within manufacturer's standards and that noise levels do not exceed levels specified.

B. Test equipment performance and balance equipment as specified in Section 23 05 93.

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 power distribution equipment, lighting equipment, underground electrical work, grounding systems, control systems, conduit and wiring, , 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 site 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 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.

1.9 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.

1.10 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.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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.

1.20 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.

1.21 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.

2.2 HEAT TRACING

A. Heat trace and insulate all exposed piping, water lines, and valves less than 8” diameter and all equipment where water may collect. Where exact sizes, panels, boxes, conduit, circuitry 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 as needed to provide freeze protection requirements as though shown in detail on the Drawings. The Contractor shall be responsible for supplying all items as required for complete heat tracing systems regardless of the level of detail shown on the Drawings.

B. Contractor shall meet all National Electrical code requirements for heat tracing and particularly to Resistance Heating Elements Article 427-21, 22 and 23.

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; 20ACI (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 l20 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; PS20ACI-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. Pigtailing 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

Addison Chloramine Booster Station

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:

   ϕA-ϕB_____ ϕB-ϕC_____ ϕC-ϕA_____

   ϕA-G_____ ϕB-G_____ ϕC-G_____

6. Record full load voltage and current:

   Vab_____ Van_____ Ia_____

   Vbc_____ Vbn_____ Ib_____

   Vca_____ Vcn_____ Ic_____

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 XHHW-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type XHHW-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2 single conductors in raceway.

E. Feeders in Cable Tray: Type XHHW-2, single conductors in raceway for larger than 4/0 AWG; Otherwise Type TC tray cable.

F. Exposed Branch Circuits, Including in Crawlspaces: Type XHHW-2, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW-2, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, 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 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 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. RMC: Rigid metal conduit.

B. NECA: National Electrical Contractors Association.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Equipment supports.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   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. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of cooper Industries.
      c. ERICO International Corporation

d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101. NECA publications are available at www.NECAnet.org.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size and shape of conductor gripping pieces as required to suit individual conductors or cables supported.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes and bars.

F. Mounting, Anchoring and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded 304 stainless steel stud, for use in hardened Portland cement concrete, steel or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
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). Hilti Inc.
2). ITW Ramset/Red Head; a division of Illinois tool works, Inc.
3). MKT Fastening, LLC
4). Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete with tension, shear and pullout capacities appropriate for supported loads and building materials in which used.
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 B-Line, Inc.; a division of Cooper Industries
2). Empire Tool and Manufacturing Co., Inc.
3). Hilti Inc.
4). ITW Ramset/Red head; a division of Illinois tool works, Inc.
5). MKT Fastening, LLC.
3. Concrete Inserts: Stainless steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125.
6. Toggle bolts: All-steel springhead type.
7. Hanger Rods: Threaded 304 stainless steel.
8. Nuts: Match threaded rod or bolt; double nut vertical hanger rods.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES.

A. Description: bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Outdoor locations: Supporting material shall be stainless steel or PVC-Coated galvanized steel or as described within the Drawings.

C. Indoor locations: Supporting materials shall be galvanized in dry areas and stainless steel or PVC-Coated galvanized steel in damp areas, or as described within the Drawings.

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for RMC as required by NFPA 70. Minimum rod size shall be ¼ inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   7. To Light Steel: Stainless steel sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000 psi, 28-day compressive-strength concrete.

C. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

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 “Underground Ducts and Raceways for Electrical Systems” for exterior ductbanks, manholes, and underground utility construction.
2. Division 26 Section “PVC Coated Conduit.”

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. Alflex 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: Rigid Aluminum or as noted in the Drawings
   2. Concealed: Rigid Aluminum or as noted in the Drawings.
   3. Underground: RNC, Schedule 40 in concrete encasement.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

B. Indoors:

1. Exposed: Rigid Aluminum or as noted in the Drawings.
2. Concealed: Rigid Aluminum or as noted in the Drawings.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic. Pneumatic, Electric Solenoid or Motor-Driven Equipment): LFMC.
4. Damp or Wet Locations: Rigid Aluminum 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 Aluminum Conduit: Use threaded rigid 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. 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 conduit shall be hot dip galvanized inside and out with hot galvanized threads.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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).

I. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.

J. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.

K. Independent certified test results shall be available to confirm coating adhesion under the following conditions:
   1. Conduit and condulet 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.

L. 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. All conduits with damaged coatings 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 Divison.
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 rigid 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.

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. Section 26 05 70 – Power System Study.

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 05 70 – POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a complete computer-based power system study including the following: short circuit analysis, equipment evaluation, protective device overcurrent coordination, and arc flash hazard analysis.

1.2 SCOPE

A. Perform power system study as required by this document for all new electrical equipment provided as part of the project, including electrical equipment provided as part of a manufacturer supplied equipment package. Study shall originate at the utility service transformer.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
   1. Power system analysis input data, including completed computer program input data sheets.
   2. Complete power system study report as required by this document; signed, dated, and sealed by a qualified professional engineer.
      a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
      b. Revised single-line diagram, reflecting field investigation results and results of power system analysis.

C. Qualification Data: For power system analysis specialist.

D. Product Certificates: For power system analysis software, certifying compliance with IEEE 399, IEEE 1584, and NFPA 70E.

E. Operation & Maintenance Data
   1. In addition to items specified in Division 01 “Operation and Maintenance Data,” include the following:
      a. The following parts from the Power System Study report:
         1) One-line diagram
         2) Time current coordination curves
         3) Arc flash hazard analysis results

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Power System Analysis Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Products: Subject to compliance with requirements, provide the following:
   1. SKM; PowerTools for Windows
   2. ESA International; EasyPower.

B. Comply with IEEE 399, IEEE 551, IEEE 242, IEEE 1584, and NFPA 70E.

C. Analytical features of computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 DATA COLLECTION

A. Obtain all data necessary to conduct the power system analysis.
   1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Engineer.
   2. For new equipment, use characteristics submitted under the provisions of submittals for this Project.
   3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Gather and tabulate the following input data to support power system study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service, including three phase and single phase short circuit MVA and X/R ratio.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
9. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. Motor horsepower and NEMA MG 1 code letter designation.
11. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
12. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

2.3 SYSTEM MODELING

A. Provide a list of all assumptions made. The Engineer shall review and request any changes to assumptions before final approval of the model.

B. Equipment names used in the modeling software shall be identical to the names used on the equipment nameplates installed in the field.

C. For systems with more than one available power source (such as a generator or second utility source), separate scenarios shall be modeled for each possible operating condition. Each of the operating conditions shall be documented and modeled in the software in order to determine the worst-case arch flash hazard and short circuit values for the system components.

D. All components in the model shall be based on nameplate data from the actual field device including manufacturer, type, style, ratings, actual settings, etc. Generic substitutions or assumptions shall not be allowed unless data can not be field verified. All assumptions or substitutions shall be documented in the report.

E. The model shall include all electrical components of the system from the utility service (including primary relaying) down to all equipment in excess of 50V. This includes all control panels, disconnects, or other panels where voltage greater than 50V is present. Refer to requirements of arc flash analysis for evaluating hazards for equipment less than 240V.

2.4 SHORT CIRCUIT ANALYSIS

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices.

C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

D. Actual transformer impedances shall be used if known. Design impedances shall only be used where actual impedance is unobtainable from field markings or from the manufacturer.

E. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
   1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
   1. Electric utility's supply termination point.
   2. Incoming switchgear.
   3. Low-voltage switchgear.
   4. Motor-control centers.
   5. Control panels.
   6. Standby generators and automatic transfer switches.
   7. Branch circuit panelboards.
   8. Disconnect switches.
   9. Other significant locations throughout the system

2.5 EQUIPMENT EVALUATION

A. Provide a short circuit evaluation of all electrical equipment and protective devices. Evaluation shall compare short circuit withstand and interrupting ratings of equipment with calculated short circuit values from the study.

B. The software performing the equipment evaluation shall automatically adjust results for system X/R ratios that are higher than equipment test X/R ratios.

C. Equipment in the evaluation shall be marked with the following designations:
   1. PASS –maximum short circuit current is less than 90% of equipment rating.
   2. MARGINAL –maximum short circuit current is 90%-100% of equipment rating.
   3. FAIL –maximum short circuit current is greater than 100% of equipment rating.

2.6 PROTECTIVE DEVICE COORDINATION STUDY

A. Provide settings for all overcurrent protective devices to achieve the following:
   1. Provide selective coordination for the electrical system.
   2. Protect equipment and cables from damage during overcurrent conditions.
   3. Minimize arc flash hazards.

B. Graphically illustrate the settings of all overcurrent protective devices utilizing time current curves (TCCs) meeting the following requirements:
   1. Display TCCs on log-log scale graphs printed in color on 8.5”x11” sized paper. Each TCC shall have a unique title and associated one-line diagram with legend identifying the portion of the system depicted in the TCC.
   2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

3. Each device shown on a TCC shall include a datablock identifying the name of the device, manufacturer make and model, and overcurrent settings.
4. Develop TCCs for both phase and ground protective devices.
5. Plot the following listed characteristic curves, as applicable:
    a. Power utility's overcurrent protective device.
    b. Medium voltage equipment overcurrent relays.
    c. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    d. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
    e. Transformer full load current, magnetizing inrush current, and ANSI through-fault protection curves.
    f. Cables and conductors damage curves.
    g. Ground fault protective devices.
    h. Motor starting characteristics and motor damage points.
    i. Generator short-circuit decrement curve and generator damage point.
    j. The largest feeder circuit breaker in each motor control center, switchboard, and panel board.
6. Provide number of TCCs as required to adequately display the selective coordination of the system.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.

C. For an existing system, provide the protective device settings as existing as well as recommendations for new settings if existing does not provide adequate selectivity. If settings changes are recommended, clearly identify the recommended changes in a table format.

D. A table shall be developed to summarize the settings for all protective devices that contain adjustable settings. The table shall include the following:
1. Device identification.
2. For circuit breakers: manufacturer, type, style, sensor rating, long-time pickup, short-time pickup, instantaneous pickup, ground fault pickup, and associated time delay settings.
3. For protective relays: manufacturer, type, style, function pickup, current multiplier, time dial, and time delays. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.
4. Include both existing settings and recommended changes for all protective devices with recommended settings changes.

E. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
    a. Inrush current when first energized.
    b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

F. Motor Protection:
1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures

that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

H. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

2.7 ARC FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and IEEE 1584 for hazard analysis study.

B. Results from the short circuit current study and overcurrent coordination study shall be used as inputs to the arc flash hazard analysis.

C. The flash protection boundary and incident energy shall be calculated at all significant locations in the electrical distribution system where work could be performed on energized parts. This includes but is not limited to switchboards, switchgear, motor control centers, panelboards, busways, and disconnect switches.

D. For three-phase or single-phase equipment rated 240-V ac or less fed from transformers less than 125 kVA, refer to NFPA 70E and IEEE 1584 for determining hazard category levels. Include in the report a description of methods used to determine hazard levels for equipment in this category.

E. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

F. The incident energy calculations for multiple scenarios must be compared and the greatest incident energy must be reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full load conditions. Note that maximum utility contribution is not defined as infinite bus, but rather the maximum value reported by the utility.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond three to five cycles.

H. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

I. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
   1. When the circuit breaker is in a separate enclosure.
   2. When the line terminals of the circuit breaker are separate from the work location.

J. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

PART 3 - EXECUTION

3.1 POWER SYSTEM STUDY REPORT CONTENTS

A. Executive Summary
   1. Brief description of the important findings and recommendations of the study. The executive summary should not include general study information or methodology.

