SECTION 5
SPECIFICATIONS

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Contract description.
3. Contractor's use of Site.
4. Work sequence.
5. Work restrictions.
6. Owner occupancy.
7. Permits.
8. Specification conventions.

B. Related Requirements:

1. Section 013216 - Construction Progress Schedule: Digital project management procedures and web-based project management software package.
2. Section 015000 - Temporary Facilities and Controls: Limitations and procedures governing temporary use of Owner's facilities.
3. Section 017000 - Execution and Closeout Requirements: Coordination of Owner-installed products.
4. Section 018113 - Sustainable Design Requirements.

1.2 PROJECT INFORMATION

A. Name: Conneaut WWTP NFA Improvements

1. Project Location: Conneaut WWTP, 1206 Broad Street Extension, Conneaut, Ohio 44030

B. Owner: City of Conneaut

1. Owner's Representative: Brian Bidwell, WWTP Superintendent

C. Project Architect/Engineer: CT Consultants, Inc.

1. Architect's/Engineer's Representative: Georgia Conway, P.E.

1.3 CONTRACT DESCRIPTION

A. No Feasible Alternatives (NFA) Analysis and Improvements
1. These improvements are the result of a No Feasible Alternatives (NFA) analysis that evaluated technical alternatives to bypassing wet weather influent flows at the WWTP.

2. The selected alternative in the NFA was enhanced secondary treatment, expanding the plant's secondary treatment hydraulic capacity for wet weather flow treatment.
3. The peak wet-weather flow (10-year 2-hour storm) determined in the NFA is 10 MGD.
4. The existing WWTP headworks facility is capable of treating this entire flow but the primary clarifiers are not. A portion of the flow will bypass the primary clarifiers directly to aeration.

B. Project Overview
1. This project generally includes the following:
   a. Construction of a third clarifier to match the existing two.
   b. RAS pump replacement
   c. Construction of a new UV disinfection system in the existing chlorine contact tank.

C. Final Settling
1. A new, third clarifier will be constructed to match the existing two.
2. Internal components of the existing two clarifiers will be replaced to standardize the mechanisms across all three clarifiers.

D. RAS Pumping
1. The existing airlift pumps will be replaced with progressive cavity pumps.
2. The pumps motors will be equipped with VFDs and flow meters for flow pacing to maintain the F/M ratio.

E. UV Disinfection
1. A new UV system will be constructed in the existing chlorine contact tanks.
2. The UV system will be sized to treat 10.3 MGD.

1.4 CONTRACTOR'S USE OF SITE

A. Limits on Use of Site: Limit use of Project Site to Work in areas indicated. Do not disturb portions of Project Site beyond areas in which the Work is indicated.

1. Limit use of Site to allow:

   a. Owner occupancy.

2. Driveways, Walkways, and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

   a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
   b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on Site.

B. Utility Outages and Shutdown:

1. Coordinate and schedule electrical and other utility outages with Owner.
2. Outages: Allow only at previously agreed upon times.

3. At least one week before scheduled outage, submit outage request plan to Owner itemizing dates, times, and duration of each requested outage.

C. Construction Plan: Before start of construction, submit construction plan regarding access to Work, use of Site, and utility outages for acceptance by Owner. After acceptance of plan, construction operations shall comply with accepted plan unless deviations are accepted by Owner in writing.

1.5 WORK SEQUENCE

A. Construct Work in order to accommodate Owner's occupancy requirements during construction period. Coordinate construction schedule and operations with the Architect/Engineer and Owner.

B. Sequencing of Construction Plan: Before start of construction, post electronic file to Project website of construction plan regarding phasing of demolition and new Work for acceptance by Owner. After acceptance of plan, comply with accepted plan when coordinating construction sequencing unless deviations are accepted by Owner in writing.

1.6 WORK RESTRICTIONS

A. Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction (AHJ).

B. On-Site Work Hours: Limit Work to between 7 a.m. to 5 p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and AHJ.

C. On-Site Work Day Restrictions: Do not perform Work resulting in utility shutdowns or resulting in noisy activity on Site during Work blackout days indicated by Owner.

D. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions, and only after arranging for temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Obtain Owner’s written permission before proceeding with utility interruptions.

E. Noise, Vibration, Dust, and Odors: Coordinate with Owner operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy.

1. Notify Owner not less than two days in advance of proposed disruptive operations.
2. Obtain Owner’s written permission before proceeding with disruptive operations.

1.7 OWNER OCCUPANCY

A. Owner will occupy Site during entire period of construction for conduct of normal operations.

B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

C. Schedule Work to accommodate Owner occupancy.

1.8 PERMITS

A. Furnish necessary permits (as applicable) for construction of Work, including the following:

1. Building permit: See specification section 014126 – General Regulations and Permits
2. Stormwater permit.
3. Dewatering permit.

1.9 SPECIFICATION CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.

B. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations scheduled on the Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality assurance.

B. Product options.

C. Product substitution procedures.

1.2 QUALITY ASSURANCE

A. Contract is based on products and standards established in Contract Documents without consideration of proposed substitutions.

B. Products specified define standard of quality, type, function, dimension, appearance, and performance required. The Contractor shall prepare his bid on the particular materials and equipment specified.

C. Substitution Proposals: Permitted for specified products except where specified otherwise. Do not substitute products unless substitution has been accepted and approved in writing by Owner. Following the award of the contract, should the Contractor desire to use other equipment and materials, he shall submit to the Owner a written request for such change and state the advantage to the Owner and the savings or additional cost involved by the proposed substitution. The determination as to whether or not such change will be permitted rests with the Owner and the Engineer. Do not substitute products unless substitution has been accepted and approved in writing by the Owner.

D. Each major item of equipment shall be inspected by a manufacturer’s representative during installation and upon completion of work. The Contractor shall supply the Engineer with a certificate of such inspection.

1.3 PRODUCT OPTIONS

A. See Section 016000 - Product Requirements.

1.4 PRODUCT SUBSTITUTION PROCEDURES

A. Document each request with complete data, substantiating compliance of proposed substitution with Contract Documents, including:

1. Manufacturer's name and address, product, trade name, model, or catalog number, performance and test data, and reference standards.

2. Itemized point-by-point comparison of proposed substitution with specified product, listing variations in quality, performance, and other pertinent characteristics.
3. Reference to Article and Paragraph numbers in Specification Section.
4. Cost data comparing proposed substitution with specified product and amount of net change to Contract Sum.
5. Changes required in other Work.
6. Availability of maintenance service and source of replacement parts as applicable.
7. Certified test data to show compliance with performance characteristics specified.
8. Samples when applicable or requested.
9. Other information as necessary to assist Architect/Engineer's evaluation.

B. A request constitutes a representation that Contractor:

1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
2. Will provide same warranty for substitution as for specified product.
3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension that may subsequently become apparent.
5. Will coordinate installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects.
6. Will reimburse Owner for review or redesign services associated with reapproval by authorities having jurisdiction.

C. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals without separate written request or when acceptance will require revision to Contract Documents.

D. Substitution Submittal Procedure:

1. Submit requests for substitutions on CSI Form 13.1A Substitution Request-After the Bidding/Negotiating Stage.
2. Submit electronic files to engineer of Request for Substitution for consideration. Limit each request to one proposed substitution.
3. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
4. Architect/Engineer will notify Contractor in writing of decision to accept or reject request.

END OF SECTION 012500

SECTION 013000 - ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Coordination and Project conditions.

B. Preconstruction meeting.

C. Site mobilization meeting.

D. Progress meetings.

E. Preinstallation meetings.

F. Closeout meeting.

G. Alteration procedures.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various Sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify that utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate Work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

1. Coordination Drawings: Prepare as required to coordinate all portions of Work. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided or to function as intended. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important.