B. Introduction
   1. Describe the purpose and scope of the study and the methodology used for each analysis.
   2. Provide a description of the connection of the system and the different operating scenarios analyzed.
   3. List all engineering assumptions made for the study.

C. Input Data
   1. Provide input data for all components of the system model in tabular format, including but not limited to the following:
      a. Cable data including size, length, number per phase, conduit type, and conductor material
      b. Transformer data including winding connections, kVA rating, primary and secondary voltage ratings, %Z, and X/R ratios.
      c. Reactor data including voltage rating and inductance.
      d. Generator contribution data including kVA rating, power factor, voltage, and subtransient reactance.
      e. Utility contribution data including rated voltage and three phase and single-line-ground contributions with X/R ratios.

D. One-Line Diagram
   1. Provide one-line diagram(s) generated from the computer software package that show all electrical distribution for the system. Include as a minimum the following information on the diagram(s):
      a. Protective device designations and ampere ratings.
      b. Cable sizes and lengths.
      c. Transformer kilovolt ampere (kVA), voltage, and impedance ratings.
      d. Motor and generator designations and kVA ratings.
      e. Utility contribution data
      f. Switchgear, switchboard, motor-control center, and panelboard designations, voltage ratings, bus ampacities, and short circuit current ratings.

E. Short Circuit Current Analysis
   1. Output data shall include but not be limited to the following reports:
      a. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
         1) Voltage.
         2) Calculated fault-current magnitude and angle.
         3) Fault-point X/R ratio.
         4) Equivalent impedance.
      b. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
         1) Voltage.
         2) Calculated symmetrical fault-current magnitude and angle.
         3) Fault-point X/R ratio.
         4) Calculated asymmetrical fault currents:
            a) Based on fault-point X/R ratio.
            b) Based on calculated symmetrical value multiplied by 1.6.

c) Based on calculated symmetrical value multiplied by 2.7.

c. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   1) Voltage.
   2) Calculated symmetrical fault-current magnitude and angle.
   3) Fault-point X/R ratio.
   4) No AC Decrement (NACD) ratio.
   5) Equivalent impedance.
   6) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.

d. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Equipment Evaluation
1. The results of the short circuit equipment evaluation shall be reported in tabular format and provide the following information:
   a. Equipment name, voltage rating, and short circuit rating
   b. Calculated maximum available short circuit current at each device and bus
   c. Percent over/under duty and PASS/FAIL/MARGINAL designation as defined in Part 2 of this specification.
   d. Components that fail the equipment evaluation shall be highlighted for easy visual identification.

G. Protective Device Coordination Study
1. Provide a brief summary of the findings of the study including any major selectivity problems or recommendations.
2. Provide all TCCs needed to illustrate the system including a table of contents and descriptions for all TCCs included.
3. Include a settings table to summarize the settings for all protective devices as required in Part 2 of this specification.

H. Arc Flash Hazard Analysis
1. Provide a brief summary of the findings of the study including a list of any locations identified as Dangerous hazard category and recommendations for hazard category reductions.
2. Provide a table indicating the worst case scenario of all busses evaluated. Table shall include but is not limited to the following:
   a. Arcing fault magnitude.
   b. Protective device clearing time.
   c. Duration of arc.
   d. Arc flash boundary.
   e. Working distance.
   f. Incident energy.
   g. Hazard risk category.
3. Provide a separate table for each operating scenario. Provide the same information as required above for each table.

I. Recommendations
1. Provide a section that summarizes and lists all recommendations for changes to the system as a result of the study. This includes protective device settings changes, equipment short circuit deficiency corrections, or other items as applicable.

3.2 ARC FLASH WARNING LABELS

A. Provide a thermal transfer type label of high-adhesion polyester for each work location included in the analysis. Labels shall have a minimum size of 3.5”x5”.

B. The labels shall include the following information taken directly from the arc flash hazard analysis:
   1. Equipment name (must match name on equipment nameplate).
   2. Nominal voltage.
   3. Flash protection boundary.
   4. Hazard risk category.
   5. Incident energy.
   6. Available short circuit current.
   7. Working distance.
   8. Glove class.
   9. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

D. Labels to be applied on outdoor equipment shall have a weatherproof coating for protection from deterioration or fading due to rain and UV exposure.

3.3 LABELING

A. Apply one arc flash label for each of the following locations:
   1. Panelboards
   2. Disconnects
   3. Motor control centers
   4. Switchboards
   5. Switchgear
   6. Control panels
   7. Any equipment likely to require servicing while energized

B. Installation of arc flash warning labels shall be done under the direct supervision and control of the power system study specialist.

3.4 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with power system study.

3.5 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

B. Train Owner’s operating and maintenance personnel in the potential arc flash hazards associated with working on energized equipment and the significance of arc flash warning labels.

END OF SECTION

SECTION 26 09 43 - FIBER OPTIC NETWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:
   1. General Instrumentation and Control.

B. 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.

C. System Description

1.2 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.

1.3 SUBMITTALS

A. Product Data: Installation Details
   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.
   2. 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. The Contractor shall furnish the Engineer with six (6) copies of the submission.
   3. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Delivery, storage, and handling shall be in accordance with manufacturer’s recommendation and other sections herein.

PART 2 - PRODUCTS

2.1 FIBER OPTIC CONNECTORS

A. All fiber optic connectors shall be type ST. All connectors on equipment and cables shall be fully compatible.

B. Number cables and connect each cable to its numbered port on the indicated switch.

2.2 12-STRAND ALL ENVIRONMENT MULTI-MODE FIBER OPTIC CABLE

A. Fiber optic cable shall be industrial grade, extended performance. The cable shall consist of 12 fibers with 62.5-micron core and 125-micron cladding and shall be suitable for multimode operation at 850 and 1300 nanometers. Acceptable losses for multimode fiber lengths with connector pairs at each end shall not be greater than 3.75 dB/km at 850 nm and 1.5dB/kM at 1300nm. Cable shall be rated for installation in harsh environments such as direct burial, aerial lashing, and conduit and pathways that are subject to wide temperature variations. Cable shall be plenum rated. Cable shall comply with ANSI/TIA/EIA-568-B including all addendums for fiber optic cable performance specifications.

B. The cable shall be suitable for the installation as certified by the fiber optic interface manufacturer and proven by test results. Fiber optic cable shall be supplied in continuous lengths between patch panels. Cable shall be as manufactured by Phoenix Digital or Optical Cable Corporation or Siecor or Lucent or Berk-Tek or equal.

2.3 24-PORT FIELD FIBER OPTIC PATCH PANEL / TERMINATION PANEL

A. Patch panel shall be a wall mountable enclosure specifically designed for fiber optic cable termination and distribution. Cabinet shall be constructed of metal and shall include cable strain relief and radius limiting, buffer tube fan-out kits, space for a splice tray holder, and capacity for 24 ST connectors.

B. Install patch panel in control panel. Terminate into ST connectors the two fibers required at each location. Terminate and jumper each fiber that continues on to another location.

C. Provide Corning WCH-02P or Siemon or equal.

2.4 FIBER OPTIC PATCH CORDS

A. Fiber optic patch cords shall be duplex ST to ST cords with two tight buffered 62.5/125 multi-mode strands. Patch cords must comply with ANSI/EIA/TIA standards. Provide Ortronics or Lucent or Amp or Molex Premise or NORDX/CDT or Panduit or Siemon or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide and install fiber optic cable, connectors, transceivers and converters, network cable, connectors, hubs and network switches to interconnect the PLCs. Fiber optic materials and equipment shall be installed, tested and terminated by experienced fiber optic system personnel.

B. Cable shall be carefully installed and professionally terminated. Submit credentials and a sample of fiber termination technician. All terminations shall be compatible with the terminal and communicating equipment. Fiber optic cable shall be installed in underground concrete encased conduit. Network cable shall be installed in interior locations in conduit.

C. Fiber Optic splices are not desired or permitted except in unavoidable circumstances. In the event of fiber optic cable damage exterior splices shall be made in handholes at no additional cost to the Owner and at the contractor's risk. The losses due to the splice shall not exceed 0.2dB per mechanical splice. No more than 1 set of splices shall be allowed in a run. The Contractor shall protect exposed ends of cable during construction. Network cable shall not be spliced.

D. All required splicing materials shall be included with the fiber optic cable and shall meet the requirements of the terminal and communicating devices, transceivers and media converters and the fiber optical cable manufacturer's specifications.

E. Fiber Optic Cable with connectors on each fiber strand shall be coiled in each Control Panel with 5 feet minimum slack ready for immediate use.

F. Cable Testing: The fiber optic cable shall be tested at the factory and at the job site before and after installation. Provide docket of shipment report with attenuation test results to the engineer prior to installation. These tests shall be signed, dated and immediately transmitted to the Engineer. Category 5 cable shall be third party verified to TIA/EIA 568-A Category 5.

G. OTDR Tests: This test shall utilize an OTDR test instrument with signature trace printout capability and shall document the end-to-end attenuation for fiber, connectors and mechanical splices (if any).

H. Site acceptance test: While cable is still on the reel as delivered to the site, prior to installation submit printed, signed and dated results of on-site, on-reel OTDR attenuation test of each fiber strand. Verify Category 5 cable performance with 100MHz test set.

I. Post installation test: Following installation of fiber cable and termination of all strands submit results of on-site attenuation test of each terminated fiber strand. Tests shall be performed with an OTDR test instrument with printout capability. Test each terminated Category 5 cable with 100MHz test set.

J. All cable with attenuation results lower than acceptable limits shall be removed and replaced at no additional cost to the Owner.

K. Fiber optic and network devices installation: Modems and connecting cables shall be preconfigured at the factory for the application. No modem field settings, programming or adapters shall be required

L. Fiber Optic Cable Installation: Fiber optic cable installation and termination shall be accomplished by technicians skilled and experienced in the type work indicated. Experience shall include 5 years of installation experience with proper training in use of the tools and equipment recommended by the fiber optic cable manufacturer for installation and termination in an approved manner. The installer shall have test equipment available to demonstrate that the completed installation complies with the specified bandwidth and transmission parameters. A licensed electrical or specialty controls contractor in the State of Texas shall perform this work.

3.2 DEMONSTRATION

A. System Demonstration and 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.
   2. The system shall operate with 100 percent reliability during the test period. Failure of hardware 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.

B. Service: 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.

C. Maintenance Instruction: 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.

D. Warranty: All equipment and workmanship furnished under this contract shall be guaranteed to be free of defects in materials and workmanship for a period of one (1) year 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 22 00 - LOW-VOLTAGE TRANSFORMERS

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 types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Dry-Type distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.
   1. Wiring Diagrams: Power, signal and control wiring.

C. Qualification Data: For testing agency

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. 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.

D. Comply with IEEE C57.12.91, “Test Code for Dry-Type Distribution and Power Transformers.”

1.5 DELIVERY, STORAGE AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer’s written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is

not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03. Construct housekeeping pad for floor mounted transformers.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

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, but are not limited to the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Products.
   2. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and –tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Aluminum

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

G. Energy Efficiency for Transformers Rated 15 kVA and larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

H. Electrostatic Shielding: Each winding shall have an independent, single full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:
    a. Capacitance between Primary and Secondary windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
    b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
    c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

I. Wall Brackets: Manufacturer's standard brackets.

J. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 16 Section "Grounding and Bonding for Electrical systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements.

C. Ground the neutral on the secondary of all transformers.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

B. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed “Satisfactory Test” label to tested component.

3.5 ADJUSTING

A. Monitor transformer secondary voltage at each unit for at least 2 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 16 – PANELBOARDS

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. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

A. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   6. Finishes:
      a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Galvanized steel.
   7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top and bottom as required by job conditions.

C. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; a brand of Schneider Electric.
2. Eaton.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; a brand of Schneider Electric.
2. Eaton.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.
   2. Eaton.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
   4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Application Listing: Appropriate for application; Type HACR for breakers serving Heating, Air Conditioning and Refrigeration (HACR) loads.
      e. Dual rated SWD and HACR breakers are acceptable.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete or Miscellaneous Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to panelboards.
   5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1). Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. ADJUSTING

G. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

H. Set field-adjustable circuit-breaker trip ranges as indicated and recommended by manufacturer.

I. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes if directed by the Engineer.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 24 19 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes modifications to existing motor-control centers for use on ac circuits rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each type of controller and each type of motor-control center. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings and finishes.

B. Shop Drawings: for each motor-control center.
   1. Include dimensioned plans, elevations, sections and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current ratings of buses and installed units.
      d. Vertical and horizontal bus capacities.
      e. UL listing for series rating of overcurrent protective devices in combination controller.
      f. Features, characteristics, ratings, and factory settings of each motor-control center unit.
   2. Wiring Diagrams: Power, signal and control wiring for class and type of motor-control center. Provide schematic wiring diagram for each type of controller.

C. Coordination Drawings: floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around motor-control centers where pipe and ducts are prohibited. Show motor-control center layout and relationships between electrical components and adjacent structural and mechanical elements. Show compliance with NFPA 70, Article 240.24 height limitation of overcurrent device operating handles. Show support locations, type of support and weight on each support. Indicate field measurements.

D. Qualification Data: for manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: for motor-control centers, all installed devices and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for motor-control centers and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 250 miles of Project site, a service center capable of providing training, parts and emergency maintenance and repairs.

B. Source Limitations: Obtain motor-control centers and controllers of a single type through one source from a single manufacturer.

C. 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.

D. Comply with NFPA 70.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver motor-control centers in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Handle motor-control centers according to the following:
   1. NEMA ICS 2.3, “Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers Rated Not More Than 600 Volts.”
   2. NECA 402, “Recommended Practice for Installing and Maintaining Motor Control Centers.”

1.5 COORDINATION

A. Coordinate layout and installation of motor-control centers with other construction including conduit, piping, equipment and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate features of motor-control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each motor-control center, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Eaton – Cutler Hammer
   2. Schneider Electric – Square D

2.2 MOTOR-CONTROL CENTERS

A. Wiring: NEMA ICS 3, Class I, Type B.

B. Enclosures: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location. Standard, 20" depth.
   1. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
   2. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor-control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
   3. Final installation height of disconnect devices, accounting for pad height under the motor control center, shall be in compliance with NFPA 70, Article 240.24.
   4. Wiring spaces: Wiring channel in each vertical section for vertical and horizontal wiring to each unit compartment; supports to hold wiring in place.

C. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.3 BUSES

A. Material: Plated hard-drawn copper, 98 percent conductivity.

B. Ampacity Ratings: Match ampacity ratings of existing MCC structure.

C. Neutral Buses: Full size or as available relative to the main ampacity.

D. Equipment Ground Bus: Non-insulated, horizontal configuration; adequate for equipment ground conductors; bonded to enclosure.

E. Horizontal Bus Arrangement: Main phase, neutral and ground buses extended with same capacity the entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections or equivalent.

F. Short-Circuit Withstand Rating: Same as short-circuit current rating of existing MCC structure.

2.4 FUNCTIONAL FEATURES

A. Description: Modular arrangement of controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center.

B. Controller Units: Combination controller units of types and with features, ratings and circuit assignments indicated:
   1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   2. Provide units with short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center sections.

3. Equip units in Type B and Type C motor-control centers with pull-apart terminal strips or drawout terminal boards for external control connections.
4. Controller Disconnecting Means: Factory-assembled combination disconnect and controller.
    a. Circuit-Breaker Disconnecting Means: NEMA AB1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

C. Overcurrent Protective Devices: Individual feeder-tap units through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions. Installed height, including that of the concrete base, of operating handles of overcurrent protective devices shall not exceed the height limitation of NFPA 70, Article 240.24.

D. Surge Protective Devices: Connect to motor-control center bus.

E. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

F. Spare Units: Type, sizes, and ratings indicated; installed in compartments indicated “spare.”

2.5 FEEDER OVERCURRENT PROTECTION

A. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
1. Electronic Trip Unit circuit Breakers: RMS Sensing; field-replaceable rating plug; with the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long-and short-time pickup levels.
    c. Long-and short-time time adjustments.
    d. Ground-fault pickup level, time delay and I^2t response.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings and number of poles.
1. Lugs: Mechanical Compression style, suitable for number, size, trip ratings and material of conductors.
2. Application Listing: Appropriate for application: Type SWD for switching fluorescent lighting loads; type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

2.6 FACTORY FINISHES

A. Finish: manufacturer’s standard paint applied to factory-assembled and –tested, motor-control centers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive motor-control centers for compliance with requirements, installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor each motor-control center assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with motor-control center mounting surface.

B. Install motor-control centers on concrete bases.

3.3 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

3.4 IDENTIFICATION

A. Identify motor-control center, motor-control center components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each motor-control center element, bus, component, connecting supply, feeder and control circuit.
   2. Test continuity of each circuit.

B. Perform the following field test and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection tests, stated in NETA ATS "Motor Control Centers." Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain components of motor-control centers.

END OF SECTION

SECTION 26 28 13 – FUSES

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. Section Includes:
   1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, controllers and motor-control centers.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics and ratings.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Feeders: Class L, fast acting Class RK1or fast acting Class RK5.
   2. Motor Branch Circuits: Class RK1, time delay.
   3. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section “Identification for Electrical Systems” and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket and holder.

END OF SECTION

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Molded-case switches.
   5. Enclosures.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories and finishes.
   1. Enclosure types and details for all types indicated, including NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of Nationally Recognized Testing Laboratory listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: for power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Square D; a brand of Schneider Electric.
   2. Eaton.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Lugs: Mechanical type, suitable for number, size and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Square D; a brand of Schneider Electric.
   2. Eaton.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Square D; a brand of Schneider Electric.
2. Eaton.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Features and Accessories:
1. Standard frame sizes, trip ratings and number of poles.

2.4 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include:
1. Square D; a brand of Schneider Electric.
2. Eaton.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
1. Standard frame sizes and number of poles.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoors: NEMA 1
2. Outdoors: NEMA 4X, stainless steel

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Installation height of disconnect devices shall be in conformance with NFPA 70, Article 240.24.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts form enclosures and components.

D. Furnish and install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section “Identification for Electrical Systems.”
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

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. Section includes lightning protection for building site components.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: for air terminals and mounting accessories.
   1. Layout of the lightning protection system, along with details of the components to be used in the installation.
   2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
   1. Ground rods.
   2. Ground loop conductor.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. Electrical components, Devices and Accessories: Listed and labeled as defined in NFPA 780, “Definitions” Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturer’s specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I copper unless otherwise indicated.
1. Manufacturers: subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. East Coast Lightning Equipment Inc.
b. ERICO International Corporation.
c. Harger.
d. Heary Bros. Lightning Protection Co., Inc.
e. Independent Protection Co.
f. Preferred Lightning Protection.
g. Robbins Lightning, Inc.
h. Thompson Lightning Protection, Inc.
2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
3. Single-membrane, Roof-Mounted, Air Terminals: Designed specifically for single-membrane roof system materials.

C. Main and Bonding Conductors: Copper.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; ¾ inch in diameter by 10 feet long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:
1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view of exterior locations at grade within 200 feet of building.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

E. Bond extremities of vertical metal bodies exceeding 60 feet in length of lightning protection components.

F. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.
1. Bury ground ring not less than 30 inches.
2. Bond ground terminals to the ground loop.

3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

END OF SECTION

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.

1.2 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast, including BF.
   4. Energy-efficiency data.
   5. Life, output (lumens, CCT, and CRI) and energy-efficiency data for lamps.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy efficient Lighting Products.

B. Installation instructions.

C. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

G. Warranty: 12 months after project acceptance.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturer's laboratories that are accredited under the National volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electric Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system and partition assemblies.

1.6 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 Insert quantity of each type and rating installed. Furnish at least one of each type.
   2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.
   4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

B. Substitutions:

1. Provide complete literature for each luminaire substitution:
2. Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
    a. Photometric data:
        1) IES file in standard IES format.
        2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
        3) Candlepower distribution curves.
        4) Average luminaire brightness.
        5) Lumen output charts.
        6) Power requirements in watts and volt-amperes.
    b. Calculations:
        1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
            a) Use surface reflectance values and luminaire light loss factors approved by the ENGINEER to perform all calculations.
3. Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
4. Substitutions shall comply with all applicable building codes.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
    a. Lens thickness: At least 0.125 inch minimum unless otherwise indicated.
    b. UV stabilized.
2. Glass: Annealed crystal glass unless otherwise indicated.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
    a. “USE ONLY” and include specific lamp type.
    b. Lamp diameter code (T-4, T-5, T-8, T-12, etc), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent lunimaires.
    e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    f. CCT and CRI for all luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts.
   1. Comply with UL 935 and with ANSI C82.11.
   2. Designed for type and quantity of lamps served.
   3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
   4. Sound Rating: Class A.
   5. Total Harmonic Distortion Rating: Less than 10 percent.
   6. Transient Voltage Protection: IEEE C62.41 and IEEE C62.41.2, Category A or better.
   7. Operating Frequency: 42 kHz or higher.
   8. BF: 0.88 insert value or higher.
   9. Power Factor: 0.95 or higher.

B. Electronic Programmed Start Ballasts for T5 and T8 Lamps: comply with ANSI C82.11 and the following:
   1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
   2. Automatic lamp starting after lamp replacement.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
   1. Ballast Manufacturer Certification: Indicated by label.

D. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Degrees F and Higher: electronic type rated for 0 degrees F starting and operating temperature with indicated lamp types.
   2. Temperature Minus 20 degrees F and Higher. Electromagnetic type designed for use with indicated lamp types.

E. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR18, Ch. 1, subpart C, for imitations on electromagnetic and radio-frequency interference for consumer equipment.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: Class A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher unless otherwise indicated.
   9. Power Factor: 0.95 or higher.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
   1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

2.6 BALLASTS FOR HID LAMPS

A. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
1. Minimum Starting Temperature: Minus 20 degrees F for single-lamp ballasts.
2. Rated Ambient Operating Temperature: 130 degrees F.
3. Lamp end-of-life detection and shutdown circuit.
4. Sound Rating: Class A
5. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Lamp Current Crest Factor: 1.5 or less.
8. Power Factor: 0.90 or higher.
9. Protection: Class P thermal cutout.

2.7 QUARTZ LAMP LIGHTING CONTROLLER

A. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.

B. Standby (Quartz Restrike): automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.

C. Connections: Designed for a single branch-circuit connection.

D. Switching Off: automatically switches quartz lamp off when HID lamp strikes.

E. Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

2.8 EXIT SIGNS

A. General Requirements for Exit Signs: comply with UL 924; for sign colors, visibility, luminance and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery type): Integral automatic charger in a self-contained power pack.
    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.9 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicated trickle charge; bright glow indicates charging at end of discharge cycle.

2.10 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 28000 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

B. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.
1. 26 W: T4 double or triple tube, rated 1800 initial lumens (minimum).

2.11 HID LAMPS

A. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000K.

2.12 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section “Hangers and Supports for Electrical Systems” for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Engineer, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminiaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps and reinstall.

C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
   4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

D. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section “Identification for Electrical Systems.”

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Adjust aimable luminaires in the presence of Owner and Engineer.

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 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.
   14. Control System Specialist – a company specializing in control, computer, and software system implementation, networking, installation, and configuration.

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 QUALITY ASSURANCE

A. The Contractor shall designate in writing the qualified Control System Specialist, including a detailed listing of the firm, resumes and work history of each person working on the project, and project specific references. The qualifications of the Control System Specialist shall be subject to approval of the Owner and the Engineer.

B. The minimum qualifications for the Control System Specialist shall include:
   1. An established firm in operation as a control and automation company for a minimum of 3 years.

2. Staffed with experienced personnel capable of executing the required aspects of the project.
3. Certified Systems Integrator for both hardware and software products.
4. Database programming and custom application development.
5. Demonstrated water and wastewater treatment plant experience.

1.5 PROVIDERS

A. The Control System Specialist responsible for all instrumentation, control, and SCADA work shall be Prime Controls. Contact Colby Cobb, 214-475-4713, cj.cobb@prime-controls.com.

1.6 SCOPE OF WORK

A. The General Contractor shall engage the services of a Control System Specialist, who shall furnish all materials, equipment, labor and services to provide remote monitoring and control of the new chloramine booster systems.

B. The Control System Specialist shall be responsible for providing and installing all instrumentation, networking equipment, SCADA hardware and software, and other control system hardware and software as specified to interface with the chloramine booster systems.

C. In general, the Control System Specialist shall perform the following tasks:
1. Furnish, install, configure, and calibrate instrumentation as detailed on the Drawings and in the Specifications. Refer to specification section 26 90 10.
2. Provide PLC programming and integration services to achieve remote monitoring and control of the systems as details on the drawings and specifications.
3. Install all control wiring and control conduit as detailed on the plans and specifications and as required for a complete process control system installation.
4. Provide hardware and software as required to monitor and control new process equipment from the Owner's existing SCADA system.
5. All hardware required to properly communicate to the existing SCADA system network, whether or not explicitly identified in the drawings or specifications.
6. Develop new HMI graphics as part of the Owner's existing SCADA application to provide monitoring and control of new process equipment. Contractor is responsible for purchasing additional tags to the Owner's license if required for implementation of the new HMI screens.
7. Install networking equipment and communication cables between control devices as indicating in the drawings and specifications, and provide configuration of equipment to ensure proper communication between all devices associated with the integrated operating platform.
8. Modification to existing instrumentation and control systems as required to maintain process operations.
9. Provide overall coordination, installation, supervision, and installation of control panels, instrumentation, and other miscellaneous control system components as specified.
10. Provide coordination with the Contractor and participate in all meetings as directed by the specifications or Contractor.
11. Execute the testing procedures outlined in this document. A schedule for all tests shall be submitted as part of the Baseline Schedule, set forth in Section 01 32 00, to the Owner and Engineer for review within 45 days of the NOTICE TO PROCEED

D. Vendor system packages are provided under other sections of this contract that interface with the SCADA system via communications protocol and/or hard-wired I/O. Refer to the associated specification sections and the contract drawings for additional details. The Control System Specialist shall be responsible for coordination, furnishing, installing, and configuring any communication devices or drivers necessary to ensure proper communication with each of the vendor-furnished systems.

E. Vendor system packages may include instrumentation or control panels that shall be installed and configured by the Control System Specialist according to vendor instructions. Upon satisfactory installation, configuration, and calibration, the Control System Specialist shall coordinate with each vendor to inspect finished work. The Control System Specialist shall submit documentation indicating that the vendor has inspected and approved the installation

1.7 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. Instrumentation and control testing documents shall be submitted for approval by the Engineer:
   1. Credentials of technicians doing the inspection and testing
   2. Written certification as detailed under testing requirements 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 SCADA programs furnished by Contractor on electronic media, suitable for future troubleshooting or modifications by others.

5. 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.

1.8 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.

1.9 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 subject to direct sunlight 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 Control System Specialist 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 Control System Specialist 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, interconnecting cables, and other peripheral devices required for a complete and functional system. The testing of the system shall include a Functional System Test a Final Acceptance Test.

B. The Control System Specialist shall coordinate testing of the remote SCADA monitoring and controls with the process control testing performed by the chloramine booster system vendor.

C. Functional System Test

1. The Control System Specialist shall implement the PLC and SCADA HMI programming to begin testing of remote SCADA monitoring and control.
2. The purpose of the functional system testing is to implement and test the automatic and manual process control strategies through PLC and HMI programming.
3. For this test, all equipment shall be installed, calibrated, and functioning as required in the contract documents.
4. Each analog and discrete I/O signal shall be checked through the PLC to the HMI screens to verify proper mapping of tags.
5. Functionality of the system shall be checked to ensure conformance with process control descriptions described within the contract documents.
6. PLC control loops shall be tuned to achieve stable process control.
7. During the Functional System Test, the Control System Specialist shall refine the PLC programming and SCADA HMI screens to achieve process control and monitoring as defined in the contract documents and as requested by the Owner or Engineer.
8. If during the Functional System Test, the Engineer or Owner finds that process control is not achievable due to errors in the installation, the functional testing shall stop and the Control System Specialist shall correct the installation and repeat the testing at no additional cost to the Owner.

D. Final Acceptance Test:
1. After the system has been started up and running in automatic control to the greatest extent possible, the Control System Specialist shall conduct a 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.
2. During this test, the Owner and Engineer shall have full use of the system. The duration of the test shall be 30 days.
3. Control System Specialist personnel shall be readily available to address issues onsite during the acceptance test.
4. 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/Owner within 2 days. 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.
5. Throughout the duration of the test, no modifications shall be made to the system without prior approval from the Engineer or Owner.

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 provided by the Control System Specialist. 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. This section does not include instrumentation provided as part of vendor supplied equipment packages.

C. Related Sections:
   1. Section 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. Weight Scales

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

TOTE WEIGHT SCALE WITH INTEGRAL SPILL CONTAINMENT

Power Supply	120 VAC, 1-phase, 60 Hz
Output	4-20 mA analog output scaled to application measurement range, two dry contacts actuated by separately programmable setpoints
Platform Size	As required.
Measurement Range	Adjustable up to 5000 lb
Controller	Scaletron 1020 5 digit controller. LED display scalable to display % full or gallons
Suppliers	Scaletron model 4042-63 or equal.
Instrument Tag	**Application**
20-LIT-01	Surveyor PS Hypo Tote Level
20-LIT-02	Surveyor PS LAS Tote Level

END OF SECTION

DIVISION 31

EARTHWORK

SECTION 31 05 19.13 – GEOTEXTILE FILTER FABRIC

PART 1 - GENERAL

1.1 SCOPE

A. This work shall consist of the installation of a non-woven geotextile fabric below the riprap.

1.2 RELATED SECTIONS

A. Section 31 37 00, RIPRAP

1.3 REFERENCE STANDARDS

A. ASTM D3786 – Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method

B. ASTM D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus

C. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity

D. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

E. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

F. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile

G. ASTM D4886 – Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding block Method)

H. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles

I. ASTM D6241 – Standard Test Method for Static Puncture Strength of Geotextiles and Related Products Using a 50mm Probe

1.4 QUALITY ASSURANCE

A. The installation shall be performed in accordance with the manufacturer's recommendations and as directed by Engineer.

1.5 SUBMITTALS

A. See Section 01 33 00, SUBMITTAL PROCEDURES.

B. Certificates: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MATERIAL

A. The non-woven geotextile fabric shall be an 8-ounce fabric, US Fabrics US 205NW or equal. The fabric shall be of non-woven needle punched construction and consist of long-chain polymeric filaments or fibers composed of polypropylene, polyethylene or polyamide. The

filaments and fibers shall be oriented whereby they retain their relative positions with each other and allow the passage of water as specified.

B. The fabric shall be mildew, insect and rodent resistant and shall be inert to chemicals commonly found in soil. The non-woven fabric shall conform to the physical property requirements below:

Physical Property	Test Method	Test Results
Weight	ASTM D 5261	8 oz/sy
Tensile Strength, wet, lbs	ASTM D 4632	205 lbs
Elongation, wet, %	ASTM D 4632	50%
Permittivity	ASTM D 4491	1.35 sec-1
Puncture Strength, lbs	ASTM D 4833	130 lbs
CBR Puncture	ASTM D 6241	535 lbs
Mullen Burst Strength, psi	ASTM D 3786	350 psi
Abrasion Resistance, % Strength Retained	ASTM D 4886	90
Apparent Opening Size (AOS)	ASTM D 4751	80 US Sieve
Ultraviolet Resistance, % Strength Retention	ASTM D 4355 (After 500 Xenon Weatherometer hrs.)	70%
Trapezoidal Tear	ASTM D 4533	85 lbs
Water Flow Rate	ASTM D 4491	90 gal/min/sf

C. The non-woven geotextile fabric shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fabric Exposure Following Placement - Exposure of the geotextile filter fabric to the elements, particularly the sun, between lay down and cover shall be a maximum of 7 days.

B. The non-woven geotextile fabric shall be placed in the manner and at the locations shown on the drawings or as directed by the Engineer. The surface to receive the fabric shall be prepared to a smooth condition free of obstructions, depressions and debris. The fabric shall be placed loosely, not in a stretched condition.

C. The Contractor shall anchor the geotextile fabric at outer edges of the riprap courses by embedding the fabric down, across, and up a 1-foot deep by 1-feet wide trench. The fabric shall be centered on the pipe. The anchoring trench shall be backfilled with rock material approved by Engineer. There will be no separate payment for Geotextile Fabric; it shall be subsidiary to other items.

D. Where necessary, the fabric shall be placed so as to provide a minimum 24-inch overlap. The fabric shall be placed transverse to the direction of the flow with the upstream panel overlapping the downstream panel. All installations shall be subject to approval by Engineer.

E. Repairs - A geotextile patch, of the same material, shall be placed over any damaged area and shall extend 12-inches beyond the perimeter of the tear or damaged area. Patch shall be either glued or sewn to the mother fabric or as approved by Engineer.

END OF SECTION

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/ft^3)

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)

1.3 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23.13.

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.

D. Relative Density: As defined in Section 31 23 23.13.

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 (TxDOT).

1.4 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 02 41 00.; 31 11 00.; and 31 23 16., 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 and replace with suitable material from the excavation, as specified in Section 31 23 23.13.

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 23.13 – Fill and Backfill.
   3. Section 31 23 16.13 – Trenching for Site Utilities.

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 Texas Department of Transportation.
   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 ¾” in diameter and shall be free of any trash, debris, or deleterious material.

B. Other Fill Materials: See Section 31 23 23.13.

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 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.

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 SOIL

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 SUMMARY

A. Section Includes: Backfilling and compacting for utilities outside the building to utility main connections.
B. Related Sections:
   1. Section 31 22 19 – Grading.
   2. Section 31 23 16 – Excavation.
   3. Section 31 23 23.13 – Fill and Backfill.
   4. Section 31 23 23.16 – Trench Backfill.

1.2 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.

1.3 SUBMITTALS

A. See Section 01 33 00 for submittal procedures.
B. Compaction Density Test Reports.

1.4 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.

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 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. Place filter fabric specified in Section 31 05 19.13 over compacted bedding.
    3. Cover with general fill.
    4. Fill up to subgrade elevation.
    5. 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 33 41 19 – Pipe Laying.

1.2 GENERAL

A. General Requirements: See Division 01 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 the Texas One-Call System "Texas811" two working days before starting excavation. The ONE CALL phone number is (800) 344-8377 or 811.

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.

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.

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

1.1 SUMMARY

A. The following applies to all trenched construction including, but not limited to, water mains, sanitary sewer mains, gas mains, and other pipelines.

1.2 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.

1.3 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.

1.4 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.

1.5 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 conditions 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 a 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. Section 32 11 00 – Base Course.