D. Coordination Meetings: In addition to other meetings specified in this Section, hold coordination meetings with personnel and Subcontractors to ensure coordination of Work.

E. In finished areas, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of Work of separate Sections in preparation for Substantial Completion.

G. After Owner's occupancy of premises, coordinate access to Site for correction of defective Work and Work not complying with Contract Documents, to minimize disruption of Owner's activities.

1.3 PRECONSTRUCTION MEETING

A. Engineer will schedule and preside over meeting after Notice of Award.

B. Attendance Required: Architect/Engineer, Owner, and Contractor.

C. Minimum Agenda:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of Subcontractors, list of products, schedule of values, and Progress Schedule.
5. Designation of personnel representing parties in Contract, and Architect/Engineer.
6. Communication procedures.
7. Procedures and processing of requests for interpretations, field decisions, field orders, submittals, substitutions, Applications for Payments, proposal request, Change Orders, and Contract closeout procedures.
8. Scheduling.
9. Critical Work sequencing.

D. Construction Manager: Record minutes and distribute to participants within two days after meeting, to Architect/Engineer, Owner, and those affected by decisions made.

1.4 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.

B. Contractor: Make arrangements for meetings, prepare agenda with copies for participants, and preside over meetings.

C. Attendance Required: Contractor, Job superintendent, major Subcontractors and suppliers, and Architect/Engineer, Owner, as appropriate to agenda topics for each meeting.

D. Minimum Agenda:

1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems impeding planned progress.
5. Review of submittal schedule and status of submittals.
6. Review of off-Site fabrication and delivery schedules.
7. Maintenance of Progress Schedule.
8. Corrective measures to regain projected schedules.

9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on Progress Schedule and coordination.
13. Other business relating to Work.

E. Contractor: Record minutes and distribute to participants within two days after meeting, to Architect/Engineer, Owner, and those affected by decisions made.

1.5 PREINSTALLATION MEETINGS

A. When required in individual Specification Sections, convene preinstallation meetings at Project Site before starting Work of specific Section.

B. Require attendance of parties directly affecting, or affected by, Work of specific Section.

C. Notify Architect/Engineer four days in advance of meeting date.

D. Prepare agenda and preside over meeting:

1. Review conditions of installation, preparation, and installation procedures.
2. Review coordination with related Work.

E. Record minutes and distribute to participants within two days after meeting to Architect/Engineer, Owner, and those affected by decisions made.

1.6 CLOSEOUT MEETING

A. Schedule Project closeout meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meeting and be responsible for minutes.

B. Attendance Required: Contractor, major Subcontractors, Architect/Engineer, Owner, and others appropriate to agenda.

C. Notify Architect/Engineer four days in advance of meeting date.

D. Minimum Agenda:

1. Start-up of facilities and systems.
2. Operations and maintenance manuals.
3. Testing, adjusting, and balancing.
4. System demonstration and observation.
5. Operation and maintenance instructions for Owner's personnel.
6. Contractor's inspection of Work.
7. Contractor's preparation of an initial "punch list."
8. Procedure to request Architect/Engineer inspection to determine date of Substantial Completion.
9. Completion time for correcting deficiencies.
10. Inspections by authorities having jurisdiction.
11. Certificate of Occupancy and transfer of insurance responsibilities.

12. Partial release of retainage.
13. Final cleaning.
14. Preparation for final inspection.
15. Closeout Submittals:

    a. Project record documents.
    b. Operating and maintenance documents.
    c. Operating and maintenance materials.
    d. Affidavits.

16. Final Application for Payment.
17. Contractor's demobilization of Site.
18. Maintenance.

E. Record minutes and distribute to participants within two days after meeting, to Architect/Engineer, Owner, and those affected by decisions made.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 ALTERATION PROCEDURES

A. Entire facility will be occupied for normal operations during progress of construction. Cooperate with Owner in scheduling operations to minimize conflict and to permit continuous usage.

1. Perform Work not to interfere with operations of occupied areas.
2. Keep utility and service outages to a minimum and perform only after written approval of Owner.
3. Clean Owner-occupied areas daily. Clean spillage, overspray, and heavy collection of dust in Owner-occupied areas immediately.

B. Materials: As specified in product Sections; match existing products with new products for patching and extending Work.

C. Employ skilled and experienced installer to perform alteration and renovation Work.

D. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion. Comply with Section 017000 - Execution and Closeout Requirements

E. Remove unsuitable material not marked for salvage, including rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.

F. Remove debris and abandoned items from area and from concealed spaces.

G. Prepare surface and remove surface finishes to permit installation of new Work and finishes.

H. Close openings in exterior surfaces to protect existing Work from weather and extremes of temperature and humidity.

I. Remove, cut, and patch Work to minimize damage and to permit restoring products and finishes to original or specified condition.

J. Where new Work abuts or aligns with existing Work, provide smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

K. When finished surfaces are cut so that smooth transition with new Work is not possible, terminate existing surface along straight line at natural line of division and submit recommendation to Architect/Engineer for review.

L. Patch or replace portions of existing surfaces that are damaged, lifted, discolored, or showing other imperfections.

M. Finish surfaces as specified in individual product Sections.

END OF SECTION 013000

SECTION 013216 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. Bar chart schedules.

D. Review and evaluation.

E. Updating schedules.

F. Distribution.

1.2 DIGITAL PROJECT DATA LICENSING

A. Architect's/Engineer's Data Files Not Available: Architect/Engineer will not provide Architect's/Engineer's CAD drawing digital data files for Contractor's use during construction.

1.3 SUBMITTALS

A. Immediately after signing the Contract, the Contractor shall prepare a graphic progress schedule, indicating the work to be executed during each month and the rate of expected progress to secure completion on the agreed upon completion date. The progress schedule shall be approved by the Engineer and Owner prior to starting work on the site. Schedule updates and narrative progress reports shall be furnished to the Engineer with each requisition for payment.

B. Schedule Updates:

1. Overall percent complete, projected and actual.
2. Completion progress by listed activity and sub-activity, to within five days prior to submittal.
3. Changes in Work scope and activities modified since submittal.
4. Delays in submittals or resubmittals, deliveries, or Work.
5. Adjusted or modified sequences of Work.
6. Other identifiable changes.
7. Revised projections of progress and completion.

C. Narrative Progress Report:

1. Submit with each submission of Progress Schedule.
2. Summary of Work completed during the past period between reports.

3. Work planned during the next period.
4. Explanation of differences between summary of Work completed and Work planned in previously submitted report.
5. Current and anticipated delaying factors and estimated impact on other activities and completion milestones.
6. Corrective action taken or proposed.

1.4 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel specializing in CPM scheduling with experience in scheduling construction work of complexity comparable to the Project.

B. Contractor's Administrative Personnel: Experience in using and monitoring CPM schedules on comparable Projects.

1.5 BAR CHART SCHEDULES

A. Format: Bar chart Schedule, to include at least:
   1. Identification and listing in chronological order of those activities reasonably required to complete the Work, including:
      a. Subcontract Work.
      b. Major equipment design, fabrication, factory testing, and delivery dates including required lead times.
      c. Move-in and other preliminary activities.
      d. Equipment and equipment system test and startup activities.
      e. Project closeout and cleanup.
      f. Work sequences, constraints, and milestones.
   2. Listings identified by Specification Section number.
   3. Identification of the following:
      a. Horizontal time frame by year, month, and week.
      b. Duration, early start, and completion for each activity and subactivity.
      c. Critical activities and Project float.
      d. Subschedules to further define critical portions of Work.

1.6 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of schedules with Architect/Engineer at each submittal.

B. Evaluate Project status to determine Work behind schedule and Work ahead of schedule.

C. After review, revise schedules incorporating results of review, and resubmit within 10 days.

1.7 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update schedules to depict current status of Work.

C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

D. Upon approval of a Change Order, include the change in the next schedule submittal.

E. Indicate changes required to maintain Date of Substantial Completion.

F. Submit sorts as required to support recommended changes.

G. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect.