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-µm (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/ft^3).
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/ft^3).
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 contaminates, or contaminants deleterious to proper compaction.

2.5 BASE COURSE ROCK

A. As specified in Section 32 11 00, BASE COURSE.

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 Section 32 11 00, BASE COURSE.

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 23.19 – 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 13 13 – Portland Cement Concrete Paving.
   3. Section 33 41 19 – Pipe Laying.

1.2 GENERAL

A. General Requirements: See Division 01 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 prosed 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 C33, gradation 67, commonly known as ASTM #67. The gradation shall be as follows:

ASTM #67 Gradation	
Sieve Size	Percent Passing
1 in.	100
3/4 in.	90-100
3/8 in.	20-55
No. 4	0-10
No. 8	0-5

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 and Section 33 41 19.

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 prosed 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. Concrete Pavement: Replace settled areas or fill with concrete as specified in Section 32 13 13,.

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 32 00 - SOIL EROSION STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to minimize erosion and comply with Storm Water Pollution Prevention Plan.

1.2 STABILIZATION

A. Soil Erosion Stabilization:
   1. Ground surfaces exposed during the wet weather conditions:
   2. Areas which will not be subjected to heavy wear by ongoing construction traffic.
   3. Temporary and long term stabilization of new or disturbed ditches, swales, detention ponds, or disturbed ground with intermittence construction traffic.

B. Permanent Stabilization:
   1. Permanently stabilize exposed soil surfaces at finished grades.
   2. Permanent stabilization methods include, but are not limited to, seeding (permanent), mulching, and landscaping.
   3. Immediately perform permanent stabilization at each completed excavation and areas except for areas that are scheduled to be redisturbed.
   4. Incorporate all permanent erosion control features into the project at the earliest practical time.

C. Buffer Zone: Undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a disturbed area that reduces erosion and runoff.

D. Standard Specifications: The latest edition, including supplements, of the Texas Department of Transportation Standard Specifications for Highway Construction.

1.3 SUBMITTALS

A. Shop Drawings: Product Data for the following items:
   1. Erosion control rock.
   2. Fertilizer.
   3. Seed.
   4. Mulch.
   5. Erosion control rock.
   6. Soil tackifier
   7. Reinforced plastic covering.
   8. Silt fence.
   9. Straw bales.
   10. Posts for straw bales.
   11. Dust controller.
   12. Wire mesh.

B. See Section 01 33 00.

1.4 DELIVERY, STORAGE, AND PROTECTION

A. General: Prevent or reduce the discharge of pollutants to stormwater from all material delivery and storage by minimizing the storage of hazardous materials storing materials in a designated

area, installing Secondary containment, conducting regular inspection, and training employees and subcontractors.

B. Seed:
   1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
   2. Keep dry during storage.

C. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.5 SEQUENCING AND SCHEDULING

A. Install erosion and sediment control devices before starting earth disturbance activities and as drainage facilities get constructed.

B. Complete Soil Preparation: Seeding, fertilizing, mulching and matting on disturbed areas that will require stabilization either because the area has reached final grade (permanent landscaping) or because the area will remain unworked for over 14 days (temporary seeding) during the wet season.

C. Notify Engineer at least 3 days in advance of:
   1. Materials delivery.
   2. Start of stabilization activity.

D. Seeding: Perform between March 15 and September 15.

1.6 MAINTENANCE

A. Operations:
   1. Seeded Areas: Perform during maintenance period to include:
      a. Watering: Keep seeded surface moist.
      b. Washouts: Repair by filling with topsoil, fertilizing, seeding, and mulching.
      c. Mulch: Replace wherever and whenever washed or blown away.
      d. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
      e. Reseed during next planting season if scheduled end of maintenance period falls after September 15.
      f. Reseed entire area if satisfactory stand does not develop by July 1 of the following year.
      g. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
   2. Inspect, repair, and replace as necessary all erosion control measures during the time period from start of construction to completion of construction.
   3. Inspect a minimum of at least once every 7 days or after a 1/2-inch storm event in a 24-hour period.
   4. Furnish and install a rain gauge at the project site to monitor rainfall. At no time shall more than 1-foot depth of sediment be allowed to accumulate in any erosion control device.

B. Sediment Removal:
   1. Remove sediment from erosion control devices and work into the grading plan at least once a week as required to maintain proper operation of devices. The cleaning operation shall not dispose of sediment offsite.

2. Sediment shall be removed and the controls upgraded or repaired as needed as soon as practicable, but not later than 2 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair operations.
3. In the event of continuous rainfall over a 24 hour period, or other circumstances that preclude equipment operation in the area, hand carry and install additional sediment controls as approved by the Engineer.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

B. Fertilizer shall have the following minimum percentage of plant food by weight:
1. Summer Hydroseed Mix:
   a. Nitrogen: 20 percent.
   b. Phosphoric Acid: 10 percent.
   c. Potash: 10 percent.
2. Winter Hydroseed Mix:
   a. Nitrogen: 16 percent.
   b. Phosphoric Acid: 8 percent.
   c. Potash: 0 percent.

2.2 SEED

A. Common bermudagrass meeting the requirements of Section 735 of the Texas Department of Transportation Standard Specifications for Highway Construction.

2.3 MULCH

A. Wood Cellulose Fiber Mulch:
1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form a homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

B. Straw:
1. Clean salt hay or threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds. Suitable for spreading with mulch blower equipment.
2. Average Stalk Length: 6 inches.
3. Seasoned before baling or loading.

2.4 EROSION CONTROL MATTING

A. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.

B. Manufacturers and Products:
1. American Excelsior Company, Dallas, TX; Curlex Mat.
2. North American Green, Evansville, IN; S150 blanket.

2.5 REINFORCED PLASTIC COVERING

A. Co-extruded, copolymer laminate reinforced with a nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.

B. Black in color and ultraviolet stabilized.

C. Physical Requirement (Minimum Average Roll Values):
   1. Tear Strength: 130 pounds.
   2. Elongation: 620 percent.
   3. Minimum Thickness: 6 mil.

D. Manufacturers:
   1. Reef Industries, Inc., Houston, TX.
   2. Griffolyn Co., Houston, TX.

2.6 SILT FENCE

A. Support Posts: As recommended by manufacturer of geotextile.

B. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

C. Filter Fabric: Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.
   1. Filaments: Resistant to damage from exposure to ultraviolet rays and heat.
   2. Material Edges: Finish so that, filaments retain their relative positions under stress.

D. In accordance with requirements of Table No. 1:

Table No. 1 – Filter Fabric

Physical Property	Required Value	Test Method
Weight, pz/sq yd, min.	4	ASTM D3776
Equivalent Opening Size, max.	50-70	U.S. Standard Sieve
Grab Tensile Strength, lb, min. ARV	160	ASTM D4632
Elongation, % max.	25	ASTM D1682
Mullen Burst Strength, psi, min. ARV	200	ASTM D3786
Ultraviolet Radiation Resistance, % Strength Retention	70	ASTM D4355
Flow Rate, gpm/sf, min. ARV	30 to 50	ASTM D4491

E. Manufacturers:
   1. Polyfelt, Evergreen, AL.
   2. Dupont Co., Wilmington, DE.

3. Mirafi, Inc., Charlotte, NC.

2.7 STRAW BALES

A. Machine baled clean salt hay or straw of oats, wheat, barley, or rye, free from seed of noxious weeds, using standard baling wire or string.

2.8 POSTS FOR STRAW BALES

A. 2-inch by 2-inch untreated wood or commercially manufactured metal.

2.9 DUST CONTROLLER

A. Nontoxic materials that do not have an adverse effect on soil structure or establishment and growth of vegetation.

PART 3 - EXECUTION

3.1 GENERAL

A. Erosion control measures are required during all construction and site disturbance activity and shall remain until permanent site ground covers are in place.

B. The implementation of the erosion control plan and the construction maintenance, replacement and upgrading the erosion control devices are the responsibility of the Contractor until all construction is completed and landscaping established and approved. During the construction period, the erosion control devices shall be upgraded for unexpected storm events and to ensure that sediment and sediment laden water do not leave the site.

C. Maintain existing buffer zones adjacent to project limits. Keep all construction equipment, debris and soils out of the natural buffer zone.

3.2 GRAVEL CONSTRUCTION ENTRANCES

A. Provide a graveled construction access at each access point between the site and any public or private road or other paved surface.

B. Place subgrade geotextile, as specified, on the ground prior to erosion control rock placement.

C. Place erosion control rock over the geotextile to a minimum thickness of 8 inches.

D. Minimum dimensions for construction entrances are 50-foot in length by 16-foot width.

E. Contractor shall provide a minimum of 4 inches of erosion control rock for each entrance 3 times during the project at times directed by the Engineer to maintain proper function. More frequent applications of rock may be required, and if so, shall be considered as incidental work.

3.3 SOIL PREPARATION

A. Before start of hydroseeding, and after surface has been shaped and graded, and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 inch.

3.4 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 1-inch of soil.

B. Application Rate: 5 pounds per 1,000 square foot over areas to be seeded. Use of approved hydraulic equipment to sow seed and distribute fertilizer at the same time will be acceptable.

3.5 SEEDING

A. Prepare 1-inch depth seed bed; obtain Engineer's acceptance prior to proceeding.

B. Apply by hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.

C. Summer Application:
1. Prepare and apply slurry as follows:

Item	Rate
Seed Mix	200 pounds per acre
Fertilizer	750 pounds per acre
Wood Cellulose Fiber Mulch	As recommended by manufacturer
Water	As necessary

2. Irrigation: 1-inch per week to seeded areas.

3.6 MULCHING

A. Apply uniformly on disturbed areas that will remain undisturbed for 7 days or more, as requested by Engineer, and on all seeded areas.

B. Application: Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.
1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.
2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

3.7 EROSION CONTROL MATTING

A. Place on seeded slopes 4H:1V and steeper.

B. Apply seed and fertilizer prior to matting.

C. At top of slope, entrench material in a 6-inch by 6-inch trench and staple at 1-foot intervals. At the bottom of the slope, extend the mat 2 feet beyond the toe of slope, turn material under 4 inches and staple at 1-foot intervals.

D. Mats shall be stapled in place as they are installed down the slope face. The mat shall have direct contact with the soil surface.

E. Overlap:
1. Lengthwise: 1-foot minimum.
2. Crosswise: 6-inches minimum.

3.8 REINFORCED PLASTIC COVERING

A. Place on areas where hydroseeding and erosion control matting have not controlled erosion and over all temporary stockpiles.

B. Install in single thickness, strips parallel to direction of drainage. Anchor plastic in 6-inch by 6-inch trench backfilled with compacted native material.

C. Maintain tightly in place by using sand bags on ropes with a maximum 10-foot grid spacing in all directions.

D. Tape or weight down full length, overlap seams at least 12 inches.

E. Remove at final acceptance unless notified otherwise by Engineer.

3.9 SILT FENCE

A. Install prior to starting earth disturbing activities upslope of fence.

B. One-piece filter fabric or continuously sewn to make one-piece filter fabric for full height of the fence, including portion buried in the toe trench.

C. When joints are necessary, splice filter fabric together only at a support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.

D. Filter fabric shall not extend more than 24 inches above the ground surface. Securely fasten to upslope side of each support post using ties. Filter fabric shall not be stapled to existing trees.

E. Fasten wire mesh material support fence securely to upslope side of post fasteners. Extend wire into the trench a minimum of 4 inches, and not more than 36 inches above the ground surface.

F. Take precaution not to puncture filter fabric during installation. Repair or replace damaged area.

G. Remove silt fence after upslope area has been permanently stabilized. Immediately dress sediment deposits remaining after the silt fence has been removed to conform to existing grade. Prepare and seed graded area.

3.10 TEMPORARY SOIL STOCKPILES

A. Cover with reinforced plastic covering, as directed in Article REINFORCED PLASTIC COVERING.

B. Protect perimeter of stockpile from erosion with ditches.

3.11 STRAW BALES

A. Embed minimum of 4 inches in flat-bottomed trench. Place across swales or ditches to reduce velocities of concentrated flows. Space bales a minimum of 100-foot spacing.

B. Place with ends tightly abutting or overlapped. Corner abutment is not acceptable.

C. Install so that bale bindings are oriented around the sides and not over the top and bottom of the bale.

D. Use two posts for each bale. Drive posts through the bale until top of post is flush with top of bale.

E. Wedge loose straws in any gaps between bales.

3.12 DUST CONTROL

A. Apply appropriate dust control measures on a continuous basis until permanent stabilization measures are in place.

B. Apply on construction routes and other disturbed areas subject to surface dust movement and where off-site damage may occur if dust is not controlled.

C. Avoid creating erosion when using water as a dust controller.

3.13 CLEAN-UP

A. Sediment trapped in erosion control devices shall be regraded into the slopes on the site. Do not flush sediment-laden water into the drainage system.

B. After site restoration is complete and when approved by the Engineer, all temporary erosion control measures shall be completely removed. Immediately shape and permanently stabilize areas affected by the removal process.

C. Silt fence, straw bales, reinforced plastic covering, and any other erosion control devices shall be disposed off site to locations that are approved by federal, state, and local authorities.

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 sharing, 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.

END OF SECTION

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 32 10 00 - CONCRETE SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to install concrete sidewalk.

B. Related sections:
1. Section 03 30 00 – Cast-In-Place Concrete.

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 C94, Standard Specification for Ready Mixed Concrete.
b. ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
c. ASTM D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
2. American Association of State Highway and Transportation Officials (AASHTO): T 99, The Moisture-Density Relations of Soils Using a 5.5 pound (2.5 kg) Rammer and a 12-inch (305 mm) Drop.
3. American Concrete Institute (ACI): ACI Guide for Measuring, Mixing, Transporting, and Placing Concrete.
4. Standard Specification: The latest edition, including supplements of the [Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

1.3 SUBMITTALS

A. Shop Drawings:
1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Quality Control Submittals:
1. Curing Compound: Manufacturer’s Certificate of Compliance and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

PART 2 - PRODUCTS

2.1 EXPANSION JOINT FILLER

A. 1/2-inch thick, preformed asphalt-impregnated, expansion joint material meeting ASTM D994.

2.2 CONCRETE

A. As specified in Section 03 30 00.

B. Maximum Aggregate Size: 1-1/2-inch.

C. Slump: 2 to 4 inches.

2.3 CURING COMPOUND

A. Liquid membrane-forming, clear or translucent, suitable for and meeting ASTM C309, Type 1.

PART 3 - EXECUTION

3.1 FORMWORK

A. Lumber Materials:
   1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed sidewalk.
   2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:
   1. Construct forms to shape, lines, grades, and dimensions.
   2. Stake securely in place.

D. Bracing:
   1. Brace forms to prevent change of shape or movement resulting from placement.
   2. Construct short-radius curved forms to exact radius.

E. Tolerances:
   1. Do not vary tops of forms from gradeline more than 1/8-inch when checked with 10-foot straightedge.
   2. Do not vary alignment of straight sections more than 1/8-inch in 10 feet.

3.2 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.3 SIDEWALK CONSTRUCTION

A. Thickness:
   1. 4 inches in walk areas.
   2. 6 inches in driveway areas.

B. Connection to Existing Sidewalk:
   1. Remove old concrete back to an existing contraction joint.
   2. Clean the surface.
   3. Apply a neat cement paste immediately prior to placing new sidewalk.

C. Expansion Joints: Place at building corners and changes in sidewalk width around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

D. Contraction Joints:
   1. Provide transversely to walks at locations opposite contraction joints in curb.
   2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
   3. Construct straight and at right angles to surface of walk.

E. Finish:
   1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
   2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
   3. Apply curing compound to exposed surfaces upon completion of finishing.
   4. Protect sidewalk from damage and allow to cure for at least 7 days.

3.4 SLAB CONSTRUCTION ON GRADE

A. Thickness: Four inches or as shown.

B. Contraction Joints:
   1. As shown on Drawings.
   2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
   3. Construct straight and at right angles to surface of slab.

C. Finish:
   1. Broom surface with fine-hair broom and tool of edges, joints, and markings.
   2. Apply curing compound to exposed surfaces upon completion of finishing.
   3. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION

SECTION 32 11 00 - BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to install base course.

B. Related sections:
1. Section 31 22 13 – Subgrade Preparation.

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. T 89, Standard Method for Determining the Liquid Limit of Soils.
b. T 90, Determining the Plastic Limit and Plasticity Index of Soils.
c. T 96/ASTM C131, Standard Method for Resistance to Degradation of Small Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
d. T 99, Standard Methods of Test for the Moisture-Density Relations of Soils Using a 5.5 pound (2.5 kg) Rammer and a 12-inch (305 mm) Drop.
e. T 180, Standard Methods of Test for the Moisture-Density Relations of Soils Using a 10 pound (4.54 kg) Rammer and an 18-inch (457 mm) Drop.
f. T 191, Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.
g. T 238, Standard Method of Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform surface reasonably true to cross- section.

C. Standard Specifications: 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. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to project.
2. Certified Results of In-Place Density Tests from independent testing agency.

PART 2 - PRODUCTS

2.1 BASE COURSE ROCK

A. As specified for Type A, Grade 2 of Item 247 of the Standard Specifications.

2.2 SOURCE QUALITY CONTROL

A. Contractor: tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on materials' test results on installed materials.

C. Should separation of course from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 - EXECUTION

3.1 PREPARATION

A. As specified in Section 31 22 13, SUBGRADE PREPARATION.

B. Obtain Engineer’s acceptance of subgrade before placement of base course rock.

C. Do not place base materials in snow or on soft, muddy, or frozen subgrade.

3.2 EQUIPMENT

A. In accordance with Section 3 of Item 247 of the Standard Specifications.

B. Compaction Equipment: Adequate in design and number to provide compaction and obtain the specified density for each layer.

3.3 HAULING AND SPREADING

A. Hauling Materials:
1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Measure capacity of truck to determine vehicle load and quantity.
4. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:
1. Distribute material to provide required density, depth, grade and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.4 CONSTRUCTION OF COURSES

A. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.

B. Base Course:
1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:

a. Use base 1/4-minus crushed aggregate material as keystone.
b. Spread evenly on top of crushed base course, using spreader boxes or chip spreaders.
c. Roll surface until keystone is worked into interstices of crushed base course without excessive displacement. ,
d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.

6. Blade or broom surface to maintain true line, grade, and cross-section.

3.5 ROLLING AND COMPACTION

A. Blade or otherwise work existing surface as necessary to achieve a smooth and thoroughly compacted surface.

B. Commence compaction of each layer of base after spreading operations and continue until density of 100 percent of maximum density has been achieved as determined by AASHTO T 99.

C. Commence rolling at outer edges of surfacing and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain densities.

E. Place and compact each lift to required density before succeeding lift is placed.

F. Bind up preceding course before placing leveling course. Remove floating or loose stone from surface.

G. Blade or otherwise work surfacing as necessary to maintain grade and cross- section at all times, and to keep surface smooth and thoroughly compacted.

H. Surface Defects: Remedy surface defects by loosening and rerolling entire area, including surrounding surface, until thoroughly compacted.
1. Finished Surface: True to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

A. Finished Surface of Base Course: Within plus or minus 0.04-foot of grade shown at any individual point.

B. Overall Average: Within plus or minus 0.01-foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

A. In-Place Density Tests:
1. Construct base course so areas shall be ready for testing.
2. Allow reasonable length of time for testing laboratory to perform tests and obtain results during normal working hours.
3. Show proof that areas meet specified requirements before identifying density test locations.
4. Perform a minimum of 2 tests on completed course per 200 cubic yards of material placed in accordance with T 191, or T 238 at locations acceptable to Engineer.

B. Cleaning
1. Remove excess material; clean stockpile areas of aggregate.

END OF SECTION

SECTION 32 13 13 - PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Concrete sidewalks, curbs and gutters and aprons.

B. Related sections:
1. Section 01 33 00 – Submittal Procedures.
2. Section 03 30 00 – Cast-in-Place Concrete.
3. Section 07 92 00 – Joint Sealants.
4. Section 32 11 00 – Base Course.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI):
a. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
b. ACI 301 – Specifications for Structural Concrete for Buildings
c. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
d. ACI 305R – Hot Weather Concreting
e. ACI 306R – Cold Weather Concreting
2. American Society for Testing and Materials (ASTM):
a. ASTM A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
b. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
c. ASTM C33 – Standard Specification for Concrete Aggregates
d. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
e. ASTM C94– Standard Specification for Ready Mixed Concrete
f. ASTM C150 – Standard Specification for Portland Cement
g. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
h. ASTM C309- Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
i. ASTM C494– Standard Specification for Chemical Admixtures for Concrete
j. ASTM C685 – Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
k. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
l. ASTM D1752 – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

1.3 SUBMITTALS

A. See Section 01 33 00 for submittal procedures.

B. Product Data: Provide data on joint filler, admixtures, and curing compound.

C. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301.

B. Obtain cementitious materials from same source throughout.

C. Follow recommendations of ACI 305R when concreting during hot weather.

D. Follow recommendations of ACI 306R when concreting during cold weather.

1.5 ENVIRONMENTAL REQUIRMENTS

A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Form Materials: conform to ACI 301.

B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
1. Thickness: 1/2 inch.

2.2 REINFORCEMENT

A. Reinforcing Steel: ASTM A615 / A615M Grade 60 (420); deformed billet steel bars; unfinished finish.

B. Steel Welded Wire Reinforcement: Plain type, ASTM A185; in flat sheets; unfinished.

C. Dowels: ASTM A615 Grade 60 (420); deformed carbon steel bars; unfinished finish.

2.3 CONCRETE MATERIALS

A. Concrete Materials: As specified in Section 03 30 00.

2.4 ACCESSORIES

A. Curing Compound: ASTM C309, Type 1, Class A.

2.5 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations. Refer to Civil Plans and Specifications for site concrete design.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
1. For trial mixtures method, employ independent testing agency acceptable to Owners Representative for preparing and reporting proposed mix designs.

C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

D. Concrete Properties:
   1. Refer to Construction Documents.

2.6 MIXING

A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

B. Transit Mixers: Comply with ASTM C94 / C94M.

PART 3 - EXECUTIONS

3.1 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

A. Prepare subbase in accordance with the Texas Department of Transportation (TxDOT).

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

3.4 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 REINFORCEMENT

A. Place reinforcement as indicated.

B. Place dowels to achieve pavement and curb alignment as detailed.

3.6 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.

C. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

D. Apply surface retarder to all exposed surfaces in accordance with manufacturer’s instructions.

3.7 JOINTS

A. Place control and expansion joints as indicated on drawings.

B. Place control and expansion joints and edge of new concrete to align with existing joints beyond.

C. Evenly space joint patterns not dimensioned on plans. Align joints with corners of masonry where shown on plans.

D. Place joint filler between new sidewalks and building or adjacent saw cut paving.

3.8 FINISHING

A. Sidewalk and Ramp Paving: Light broom, texture perpendicular to pavement direction.

B. Place during compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.9 JOINT SEALING

A. See Section 07 92 00 for joint sealant requirements.

3.10 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch in 10 feet.

B. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests.
   1. Provide free access to concrete operations at project site and cooperate with appointed firm.
   2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
   3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

B. Compressive Strength Tests: ASTM C39 / C39M. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
   1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
   2. Perform one slump test for each set of test cylinders taken.