1.8 DISTRIBUTION

A. Following joint review, distribute copies of updated schedules to Contractor's Project site file, Subcontractors, suppliers, Architect/Engineer, Owner, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 013216

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Definitions.

B. Submittal procedures.

C. Construction progress schedules.

D. Proposed product list.

E. Product data.

F. Shop Drawings.

G. Samples.

H. Other submittals.

I. Design data.

J. Test reports.

K. Certificates.

L. Manufacturer's instructions.

M. Manufacturer's field reports.

N. Erection Drawings.

O. Construction photographs.

P. Contractor review.

Q. Architect/Engineer review.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect/Engineer's responsive action.

B. Informational Submittals: Written and graphic information and physical Samples that do not require Architect/Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

A. Transmit each submittal with Architect/Engineer-accepted form.

B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.

C. Identify: Project, Contractor, Subcontractor and supplier, pertinent Drawing and detail number, and Specification Section number appropriate to submittal.

D. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.

E. Schedule submittals to expedite Project, and deliver to Architect/Engineer through Newforma Info Exchange.
   1. Newforma Info Exchange is a web-based system for the Contractor to download data and submit information to the Engineer.
   2. Newforma Info Exchange does not provide Contractor with tools for generating logs, distributing documents or collaborating with Subcontractors. It is the responsibility of the Contractor to manage documentation independently with Subcontractors.
   3. There is no additional cost to the Contractor or Owner to access Newforma Info Exchange via a web browser.

F. For each submittal for review, allow 21 days excluding delivery time to and from Contractor.

G. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.

H. Allow space on submittals for Contractor and Architect/Engineer review stamps.

I. When revised for resubmission, identify changes made since previous submission.

J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

K. Submittals not requested will not be recognized nor processed.

L. Incomplete Submittals: Architect/Engineer will not review. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Architect/Engineer.

M. Requests for substitution will be based on a case-to-case bases. Substitution requests shall be submitted with adequate information that justifies that the substitution is an equal or superior product. Failure to supply adequate information will be cause to reject the substitution requests submittal. Review of resubmitted substitution requests will not be recognized or processed.

1.4 CONSTRUCTION PROGRESS SCHEDULES

A. Comply with Section 013216 - Construction Progress Schedule

1.5 PROPOSED PRODUCT LIST

A. Within 15 days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

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

1.6 PRODUCT DATA

A. Product Data: Action Submittal: Submit to Architect/Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents.

B. Submit electronic submittals via Newforma Info Exchange as PDF electronic files.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 017000 - Execution and Closeout Requirements.

1.7 SHOP DRAWINGS

A. Shop Drawings: Action Submittal: Submit to Architect/Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer responsible for designing components shown on Shop Drawings.

1. Include signed and sealed calculations to support design.
2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. Submit electronic submittals via Newforma Info Exchange as PDF electronic files.

E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 017000 - Execution and Closeout Requirements.

1.8 SAMPLES

A. Samples: Action Submittal: Submit to Architect/Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Samples for Selection as Specified in Product Sections:

1. Submit to Architect/Engineer for aesthetic, color, and finish selection.
2. Submit Samples of finishes, textures, and patterns for Architect/Engineer selection.

C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.

D. Include identification on each Sample, with full Project information.

E. Submit number of Samples specified in individual Specification Sections; Architect/Engineer will retain one Sample.

F. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

G. Samples will not be used for testing purposes unless specifically stated in Specification Section.

H. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 017000 - Execution and Closeout Requirements.

1.9 OTHER SUBMITTALS

A. Closeout Submittals: Comply with Section 017000 - Execution and Closeout Requirements.

B. Informational Submittal: Submit data for Architect/Engineer's knowledge as Contract administrator or for Owner.

C. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

1.10 TEST REPORTS

A. Informational Submittal: Submit reports for Architect/Engineer's knowledge as Contract administrator or for Owner.

B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.11 CERTIFICATES

A. Informational Submittal: Submit certification by manufacturer, installation/application Subcontractor, or Contractor to Architect/Engineer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product but must be acceptable to Architect/Engineer.

1.12 MANUFACTURER'S INSTRUCTIONS

A. Informational Submittal: Submit manufacturer's installation instructions for Architect/Engineer's knowledge as Contract administrator or for Owner.

B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Architect/Engineer in quantities specified for Product Data.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.13 MANUFACTURER'S FIELD REPORTS

A. Informational Submittal: Submit reports for Architect/Engineer's knowledge as Contract administrator or for Owner.

B. Submit report 5 days of observation to Architect/Engineer for information.

C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.14 ERECTION DRAWINGS

A. Informational Submittal: Submit Drawings for Architect/Engineer's knowledge as Contract administrator or for Owner.

B. Submit Drawings for information assessing conformance with information given and design concept expressed in Contract Documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by Architect/Engineer or Owner.

1.15 CONSTRUCTION PHOTOGRAPHS

A. Provide photographs of Site and construction throughout progress of Work produced by an experienced photographer acceptable to Architect/Engineer.

B. Submit photographs with Application for Payment.

C. Take photographs as evidence of existing Project conditions as follows:

D. Identify each print. Identify name of Project, orientation of view, date and time of view, name and address of photographer, and photographer's numbered identification of exposure.

E. Digital Images: Deliver complete set of digital image electronic files to Owner with Project record documents. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as sensor, uncropped.

1. Digital Images: Uncompressed TIFF format, produced by digital camera with minimum sensor size of 4.0 megapixels, and image resolution of not less than 1024 by 768 pixels.
2. Date and Time: Include date and time in filename for each image.

1.16 CONTRACTOR REVIEW

A. Review for compliance with Contract Documents and approve submittals before transmitting to Architect/Engineer Construction Manager.

B. Contractor: Responsible for:

1. Determination and verification of materials including manufacturer's catalog numbers.
2. Determination and verification of field measurements and field construction criteria.
3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
4. Determination of accuracy and completeness of dimensions and quantities.
5. Confirmation and coordination of dimensions and field conditions at Site.
6. Construction means, techniques, sequences, and procedures.
7. Safety precautions.
8. Coordination and performance of Work of all trades.

C. Stamp, sign or initial, and date each submittal to certify compliance with requirements of Contract Documents.

D. Do not fabricate products or begin Work for which submittals are required until approved submittals have been received from Architect/Engineer.

1.17 ARCHITECT/ENGINEER REVIEW

A. Do not make "mass submittals" to Architect/Engineer. "Mass submittals" are defined as six or more submittals or items in one day or 20 or more submittals or items in one week. If "mass submittals" are received, Architect/Engineer's review time stated above will be extended as necessary to perform proper review. Architect/Engineer will review "mass submittals" based on priority determined by Architect/Engineer after consultation with Owner and Contractor.

B. Informational submittals and other similar data are for Architect/Engineer's information, do not require Architect/Engineer's responsive action, and will not be reviewed or returned with comment.

C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

D. Submittal approval does not authorize changes to Contract requirements unless accompanied by Change Order, Field Order, or Construction Change Directive.

E. Owner may withhold monies due to Contractor to cover additional costs beyond the second submittal review.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality control.

B. Tolerances.

C. References.

D. Labeling.

E. Mockup requirements.

F. Testing and inspection services.

G. Manufacturers' field services.

1.2 QUALITY CONTROL

A. Monitor quality control over suppliers, manufacturers, products, services, Site conditions, and workmanship, to produce Work of specified quality.

B. Comply with specified standards as the minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

C. Perform Work using persons qualified to produce required and specified quality.

D. Products, materials, and equipment may be subject to inspection by Architect/Engineer and Owner at place of manufacture or fabrication. Such inspections shall not relieve Contractor of complying with requirements of Contract Documents.