C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures and mechanical injury.

B. Do not permit pedestrian traffic over pavement until 75 percent design strength of concrete has been achieved.

END OF SECTION

SECTION 32 92 19 - SEEDING, FERTILIZING, AND MULCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fertilizer.

B. Mulch.

C. Seed.

D. Preparation.

E. Maintenance.

1.2 RELATED SECTIONS

A. Section 31 22 19.

B. Section 31 23 16.

C. Section 31 11 00.

1.3 ALTERNATE METHODS AND PRODUCTS

A. 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.

1.4 DEFINITIONS

A. Weeds: 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.

1.5 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.6 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.

1.7 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.

1.8 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 vegetive 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:

Seed Type	% Mix (By Wt.)	Purity %	Germination %
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.

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: 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: 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: 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 11 11 – PIPING LEAKAGE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work, materials, and procedures required to test installed piping other than gravity sewer piping.

B. Related sections:
   1. Section 01 33 00 – Submittal Procedures.
   2. Section 40 23 39 – Process Piping General.

C. See Section 40 23 39 which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.2 SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00. The following specific information shall be provided:
   1. Quality Control Submittals:
      a. Testing Plan: Submit at least 30 days prior to testing and include at least the information that follows.
         1). Testing dates.
         2). Piping systems and sections(s) to be tested.
         3). Test type.
         4). Method of isolation.
         5). Calculation of maximum allowable leakage for piping sections(s) to be tested.
      b. Certifications of Calibration: Testing equipment.
      c. Certified Test Report.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:
   1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
   2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
   3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
   4. New Piping connected to Existing Piping:
      a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
      b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
   5. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.
   6. Test Pressure: As indicated on the Piping Schedule.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:
1. Perform test as specified hereinafter.
2. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
3. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.2 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Test piping as indicated in pipe schedule.

B. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

C. Exposed Piping:
1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 feet per second, applied over full area of pipe.
3. Vent piping during filling: Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning.

D. Buried Piping:
1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{S\,D\,\sqrt{P}}{148{,}000}$$

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])

7. Correct leakage greater than allowable, and retest as specified.

3.3 PNEUMATIC TEST FOR PRESSURE PIPING

A. Test piping as indicated in pipe schedule.

B. Do not perform on:
1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

C. Fluid: Oil-free, dry air.

D. Procedure:
   1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.
   2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
   3. Gradually increase pressure in system to half of specified test pressure. Thereafter increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
   4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
   5. Correct visible leakage and retest as specified.

E. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

F. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.4 HYDROSTATIC TEST FOR 18-INCH THROUGH 30-INCH GRAVITY PIPING.

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon of water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Exfiltration Test:
   1. Hydrostatic Head:
      a. At least 6 feet above maximum estimated groundwater level in section being tested.
      b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
   2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

D. Infiltration Test:
   1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered *defective* even if pipe previously passed a leakage test.

F. *Defective* Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.5 PNEUMATIC TEST FOR GRAVITY PIPING 12-INCH AND SMALLER

A. Equipment:
   1. Calibrate gauges with standardized test gauge at start of each testing day.
   2. Install gauges, air piping manifolds, and valves at ground surface.
   3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
   4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:
   1. Require that no person enter manhole where pipe is under pressure.

2. Slowly introduce air into pipe section until internal air pressure reached 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered *defective* when time required for pressure to decrease from 3.5 to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed utilizing values from following table:

D.

TABLE 1*

A	B	C	D	E	F
Pipe Diameter (Inches)	**Time per Foot up to Length in Col C (Seconds)**	**Test Length (Feet)**	**Test Time for any Length Between Col C & E**	**Length at Which time in Col F Applies (Feet)**	**Time per Foot for Total Length (Seconds)**
	0.18	636	1:54	1.114	0.10
	0.40	424	2:50	743	0.23
	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67

EXAMPLE: 15-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec – 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50

* Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered *defective* even if pipe previously passed a leakage test.

F. *Defective* Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.6 JOINT TESTING FOR 36-INCH AND LARGER GRAVITY PIPING

A. The Contractor shall develop a numbering system for the pipeline joints so that the test logs can be tied to the tested joint.

B. The Contractor shall develop a test system that allows the Engineer reasonable access for witnessing the joint testing. The contractor shall submit his proposed testing plan to the Engineer for approval prior to the start of testing.

C. Pressurize the void at the joint with air to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Allow the air pressure and temperature to stabilize before shutting off the air supply, and start of test timing. If pressure holds, or drops less than 1 psi in 5 seconds, the joint is acceptable.

D. If there is any visible leakage within the pipeline after the joint testing, repairs will be required before the pipeline is accepted.

3.7 FIELD QUALITY CONTROL

A. Test Report Documentation:
   1. Test date.
   2. Description and identification of piping tested.
   3. Test fluid.
   4. Test pressure.
   5. Remarks, including:
      a. Leaks (type, location).
      b. Repair/replacement performed to remedy excessive leakage.
   6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

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 11 11– Piping Leakage Testing

1.2 GENERAL

A. General Requirements: See Division 01 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.

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.

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 11 11.

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 theses 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 NON-FERROUS PIPE

A. Non-ferrous pipe includes PVC, Polyethylene and FRP.

B. Bedding material shall be as specified in Section 31 23 23.19.

C. 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 6-inches over the top of pipe and fittings.

D. 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.

E. Place bedding a minimum of 6-inches over the top of pipe and fittings. Bedding shall be compacted to 95% maximum density.

F. 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.

G. 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 PIPE BEDDING DUCTILE IRON PIPE

A. Bedding material shall be as specified in Section 31 23 23.19.

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.

3.9 TRENCH BACKFILL

A. Shall be as specified in Section 31 23 23.19.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14 WATER AND SEWER LINE CROSSINGS

A. Water and sewer lines crossing one another shall have a minimum 18-inch - 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 as specified in Section 33 31 13.

C. Water lines shall not pass through manholes.

3.15 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.

3.16 TESTING

A. Acceptance testing for gravity lines and force mains shall conform to Section 33 11 11.

3.17 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.

3.18 TRENCHING

A. Pipe trenching shall be as specified in Section 31 23 16.16.

3.19 CONNECTIONS TO MANHOLES

A. Pipe connections to concrete manholes and other concrete structures shall be as specified in Section 33 39 13, CONCRETE MANHOLES

3.20 STEEL ENCASEMENT

A. Pipe installed within steel encasement shall conform to Section 33 31 13.

END OF SECTION

DIVISION 40

PROCESS INTEGRATION

SECTION 40 05 13 - COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one section of Division 40 and includes joining materials, piping specialties, and basic piping installation instructions.

B. Related Sections:
1. Piping materials and installation methods peculiar to individual systems are specified within their respective system specification sections of Division 40.
2. Valves are specified in a separate section and in individual piping system sections of Division 40.
3. Supports and Anchors are specified in a separate section of Division 40.
4. Mechanical Identification is specified in a separate section of Division 40.
5. Fire Barrier Penetration Seals are specified in Division 07.

1.2 SUBMITTALS

A. Refer to Division 01 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:
1. Escutcheons
2. Dielectric Unions and Fittings
3. Mechanical Sleeve Seals

C. Quality Control Submittals:
1. Submit welders' certificates specified in Quality Assurance below.

1.3 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.1.0 - Standard Code for Pressure Piping, Power Piping, and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering piping materials and specialties which may be incorporated in the work include, but are not limited to, the following:

B. Pipe Escutcheons:
1. Chicago Specialty Mfg. Co.
2. Sanitary-Dash Mfg. Co.
3. Grinnell

C. Dielectric Waterway Fittings:
1. Epco Sales, Inc.
2. Victaulic Company of America

D. Dielectric Unions:
1. Eclipse, Inc.
2. Perfection Corp.
3. Watts Regulator Co.

E. Mechanical Sleeve Seals:
1. Thunderline Corp.

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 15 for specifications on piping and fittings relative to that particular system.

2.3 JOINING MATERIALS

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

C. Soldering Materials: Refer to individual piping system specifications for solder appropriate for each respective system.

D. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Waterway Fittings: electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

E. Sleeves:
   1. Sheet-Metal Sleeves: 10 gauge, galvanized sheet metal, round tube closed with welded longitudinal joint.
   2. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A.
   3. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
   1. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
   2. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
   3. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
   4. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
   5. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
   6. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

B. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.

C. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 07 for special sealers and materials.

3.3 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.

D. Install unions adjacent to each valve and at the final connection to each piece of equipment and plumbing fixture having 2" and smaller connections, and elsewhere as indicated.

E. Install Flanges in piping 2-1/2" and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

F. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).

G. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).

3.4 JOINTS

A. Steel Pipe Joints:
1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
2. Pipe Larger Than 2": Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
3. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
4. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.1.0 Code for Pressure Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints
1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0 - Standard Code for Pressure Piping, Power Piping and ANSI B9.1 - Standard Safety Code for Mechanical Refrigeration.
2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine Emory cloth prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4" and smaller.

D. Joints for other piping materials are specified within the respective piping system sections.

3.5 FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

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 33 11 11 – Piping Leakage Testing.
8. Section 33 13 00 – Disinfection of Water Systems.
9. Section 40 41 13 – Heat Tracing.
10. Section 40 24 00 – Process Piping Specialties.
11. Section 40 42 00 – Process Mechanical Insulation.

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 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.l0M.
   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.

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.

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.

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.

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.

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.
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.

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 Section 33 13 00.

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.

3.13 PIPE IDENTIFICATION

A. See Section 22 05 53 and 09 90 00.

3.14 INSULATION

A. See Section 40 42 00.

3.15 HEAT TRACING

A. See Section 40 41 13, HEAT TRACING.

3.16 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified. See Section 33 11 11.

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.

3.17 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are a part of this Specification.
   1. Piping Schedule.
   2. Data Sheets.

END OF SECTION

SECTION 40 23 39.1 SUPPLEMENT
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
Water, Potable	W, WL	Buried Exposed	ALL	PVC	40 23 39.43	Ambient	125	200, H	Blue	2,4
Liquid Ammonium Sulfate	LAS	Exposed Buried	ALL	PE Tubing PE Tubing (PVC Encased)	40 23 39.60	Ambient	100	115, H		2,4,5,6
Sodium Hypochlorite	SHP	Exposed Buried	ALL	PVC Tubing PVC Tubing (PVC Encased)	40 23 39.60	Ambient	100	115, H	Yellow	2,4,5,6

Notes:

1 Exposed - Inside/Outside Exposed
Submerged
Buried - Directly into Soil
Encased

2 > Greater Than
< Less Than
<= Less Than or Equal To
>= Greater Than or Equal To

3 CLDI - Cement Lined Ductile Iron
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

4 H - Hydrostatic Test
P - Pneumatic Test
G - Gravity Piping
See Section 33 11 11 for Piping Leakage Testing for requirements.
Pipe testing required as specified above

5 See Section 09 90 00 for required painting.
For buried piping, no color shall be required; coordinate for proper coatings, as necessary.
Where no color is indicated, color to be selected by Owner.
For exposed piping not coated, provide colored banding and identification.

6 General - Deviations from this schedule are indicated directly by note on Drawings where deviation is required.

7 General - The piping material shall conform to the requirements for the service listed being drained or vented

Remarks:

1 See 40 41 13 for Heat Tracing requirements.
2 Insulate piping, fittings, valve bodies, flanges, and pipe couplings (do not insulate flexible pipe couplings and expansion joints). Also, insulate vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3 Insulation shall meet the requirements of materials specified in Section 23 07 13.
4 Heat tracing and insulation required as specified on the drawings and specifications above.
5 All buried LAS and SHP shall be in PVC encased.
6 Where buried PVC piping transitions to exposed PVC/PE tubing, the buried PVC piping shall be extended at least six (6) inches above the finished floor/grade before transitioning to exposed PVC/PE tubing.
7 See Section 40 23 39 for additional requirements.

END OF SECTION

SECTION 40 23 39.43 DATA SHEET POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 23447-B conforming to ASTM D1785-05. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule 80 PVC as specified above: Conforming to the requirements of ASTM D2467.
Joints	All	Solvent socket-weld except where connection to valves and equipment may require future disassembly. Threaded joints shall not be used unless specifically approved by ENGINEER
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1-89 drilling.
Bolting	All	Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M-94 Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8" thick. Raised Face Mating Flange: Flat ring 1/8" thick, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gasket material shall be suitable for each service. Submit recommended gasket material for each service to ENGINEER.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A. Solvent cement shall be rated for use with each service. Provide manufacturer's certification that the solvent is appropriate for respective service.
Thread Lubricant	All	Teflon Tape

END OF SECTION

SECTION 40 23 39.60 – DATA SHEET REINFORCED PVC TUBING			
Item	**Description**		
Pipe	PVC tubing with braided polyethylene reinforcement. Tubing shall comply with the regulations of the FDA for materials used with potable water or in contact with food products. Tubing shall have a constant wall thickness with the interior surface glossy smooth.		
Material	**Property**	**Value or Rating**	**ASTM method**
	Minimum Working Pressure	200 psi (@ 70 deg F) 110 psi (@ 160 deg F)	
	Minimum Safety Factor	3:1	
	Minimum Burst Pressure	645 psi	
	Max Operating Temperature	165 + degrees F	
	Brittle Temperature	- 50 degrees F	D746-98
	Durometer Hardness (Shore)	80A (+/-5)	D2240-02
	Tensile Strength	2,500 psi	D412-98
	Ultimate Elongation	320%	D412-98
	Specific Gravity	1.2	D792-98
	Water Adsorption	0.12%	D570-98
Fittings	Barbed PVC with SST hose clamps.		

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 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. 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.

B. Maintenance Summary Forms: As specified in Section 01 78 23.

PART 2 - PRODUCTS

2.1 GENERAL

A. Valve to include hand wheel, chain wheel, extension stern, 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 REQUIRMENTS 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, 'l'F±. 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.

1). Stem Packing: Manually adjustable while valve is under pressure.
2). 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.
3). Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
4). 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 mechanicalmeans 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 pentrations, 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 spring. 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 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.
5. 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.
6. 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 sic closure rate.
   b. Manufacturer:
      1). DeZurik.
      2). Val-Matic.
      3). Crispin Valve.
7. 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.
8. 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.
9. 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
10. 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.

11. 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.

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 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.

9. 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

10. 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:
George Fisher.
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:
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 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.

5. 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.

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.

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.

END OF SECTION

SECTION 40 41 13 – HEAT TRACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Basic requirements for heat tracing including:
   1. Heating Cables.
   2. Control Panels.
   3. Temperature Sensors.
   4. Temperature Controllers.
   5. Contactors.
   6. Enclosures.
   7. All other auxiliary equipment and controls required to complete a heat tracing system.

B. Related 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.
   3. 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 01 33 00 – Submittal Procedures.
      b. Section 23 07 13 – Mechanical Insulation.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standards Institute (ANSI).
   2. American Society for Testing and Materials (ASTM):
      a. B193 – Standard Test Method for Resistivity of Electrical Conductor Materials.
      b. D2633 – Standard Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable.
   3. Factory Mutual Research Corp. (FM).
   4. Institute of Electrical and Electronic Engineers (IEEE):
      a. IEEE P515 – Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
      b. IEEE 622 – Design & Installation of Electric Heat Tracing SY.
   5. International Electro-Mechanical Commission (IEC).
   6. National Electrical Manufacturers' Association (NEMA):
      a. 1CS1-110.
   7. National Fire Protection Association (NFPA):
      a. NFPA 70 – National Electric Code (NEC).
   8. Occupational Safety and Health Standards (OSHA).
   9. Underwriters' Laboratories, Inc. (UL):
      a. UL 746B – Polymeric Materials – Long Term Property Evaluations.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00.

B. Product Data:

1. Catalog number, wattage output, voltage rating, and product data.
2. Installation instructions.
3. Warranty.

C. Shop Drawings: Include isometric drawings for each heat traced pipe showing installation details, and size and type of heat tracing cable.
1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements and Reference Standards: The electric heat tracing system shall conform to this specification and shall be designed, manufactured, and tested in accordance with the minimum applicable requirements of the latest edition of the following codes and standards. Additional specific requirements shall be further defined in the testing requirements for each section.

1.5 WARRANTY

A. Cables: All cables shall be warranted for a period of 10 years for manufacturing defects.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Requirements:
1. General: Heat tracing applications up to a maintain temperature of 250 degrees Fahrenheit and intermittent exposure to 420 degrees Fahrenheit shall us self-regulating heating cables and pads.
2. Self-regulating heating cable shall vary its heat output relative to the temperature of the surface of the pipe or the tank allowing cable to be crossed over itself without overheating and to be cut to length in the field.
3. Design for a useful life of 20 years or more with "power on" continuously. The criteria for life shall be to retain at least 75 percent of its original power when tested according to UL 746B.

B. Design Heating Load: Sodium Hydroxide service use 75°. All other services use 50° column.

Nominal Pipe Size (in)	50° Column Heat Trace Minimum Capacity (watts/ft)	75° Column Heat Trace Minimum Capacity (watts/ft)
1/4	1.9	2.9
1/2	2.5	3.9
3/4	2.9	4.5
1	2.2	3.4
1-1/4	2.5	3.9
1-1/2	2.8	4.3
2	3.2	5.0
2-1/2	3.8	5.8
3	4.4	6.8
3-1/2	3.6	5.5
4	3.9	6.0
6	5.3	8.2
8	6.7	10.3

Nominal Pipe Size (in)	50° Column Heat Trace Minimum Capacity (watts/ft)	75° Column Heat Trace Minimum Capacity (watts/ft)
10	8.1	12.5
12	7.3	11.3
14	7.9	12.2
16	8.9	13.8
18	8.2	12.6
20	9.0	13.9
24	10.6	16.3

2.2 HEAT TRACING CABLE

A. Self-regulating and self-limiting, 5 watts per foot, 120 volts, 60 hertz, flexible twin 16 AWG copper bus wires, with tinned copper braid overshield.

B. Manufacturers: One of the following or equal:
1. Raychem Chemelex Auto-Trace.
2. Chromalox Type SLR Rapid Trace.
3. Thermon, BSX.
4. Nelson, CLT or LT.

2.3 CONTROLLER

A. Manufacturer: One of the following or equal:
1. Raychem Monitrace1000.

B. Operating Characteristics:
1. Controller shall provide continuous monitoring of heat tracing circuit analyzing temperature through a hard-wired RTD.
2. Controller shall energize system automatically if the temperature drops below a preset point. Controller shall be equipped with local alarm to alert maintenance personnel if heat trace circuit is interrupted.
3. Controller shall have the capability of performing a self-diagnostic check on the system and advising maintenance personnel of the exact nature of any circuit problems.

C. Controller shall be fully compatible with heat trace and provided by same manufacturer as heat trace.
1. Controller shall be powered from 208 VAC. A configurable dry contact shall be provided for heat trace fault.
2. Controller shall have double pole solid state switching, temperature control from -40°F to 125° F and a 30-amp rating from -40° F to 125° F, ambient temperature.
3. Power Supply: Controller power supply shall be either 110-240 VAC with adjustable ground fault detection.
4. Controller shall have battery backup system to retain programmed parameters in the event of a power failure.
5. Enclosure: Unit shall be enclosed in a NEMA 4X panel.
6. Network Capabilities: Controller shall have network capabilities enabling monitoring and programming from a central location.

2.4 SECURING TAPE

A. Plastic Piping Systems:
1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
a. Raychem; AT-180.

b. Thermon; AL-20L.
c. Nelson; AT-50

B. Metallic Piping Systems:
1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
a. Raychem; GS54.
b. Thermon; PF-l.

2.5 CONNECTION KITS, END SEALS, SPLICE AND TEE KITS

A. Heat trace connection, end, splice and tee kits shall be designed to meet or exceed the life of the heat trace and shall be given equal consideration and evaluation.

2.6 ACCESSORIES

A. Power connection kits.
1. Manufacturer and Products:
a. Raychem; JBM-100-L-E.
b. Thermon; TBX-3LC.
c. Nelson; PLT-BC.

B. Termination kits.

C. Splice kits.
1. Manufacturer and Products:
a. Raychem; S-150.
b. Thermon; SCTK.
c. Nelson; PLT-BS.

D. End seal kits.
1. Manufacturer and Products:
a. Pentair Raychem; E-100-A, E-100-L-A.
b. Thermon; ET -6C.
c. Nelson HEC-100 or SLT-E.

E. Straps.

F. Thermostat.
1. Ambient Thermostat:
a. To be used with all services unless noted otherwise.
b. Type: Adjustable setting (15 °F to 140 °F).
c. Sensor: Fluid-filled probe.
d. Enclosure: Epoxy-coated NEMA 4X.
e. Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.
f. Manufacturers and Products:
1) Raychem; Model AMC-1A.
2) Thermon; B4X-15140.
3) Raychem; Model AMC-1H for hazardous areas.
4) Nelson; TX-4X140
2. Pipe Mounted Thermostat:
a. Type: Fixed, non-adjustable, sodium hydroxide service set at 75°F, all other services set at 50°F.
b. Sensor: Fluid-filled with 3-foot capillary.
c. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.

d. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.
e. Manufacturers and Products:
   1). Raychem; Model AMC-F5.
   2). Nelson; TF-4x40.
   3). Raychem; Model E507S for hazardous areas.
   4). Nelson; TF-4X40

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install in accordance with the Manufacturer's instructions and recommended practices.
   2. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
   3. Wiring between power-connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
   4. Install and test prior to installation of piping insulation as specified in Section 23 07 13.

B. Install heat tracing cable on piping subject to freezing in the following areas and as indicated on the Drawings:
   1. Heat trace and insulate all exposed sample water piping per Drawing 10-C102, 10-M303, 20-C102, and 20-M901
   2. Heat trace and insulate 20EWS01 and all water pipe outside per Drawing 20-M131

C. Electrical Heating Tape:
   1. Determine required length of electrical heating tape by considering length of circuit and number and type of fittings and fixtures, design heating load, and heating tape output.
   2. Where design heating load exceeds heating tape capacity, install by spiraling.
   3. De-rate heating tape capacity when installed on plastic piping.
   4. Wrap heat tracing tape with aluminum tape prior to installing insulation.
   5. Install heat tape and controls in accordance with manufacturer's published installation instructions.
   6. Install on services as indicated on the Piping Schedule and as shown on the Drawings.
   7. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

D. Install pipe insulation as specified in Section 23 07 13.

E. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 °F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

F. Thermostat:
   1. Thermostat shall be powered by 120 VAC.
   2. One single 120-volt power source will be provided to the heat tracing control system panel as indicated on the Drawings.
   3. Thermostats will be powered from the control panel box by the Contractor.
   4. Install in accordance with Manufacturer's instructions and as approved by Engineer.
   5. For each group of heat traced circuit, install one ambient thermostat.

3.2 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.
   1. Insulation Resistance: Minimum 1,000 megohm per 1,000 feet.

B. Manufacturer's Field Service.
   1. Inspect installed systems for proper installation.
   2. Instruct Owner's personnel on operations and maintenance of the systems.

END OF SECTION


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