E. Supervise performance of Work in such manner and by such means to ensure that Work, whether completed or in progress, will not be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

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' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. 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.

B. Conform to reference standard by date of issue current as of date for receiving Bids except where specific date is established by code.

C. Obtain copies of standards and maintain on Site when required by product Specification Sections.

D. When requirements of indicated reference standards conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

E. Neither contractual relationships, duties, or responsibilities of parties in Contract nor those of Architect/Engineer shall be altered from Contract Documents by mention or inference in reference documents.

1.5 LABELING

A. Attach label from agency approved by authorities having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.

B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label:

1. Model number.
2. Serial number.
3. Performance characteristics.

C. Manufacturer's Nameplates, Trademarks, Logos, and Other Identifying Marks on Products: Not allowed on surfaces exposed to view in public areas, interior or exterior.

1.6 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in individual product Specification Sections.

B. Assemble and erect specified or indicated items with specified or indicated attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mockups shall be comparison standard for remaining Work.

D. Where mockup has been accepted by Architect/Engineer and is specified in product Specification Sections to be removed, remove mockup and clear area when directed to do so by Architect/Engineer.

1.7 TESTING AND INSPECTION SERVICES

A. Employ and pay for services of an independent testing agency or laboratory acceptable to Owner to perform specified testing.

1. Before starting Work, submit testing laboratory name, address, and telephone number, and names of full-time Professional Engineer and/or specialist and responsible officer.
2. Submit copy of report of laboratory facilities' inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.

B. Independent firm will perform tests, inspections, and other services specified in individual Specification Sections and as required by Architect/Engineer.

1. Laboratory: Authorized to operate in State of Ohio.
2. Laboratory Staff: Maintain full-time Professional Engineer and/or specialist on staff to review services.
3. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

C. Testing, inspections, and source quality control may occur on or off Project Site. Perform off-Site testing as required by Architect/Engineer or Owner.

D. Reports shall be submitted by independent firm to Architect/Engineer, Contractor, and authorities having jurisdiction, indicating observations and results of tests and compliance or noncompliance with Contract Documents.

1. Submit final report indicating correction of Work previously reported as noncompliant.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

1. Notify Architect/Engineer and independent firm 24 hours before expected time for operations requiring services.
2. Make arrangements with independent firm and pay for additional Samples and tests required for Contractor's use.

F. Employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work according to requirements of Contract Documents.

G. Retesting or re-inspection required because of nonconformance with specified or indicated requirements shall be performed by same independent firm on instructions from Architect/Engineer. Payment for retesting or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

H. Agency Responsibilities:

1. Test Samples of mixes submitted by Contractor.
2. Provide qualified personnel at Site. Cooperate with Architect/Engineer and Contractor in performance of services.

3. Perform indicated sampling and testing of products according to specified standards.
4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
5. Promptly notify Architect/Engineer and Contractor of observed irregularities or nonconformance of Work or products.
6. Perform additional tests required by Architect/Engineer.
7. Attend preconstruction meetings and progress meetings.

I. Agency Reports: After each test, promptly submit report to Architect/Engineer, Contractor, and authorities having jurisdiction. When requested by Architect/Engineer, 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 Specification Section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

J. Limits on Testing Authority:

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.

1.8 MANUFACTURER'S FIELD SERVICES

A. When specified in individual Specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe Site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, testing, adjusting, and balancing of equipment, commissioning and as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Architect/Engineer 30 days in advance of required observations. Observer is subject to approval of Architect/Engineer.

C. Report observations and Site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions.

D. Refer to Section 013300 - Submittal Procedures, "Manufacturer's Field Reports" Article.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 014000

SECTION 014126 - GENERAL REGULATIONS AND PERMITS

PART 1 - GENERAL

1.1 REGISTRATION

All Contractors shall be registered with the Ashtabula County Building Department. Contact the Building Department for additional registration information.

1.2 PERMITS & PLAN REVIEWS

The Contractor shall apply for and pay for all permits and plan review fees from the Ashtabula County Building Department or other authorities having jurisdiction.

1.3 ARCHAEOLOGICAL DISCOVERIES

Contractors and subcontractors are required under O.R.C. Section 149.53, to notify the Ohio Historical Society and the Ohio Historic Site Preservation Board of Archaeological Discoveries located in the project area, and to cooperate with those entities in archaeological and historic surveys and salvage efforts if such discoveries are uncovered within the project area.

Contact: Ohio's State Historic Preservation Office
Diana Welling, Resource Protection & Review Department Manager
Phone: 1-614-298-2000
Email: dwelling@ohiohistory.org

Should archaeological discoveries or other activities delay progress of the work, an adjustment in contract time will be made.

END OF SECTION 014126

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:

1. Temporary electricity.
2. Temporary lighting for construction purposes.
3. Temporary heating.
4. Temporary cooling.
5. Temporary ventilation.
6. Temporary water service.
7. Temporary sanitary facilities.

B. Construction Facilities:

1. Field offices and sheds.
2. Parking.
3. Progress cleaning and waste removal.
4. Project identification.

C. Temporary Controls:

1. Barriers.
2. Security.
3. Water control.
4. Dust control.
5. Erosion and sediment control.
6. Noise control.
7. Pollution control.

D. Removal of utilities, facilities, and controls.

1.2 REFERENCES

A. ASTM International:

1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
3. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

1.3 TEMPORARY ELECTRICITY

A. Owner will pay cost of energy used. Exercise measures to conserve energy. Use Owner's existing power service.

B. Do not disrupt Owner's use of service.

1.4 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain incandescent lighting for construction operations to achieve minimum lighting level of 2 watts/sq ft.

B. Provide and maintain 1 watt/sq ft to exterior staging and storage areas after dark for security purposes.

C. Provide and maintain 0.25 HID lighting to interior work areas after dark for security purposes.

D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, lamps, and the like, for specified lighting levels.

E. Maintain lighting and provide routine repairs.

F. Permanent building lighting may be used during construction.

1.5 TEMPORARY HEATING

A. Provide temporary heating devices and heat as needed to maintain specified conditions for construction operations.

B. Owner will pay cost of temporary heat. Exercise measures to conserve energy.

1.6 TEMPORARY COOLING

A. Provide temporary cooling devices and cooling as needed to maintain specified conditions for construction operations.

B. Owner will pay cost of temporary cooling. Exercise measures to conserve energy.

1.7 TEMPORARY VENTILATION

A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.8 TEMPORARY WATER SERVICE

A. Owner will pay cost of temporary water. Exercise measures to conserve energy. Use Owner's existing water system, extended and supplemented with temporary devices as needed to maintain specified conditions for construction operations.

B. Extend branch piping with outlets located so that water is available by hoses with threaded connections.

1.9 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide facilities at time of Project mobilization.

1.10 PARKING

A. If Site space is not adequate, provide additional off-Site parking.

1.11 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain Site in clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, before enclosing spaces.

C. Broom and vacuum clean interior areas before starting surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and rubbish from Site periodically and dispose of off-Site. Comply with Section 017419 - Construction Waste Management and Disposal.

1.12 PROJECT IDENTIFICATION

A. Project Identification Sign:

1. One painted sign of construction, design, and content shown on Drawings, location designated.

1.13 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to allow for Owner's use of Site, and to protect existing facilities and adjacent properties from damage from construction operations.

B. Protect non-owned vehicular traffic, stored materials, Site, and structures from damage.

1.14 SECURITY

A. Security Program:

1. Protect Work on existing premises and Owner's operations from theft, vandalism, and unauthorized entry.

1.15 WATER CONTROL

A. Grade Site to drain. Maintain excavations free of water. Provide, operate, and maintain necessary pumping equipment.

B. Protect Site from puddles or running water.

1.16 DUST CONTROL

A. Execute Work by methods that minimize raising dust from construction operations.

B. Provide positive means to prevent airborne dust from dispersing into atmosphere and into Owner-occupied areas.

1.17 EROSION AND SEDIMENT CONTROL

A. Plan and execute construction by methods to control surface drainage from cuts and fills from borrow and waste disposal areas. Prevent erosion and sedimentation.

B. Minimize surface area of bare soil exposed at one time.

C. Provide temporary measures including berms, dikes, drains, and other devices to prevent water flow.

D. Construct fill and waste areas by selective placement to avoid erosive surface silts and clays.

E. Periodically inspect earthwork to detect evidence of erosion and sedimentation. Promptly apply corrective measures.

F. Comply with sediment and erosion control plan indicated on Drawings.

1.18 NOISE CONTROL

A. Provide methods, means, and facilities to minimize noise produced by construction operations.

1.19 POLLUTION CONTROL

A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances and pollutants produced by construction operations.

B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.20 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, and materials before Final Application for Payment inspection.

B. Remove underground installations to minimum depth of 2 feet. Grade Site as indicated on Drawings.

C. Clean and repair damage caused by installation or use of temporary Work.

D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Product delivery requirements.

C. Product storage and handling requirements.

D. Product options.

1.2 PRODUCTS

A. At minimum, comply with specified requirements and reference standards.

B. Specified products define standard of quality, type, function, dimension, appearance, and performance required.

C. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise. Confirm that manufacturer's production capacity can provide sufficient product, on time, to meet Project requirements.

D. Do not use materials and equipment removed from existing premises except as specifically permitted by Contract Documents.

E. Furnish interchangeable components from same manufacturer for components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Comply with delivery requirements in Section 017419 - Construction Waste Management and Disposal.

B. Transport and handle products according to manufacturer's instructions.

C. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

D. Provide equipment and personnel to handle products; use methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products according to manufacturer's instructions.

B. Store products with seals and labels intact and legible.

C. Store sensitive products in weathertight, climate-controlled enclosures in an environment suitable to product.

D. For exterior storage of fabricated products, place products on sloped supports aboveground.

E. Provide off-Site storage and protection when Site does not permit on-Site storage or protection.

F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

H. Provide equipment and personnel to store products; use methods to prevent soiling, disfigurement, or damage.

I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Products complying with specified reference standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and complying with Specifications; no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit Request for Substitution for any manufacturer not named, according to Section 012500 - Substitution Procedures.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 016000

SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Examination.

B. Preparation.

C. Field engineering.

D. Execution.

E. Cutting and patching.

F. Protecting installed construction.

G. Starting of systems.

H. Demonstration and instruction.

I. Closeout procedures.

J. Project record documents.

K. Manual for materials and finishes.

L. Manual for equipment and systems.

M. Spare parts and maintenance products.

N. Product warranties and product bonds.

O. Final cleaning.

1.2 EXAMINATION

A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual Specification Sections.

D. Verify that utility services are available with correct characteristics and in correct locations.

1.3 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

1.4 FIELD ENGINEERING

A. Employ land surveyor registered in State of Ohio.

B. Locate and protect survey controls and reference points. Promptly notify Architect/Engineer of discrepancies discovered.

C. Control datum for survey is indicated on Drawings.

D. Prior to beginning Work, verify and establish floor elevations of existing facilities to ensure that new Work will meet existing elevations in smooth and level alignment except where specifically detailed or indicated otherwise.

E. Verify setbacks and easements; confirm Drawing dimensions and elevations.

F. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.

G. Submit copy of Site drawing and certificate signed by land surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

H. Maintain complete and accurate log of control and survey Work as Work progresses.

I. On completion of foundation walls and major Site improvements, prepare certified survey illustrating dimensions, locations, angles, and elevations of construction and Site Work.

J. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.

K. Promptly report to Architect/Engineer loss or destruction of reference point or relocation required because of changes in grades or other reasons.

L. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect/Engineer.

M. Final Property Survey: Prior to Substantial Completion, prepare final property survey illustrating locations, dimensions, angles, and elevations of buildings and Site Work that have resulted from construction indicating their relationship to permanent bench marks and property lines.

1. Show significant features (real property) for Project.

2. Include certification on survey, signed by surveyor, that principal metes, bounds, lines, levels, and elevations of Project are accurately shown.

1.5 EXECUTION

A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until completion of construction.

B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
2. Physically separate products in place and provide electrical insulation or protective coatings to prevent galvanic action or corrosion between dissimilar metals.
3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual effect choices to Architect/Engineer for final decision.

E. Allow for expansion of materials and building movement.

F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.

1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

G. Mounting Heights: Where not indicated, mount individual units of Work at industry-recognized standard mounting heights for particular application indicated.

1. Refer questionable mounting height choices to Architect/Engineer for final decision.
2. Elements Identified as Handicap Accessible: Comply with applicable codes and regulations.

H. Adjust operating products and equipment to ensure smooth and unhindered operation.

I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

1.6 CUTTING AND PATCHING

A. Employ skilled and experienced Installers to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements affecting the following:

1. Structural integrity of element.
2. Integrity of weather-exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Visual qualities of sight-exposed elements.
5. Work of Owner or separate Contractor.

C. Execute cutting, fitting, and patching, including excavation and fill, to complete Work and to accomplish the following:

1. Fit the several parts together, to integrate with other Work.
2. Uncover Work to install or correct ill-timed Work.
3. Remove and replace defective and nonconforming Work.
4. Remove samples of installed Work for testing.
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.

E. Cut masonry and concrete materials using masonry saw or core drill.

F. Restore Work with new products according to requirements of Contract Documents.

G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.

H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

I. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

J. Identify the hazardous substances or conditions exposed during the Work to Architect/Engineer for decision or remedy.

1.7 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual Specification Sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

1.8 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Notify Architect/Engineer and Owner seven days prior to startup of each item.

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

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

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to manufacturer's instructions.

G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.

H. Submit a written report in accordance with Section 013300 - Submittal Procedures stating that equipment or system has been properly installed and is functioning correctly.

1.9 DEMONSTRATION AND INSTRUCTION

A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.

B. Demonstrate Project equipment and instruct in classroom environment located at the Project Site and instructed by manufacturer's representative who is knowledgeable about the Project.

C. Video Recordings: Provide high-quality color video recordings of demonstration and instructional sessions. Engage commercial videographer to record sessions. Include classroom instructions, demonstrations, board diagrams, and other visual aids. Include menu navigation.

D. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

E. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

F. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.

G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

H. Allot the required instruction time for each item of equipment and system as specified in individual Specification Sections.

1.10 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:

1. Submit maintenance manuals, Project record documents, digital images of construction photographs, video recordings, and other similar final record data in compliance with this Section.
2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
4. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
5. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
6. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
7. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:

1. When Contractor considers Work to be substantially complete, submit to Architect/Engineer.

    a. Written certificate that Work, or designated portion, is substantially complete.
    b. List of items to be completed or corrected (initial punch list).

2. Within seven days after receipt of request for Substantial Completion, Architect/Engineer will make inspection to determine whether Work or designated portion is substantially complete.
3. Should Architect/Engineer determine that Work is not substantially complete:

    a. Architect/Engineer will promptly notify Contractor in writing, stating reasons for its opinion.
    b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Architect/Engineer.
    c. Architect/Engineer will reinspect Work.
    d. Redo and Inspection of Deficient Work: Repeated until Work passes Architect/Engineer's inspection.

4. When Architect/Engineer finds that Work is substantially complete, Architect/Engineer will:

a. Prepare Certificate of Substantial Completion on EJCDC C-625 - Certificate of Substantial Completion, accompanied by Contractor's list of items to be completed or corrected as verified and amended by Architect/Engineer and Owner (final punch list).
b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.

5. After Work is substantially complete, Contractor shall:

a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
b. Complete Work listed for completion or correction within time period stipulated.

6. Owner will occupy all of WWTP site as specified in Section 011000 - Summary.

C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.

1. When Contractor considers Work to be complete, submit written certification that:

a. Contract Documents have been reviewed.
b. Work has been examined for compliance with Contract Documents.
c. Work has been completed according to Contract Documents.
d. Work is completed and ready for final inspection.

2. Submittals: Submit following:

a. Final punch list indicating all items have been completed or corrected.
b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
d. Accounting statement for final changes to Contract Sum.
e. Contractor's affidavit of payment of debts and claims.
f. Consent of surety to final payment.
g. DBE Subcontractor Participation Forms SR-EPA.7-8 (Applicable for WPCLF & WSRLA funded projects only).

3. Perform final cleaning for Contractor-soiled areas according to this Section.

D. Final Completion Inspection:

1. Within seven days after receipt of request for final inspection, Architect/Engineer will make inspection to determine whether Work or designated portion is complete.
2. Should Architect/Engineer consider Work to be incomplete or defective:

a. Architect/Engineer will promptly notify Contractor in writing, listing incomplete or defective Work.
b. Contractor shall remedy stated deficiencies and send second written request to Architect/Engineer that Work is complete.

c. Architect/Engineer will reinspect Work.
d. Redo and Inspection of Deficient Work: Repeated until Work passes Architect/Engineer's inspection.

1.11 PROJECT RECORD DOCUMENTS

A. Maintain on Site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, product data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates used.
3. Changes made by Addenda, bulletin, Change Order, and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction as follows:

1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
2. Include locations of concealed elements of the Work.
3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
5. Identify and locate existing buried or concealed items encountered during Project.
6. Measured depths of foundations in relation to finish floor datum.
7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
9. Field changes of dimension and detail.
10. Details not on original Drawings.

G. Submit marked-up paper copy documents to Architect/Engineer with claim for final Application for Payment.

H. Submit PDF electronic files of marked-up documents to Architect/Engineer with claim for final Application for Payment.

1.12 MANUAL FOR MATERIALS AND FINISHES

A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect/Engineer will review draft and return one copy with comments.

B. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes 15 days prior to final inspection. Completed volumes, with Architect/Engineer comments, will be returned after final inspection. Revise content of document sets as required prior to final submission.

D. Submit two sets of revised final volumes within 10 days after final inspection.

E. Submit in PDF composite electronic indexed file of final volumes within 10 days after final inspection.

F. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for re-ordering custom-manufactured products.

G. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

H. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.

I. Additional Requirements: As specified in individual product Specification Sections.

J. Include listing in table of contents for design data, with tabbed fly sheet and space for insertion of data.

1.13 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect/Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes 15 days prior to final inspection. Completed volumes, with Architect/Engineer comments, will be returned after final inspection. Revise content of document sets as required prior to final submission.

D. Submit two sets of revised final volumes within ten days after final inspection.

E. Submit in PDF composite electronic indexed file of final volumes within ten after final inspection.

F. Equipment and Systems: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

G. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications.

H. Include color-coded wiring diagrams as installed.

I. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.

J. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

K. Include servicing and lubrication schedule and list of lubricants required.

L. Include manufacturer's printed operation and maintenance instructions.

M. Include sequence of operation by controls manufacturer.

N. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

O. Include control diagrams by controls manufacturer as installed.

P. Include Contractor's coordination drawings indicating installed color-coded piping diagrams.

Q. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

R. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

S. Include test and balancing reports as specified in Section 014000 - Quality Requirements.

T. Additional Requirements: As specified in individual product Specification Sections.

U. Include listing in table of contents for design data with tabbed dividers and space for insertion of data.

1.14 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.

B. Deliver to Project Site and place in location as directed by Owner; obtain receipt prior to final payment.

1.15 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible Subcontractors, suppliers, and manufacturers within ten days after completion of applicable item of Work.

B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.

C. Verify documents are in proper form, contain full information, and are notarized.

D. Co-execute submittals when required.

E. Include table of contents and assemble in three D side ring binder.

F. Submit prior to final Application for Payment.

G. Time of Submittals:

1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten days after acceptance.
2. Make other submittals within ten days after date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

1.16 FINAL CLEANING

A. Execute final cleaning prior to final Project assessment.

1. Employ experienced personnel or professional cleaning firm.

B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces.

C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.

D. Clean debris from roofs, gutters, downspouts, and drainage systems.

E. Clean Site; sweep paved areas, rake clean landscaped surfaces.

F. Remove waste and surplus materials, rubbish, and construction facilities from Site.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 017000

SECTION 017800 - FINAL COMPLIANCE AND SUBMITTALS

PART 1 - GENERAL

1.1 The following forms and related sign-offs shall be documented in accordance with provisions of the contract. These forms shall be completed by the Contractor and approved by the Owner before final retainer is approved for release. Forms for Items A to E will be attached to the Contractor's executed copy of the contract.

A. Certificate of Substantial Completion (To be submitted at time of Substantial Completion).

B. Contractor's Certification of Completion.

C. Contractor's Affidavit of Prevailing Wage.

D. Consent of Surety Company for Final Payment.

E. Affidavit of Final Acceptance Date and Correction Period.

F. Before the OWNER will approve and accept the work and release the retainer, the CONTRACTOR will furnish the OWNER a written report indicating the resolution of any and all property damage claims filed with the CONTRACTOR by any party during the construction period. The information to be supplied shall include, but not be limited to, name of claimant, date filed with CONTRACTOR, name of insurance company and/or adjuster handling claim, how claim was resolved and if claim was not resolved for the full amount, a statement indicating the reason for such action.

G. DBE Subcontractor Participation Forms SR-EPA.7-8 (Applicable for WPCLF & WSRLA funded projects only).

END OF SECTION 017800

SECTION 030000 - CONCRETE WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1. Section 013319 – Field Testing Requirements

1.2 SUMMARY

A. Provide all materials and labor necessary to complete all concrete, plain and reinforced, as indicated on Drawings or as specified in these specifications and as required to complete the Project. Work, without limiting the generality thereof, includes:
1. Installation of concrete to provide footings, foundations, foundation walls, slabs on grade, and other incidental concrete Work.
2. Concrete pads for mechanical equipment.
3. Furnishing and installation of admixtures.
4. Work of other trades required to be built into concrete, such as inserts for connections to steel members, waterstops, flashing reglets, anchors, embedded plates, high strength mortar, controlled low strength material, grouting of precast members, and reinforcing dowels.
5. Providing vapor retarder [or waterproofing membrane] below slabs on grade.
6. Finishing of concrete as specified herein or as indicated on Drawings.

B. This Section specifies cast-in place concrete, including form work, reinforcing, mix design, placement procedures and finishes.

1. Extent of concrete work is shown on drawings.
2. Concrete paving and walks are specified in Division 2.
3. Precast concrete is specified in other Division-3 sections.
4. Mechanical finishes and concrete floor toppings are specified in other Division-3 sections.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements and 01 33 00 - Submittal Procedures, for submittal procedures.

B. Product Data: Submit data for proprietary materials and items, including but not limited to, repair mortar, concrete mix design data, Portland cement. fly ash, reinforcement, forms, forming accessories, bonding agent, admixtures, patching compounds, waterstops, joint systems, high strength repair/patching mortar, control joint/construction joint locations, curing compounds, dry-shake finish materials, and others as requested by Engineer.

1. Mix Design: Submit each proposed concrete mix design. Provide the following data:
   a. The expected strength.
   b. Corresponding slump before and after the introduction of mid- or high-range water-reducing admixtures.

c. Weights and test results of the ingredients.
d. Concrete mix compressive strength test results.
e. Other physical properties necessary to review each mix design for conformance with these specifications.
f. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
g. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.

2. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.

C. Shop Drawings; Reinforcement: Submit original shop drawings prepared for fabrication, bending, and placement of concrete reinforcement. Comply with ACI Detailing Manual showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

D. Shop Drawings; Form work: Submit shop drawings prepared by a registered Professional Engineer for fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals, location and pattern of form tie placement, and other items which affect exposed concrete visually.

1. Engineer's review is for general architectural applications and features only. Design of form work for structural stability and efficiency is Contractor's responsibility.

E. Samples: Submit samples of materials as requested by Engineer, including names, sources, and descriptions.

F. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design tests.

1. The proposed mix design submittal(s) shall follow the procedures of Chapter 5, Sections 5.2 to 5.3 of ACI-318.
2. Reference should be made to ACI-211.5R "Guide for Submittal of Concrete Proportions" for the required submittal information. Sample forms for presenting the necessary information can be found in the addendum at the end of this section. Example Form B should follow a completed Example A in the submittal when laboratory trial batches are used to document a water-cementious materials ratio curve.
3. Additional data summarizing the past performance records should be an integral part of the submittal if the submittal is based on past performance with the proposed materials and proportions.

G. Materials Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Engineer. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, latest revisions, except where more stringent requirements are shown or specified:

1. ACI 301 "Specifications for Structural Concrete for Buildings."
2. ACI 318 "Building Code Requirements for Reinforced Concrete."
3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."
4. ACI 347 "Guide to Form work for Concrete."
5. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
6. ACI 232.3R - Report on High-Volume Fly Ash Concrete for Structural Applications.
7. ACI 305R - Guide to Hot Weather Concreting.
8. ACI 305.1 (305.1M) - Specification for Hot Weather Concreting.
9. ACI 306.1 - Standard Specification for Cold Weather Concreting.
10. ACI 306R - Guide to Cold Weather Concreting.
11. ACI 308.1 (308.1M) - Specification for Curing Concrete.
12. ACI 350.5 (350.5M) - Specifications for Environmental Concrete Structures.
13. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
14. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
15. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
16. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
17. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
18. ASTM C150/C150M - Standard Specification for Portland Cement.
19. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
20. ASTM C172/C172M - Standard Practice for Sampling Freshly Mixed Concrete.
21. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
22. ASTM C231/C231M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
23. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
24. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

B. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.

C. Engage a testing agency acceptable to Engineer to perform initial material evaluation and certification tests for mix designs and to design concrete mixes.

D. Pre-installation Conference: Conduct conference at project site to comply with requirements of Division 1 Section "Project Meetings" and the following:

1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials, inspection, testing and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

    a. Contractor's Superintendent
    b. Agency responsible for concrete design mixes.
    c. Agency responsible for field quality control.

d. Ready-mix concrete producer.
e. Concrete Subcontractor
f. Primary admixture manufactures.

E. Concrete Testing Service: Employ and pay an independent testing laboratory, acceptable to the Owner and Architect to perform material evaluation tests and to review concrete mix designs proposed by Contractor to conform to this Specification.

F. Alkali-Silica Reactivity Testing: Aggregates used in the concrete shall be tested by an independent testing agency for alkali-silica reactivity in accordance with ASTM C1260.

1.5 PROJECT CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301, ACI 306.1, and as follows:

1. Protect concrete Work from physical damage or reduced strength caused by frost, freezing actions, or low temperatures.
2. 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.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg. F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge not to exceed 95 deg. F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

C. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two (2) edges and one side for tight fit.

C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Engineer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

D. Forms for Cylindrical Columns and Supports: Metal, fiberglass reinforced plastic, or paper or fiber tubes. Construct paper or fiber tubes of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.

E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

F. Form Ties: Factory-fabricated, adjustable-length, snapoff metal or glass fiber-reinforced plastic form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units which will leave no metal closer than 1-1/2" to the exposed surface.

1. Provide ties which, when removed, will leave holes not larger than 1" diameter in concrete surface.
2. All form ties shall have a factor of safety of two (2) to determine the recommended safe working load.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf) hot-dip galvanized, after fabrication and bending.

C. Epoxy-Coated Reinforcing Bars: ASTM A 775.

1. Repair of damaged epoxy-coating - When required, damaged epoxy-coating shall be repaired with patching material conforming to ASTM A 775. Repair shall be done in accordance with the patching material manufacturer's recommendations.

D. Steel Wire: ASTM A 82, plain, cold-drawn steel.

E. Welded Wire Fabric: ASTM A 185, welded steel wire fabric. (Flat sheets only)

F. Welded Deformed Steel Wire Fabric: ASTM A 497.

G. Epoxy - Coated Welded Wire Fabric: ASTM A884, Class A.

H. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type II, I/II, V low alkali, and ASTM C595M, Type IP, unless otherwise specified. (See Table I, Concrete Requirements).

1. Use one brand of cement throughout project, unless otherwise acceptable to Engineer.
2. Portland cement shall contain less than 0.60 percent alkalis. Portland-pozzolan cement shall be low alkali.

B. Pozzolan shall be Class N, natural pozzolan, or Class F, fly ash, conforming to ASTM C618. Fly ash pozzolan shall contain less than 1 percent by weight carbon and less than 3 percent by weight sulfur trioxide. Pozzolan supplied during the life of the project shall have been formed at the same single source. The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.

C. Normal Weight Aggregates: Fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates shall be regarded as separate ingredients.

1. Aggregates shall be non-reactive and shall be washed before use. Provide aggregates from a single source for exposed concrete.
2. Tests for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to produce a concrete that has optimum workability and consolidation characteristics. The final combined aggregate gradation shall be established during the design mix.
3. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
4. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Engineer.
5. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3-mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3 mm).

D. Fine aggregate: fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33.

E. Coarse aggregate: coarse aggregate shall be hard, angular (not river washed), dense and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 3. Gradation of each coarse aggregate size shall conform TO ASTM C33, Table 2.

F. Water: Conform with ASTM C94. Water for washing aggregate, for mixing and for curing shall be potable and free from oil and deleterious amounts of acids, alkalis, and organic materials; shall not contain more than 1,000 mg/l of chlorides as Cl, nor more than 1300 mg/l of sulfates as SO4; and shall not contain an amount of impurities that may cause a change of more than 25 percent in the setting time of the cement nor a reduction of more than 5 percent in the compressive strength of

the concrete at 14 days when compared with the result obtained with distilled water. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

G. Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the concrete mix.

1. Prohibited Admixtures: Calcium chloride thyocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.

H. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Air-Mix"; Euclid Chemical Co.
b. "Sika Aer"; Sika Corp.
c. "MB-VR or MB-AE"; Master Builders.

I. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.1 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "WRDA"; W.R. Grace.
b. "Eucon WR-75"; Euclid Chemical Co.
c. "Pozzolith Normal"; Master Builders.

J. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F and containing not more than 0.1 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Sikament 300"; Sika Chemical Corp.
b. "Eucon 37"; Euclid Chemical Co.
c. "Rheobuild or Polyheed"; Master Builders.

K. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.1 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Accelguard 80"; Euclid Chemical Co.
b. "Pozzutec 20"; Master Builders.
c. "Daraset"; W.R. Grace & Co.

L. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and containing not more than 0.1 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Pozzolith"; Master Builders.
b. "Eucon Retarder 75"; Euclid Chemical Co.
c. "Plastiment"; Sika Chemical Co.

M. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Catexol 1000CL; Axim Concrete Technologies.
b. MCI 2000 or MCI 2005; Cortec Corporation.
c. DCI or DCI-S; W.R. Grace & Co., Construction Products Div.
d. Rheocrete 222+; Master Builders, Inc.
e. FerroGard-901; Sika Corporation.

N. Fiber Reinforcement:

1. Synthetic fiber reinforcing shall be added to the concrete for the areas so indicated in the drawings. Only fibers designed and manufactured specifically for use in concrete shall be acceptable as secondary reinforcement, complying with ASTM C1116, not less than ¾ inch long.
2. The fibers may be added at the batch plant. The incorporation of said fibers shall be documented on the delivery ticket from the ready mix producer. Fibers shall be added to the concrete in strict accordance with manufacturer's printed instructions.
The minimum dosage rate shall be 1.5 lbs/cubic yard.
3. Nylon fibers containing 100% virgin nylon monofilaments shall be utilized to impart a "non-hairy" surface to the finished concrete.
4. Products: Subject to compliance with requirements, provide the following fibrous reinforcement or approved equal:

a. Nycon Fiber; Nycon, Inc.
b. Nylo-Mono; Forta Corp.
c. Fibrasol N; Axim Concrete Technologies

2.2 RELATED MATERIALS

A. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gage galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

B. Waterstops: Provide waterstops at construction joints and other joints as indicated and specified in Section 030000.02.

C. Granular Base: Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.

D. Vapor Retarder: Provide vapor retarder cover, ASTM E1745 Class C, over prepared base material where indicated below slabs on grade. Use only materials which are resistant to deterioration when tested in accordance with ASTM E 154, as follows:

1. Polyethylene sheet not less than 10 mils thick.
2. Water resistant barrier paper consisting of heavy Kraft papers laminated together with glass fiber reinforcement and over-coated with black polyethylene on each side.

    a. Product: Subject to compliance with requirements, provide Moistop Ultra 10 by Fortifiber Corporation, Stego Wrap 10-mil by Stego Industries or equal.

E. Non-Shrink Grout: CRD-C 621 and ASTM C-1107, factory pre-mixed grout.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Non-metallic

        1) "Set Grout"; Master Builders.
        2) "Euco-NS"; Euclid Chemical Co.
        3) "Five Star Grout"; U.S. Grout Corp.

F. Non-slip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rust-proof, and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.

G. Colored Wear-Resistant Finish: Packaged, dry, combination of materials, consisting of Portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, non-fading mineral oxides, interground with cement. Color as selected by Engineer, unless otherwise indicated.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. "Colorcron"; Master Builders.
    b. "Surflex"; Euclid Chemical Co.
    c. "Lithochrome"; L.M. Scofield Co.

H. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

I. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

J. Liquid Membrane-Forming Curing Compound: Liquid type membrane- forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg./sq. m. when applied at 200 sq ft./gal.

1. Products: Subject to compliance with requirements, provide one of the following:

a. “Masterkure”; Master Builders.
b. “Ecocure”; Euclid Chemical Co.
c. “Horn Clear Seal”; A.C. Horn, Inc.

K. Underlayment Compound: Freeflowing, self-leveling, pumpable cementitious base compound for applications from 1 inch thick to feathered edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. “Flo-Top”; Euclid Chemical Co.
b. “Underlayment 110,” Master Builders, Inc.
c. “Thoro Underlayment Self-Leveling”; Thoro System Products.

L. Bonding Compound: Polyvinyl acetate or acrylic base.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Polyvinyl Acetate (Interior Only):

1) “Euco Weld”; Euclid Chemical Co.
2) “Weldcrete”; Larsen Products Corp.
3) “Everweld”; L&M Construction Chemicals, Inc.

b. Acrylic or Styrene Butadiene:

1) “Day-Chem AD Bond”; Dayton Superior Corp.
2) “Everbond”; L & M Construction Chemicals.
3) “SBR Latex”; Euclid Chemical Co.

M. Epoxy Adhesive: ASTM C 881, two component material suitable for use on dry or damp surfaces. Provide material “Type,” “Grade,” and “Class” to suit project requirements.

1. Products: Subject to compliance with requirements, provide one of the following:

a. “Epoxtite Binder 2390”; A.C. Horn, Inc.
b. “Sikadur 32 Hi-Mod”; Sika Chemical Corp.
c. “Euco Epoxy 452 or 620"; Euclid Chemical Co.

N. High Strength Repair/Patching Mortar: Contractor can, either provide a batch/site mix or a premanufactured bag mix. See Table I for a batch/site mix.

1. premanufactured bag mix shall be polymer modified shrinkage compensated, rapid setting, high strength mortar specifically formulated to make structural repairs in vertical and overhead applications.
2. Bag mix shall conform to ASTM C928 R2 for structural concrete repair and have a 28-day strength of at least 6,000 psi.
3. Bag mix maybe extended with aggregate if approved by manufacturer.
4. The following are approved manufacturers::

a. Sika Chemical Corp.

b. Five Star Products. Inc
c. Euclid Chemical Company
d. CTS Cement Manufacturing Corp.
e. Dayton Superior Corporation
f. SpecChem

2.3 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301 and ACI 211. If the trial batch method is used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to Engineer.

1. Concrete shall be normal weight concrete composed of specified cement, pozzolan, admixtures, aggregates and water proportioned and mixed to produce a workable, strong, dense, and impermeable concrete.
2. The Contractor may substitute interground Portland-pozzolan cement conforming to ASTM C595, containing the specified amount of pozzolan in lieu of Portland cement and pozzolan. Pozzolan may be omitted in concrete exposed to normal atmospheric conditions and concrete not in contact with the ground or liquid. Water/cement ratio is based on the combined contents of cement and pozzolan in a given mix proportion.
3. Controlled Low Strength Material (CLSM) shall be a flowable concrete slurry mix, consisting of cement, pozzolan, water, coarse and fine aggregate. The concrete slurry mix shall be produced by a ready-mix concrete supplier.

B. Submit written reports to Engineer and Structural Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Engineer.

C. Design mixes to provide normal weight concrete with the following properties, as indicated in Table I. :

TABLE 1

CONCRETE REQUIREMENTS

Concrete Class	ASTM Coarse Aggregate Size	Maximum Water/Cement Ratio	Pozzolan, Percent by Weight of Cementitious Materials[a]	Minimum Air Content (Percent)	Minimum[b] 28-Day Compressive Strength, PSI	Slump Range Min-Max /Admix[e] (Inches)
A	57	0.40	20-28	5.5[c]	4500	3-4/8
B	467[d]	0.45	20-28	5.5[c]	3500	4-5/8
G	78[j]	0.45	-	-	3000	7[j]
M	78[j]	0.40	0-20	5.5	5500	3-4/5
F	57[h]	1.33[h]	5-50[h]	15[h]	100[i]	8[h]

a Pozzolan content may be included in cementitious fraction.
b Compressive strength shall be determined at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39.
c Plus or minus 1.5 percent.
d ASTM coarse aggregate gradation 57 may be substituted at Contractor's option.
e Min and max represent slump due to water only. Admix refers to recommended maximum slump for the mix after the incorporation of water reducing admixtures.
h Contractor to determine.
i Plus or minus 25 psi.
J Contractor may sumit substitution for approval.

1. Typical cast-in-place structural concrete shall be Class A, except as otherwise specified or shown on the drawings.
2. Sitework, non-structural concrete (sidewalks, curbs, pavers, manhole inverts etc.) shall be Class B unless otherwise noted on the drawings.
3. Masonry grout, for bond beams, grouting cells and precast planks shall be class G.
4. High strength repair mortar shall be class M.
5. Controlled Low Strength Material shall be Class F.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

E. Admixtures:

1. Use high range water-reducing admixture (super plasticizer) in Classes A and D concrete unless noted otherwise.
2. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
3. Use air-entraining admixture in all concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content within limits shown in Table I.
4. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.
5. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as shown in Table I:

    a. Concrete containing HRWR admixture (super-plasticizer): Not more than 8" after addition of HRWR to site-verified 2"-3" slump concrete.

2.4 CONCRETE MIXING

A. Job-Site Mixing: Mix materials for concrete in appropriate drum type batch machine mixer. For mixers of one cu. yd., or smaller capacity, 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. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd., or fraction thereof.

1. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

a. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2.5 WATERSTOPS

A. POLYVINYL CHLORIDE (PVC):

1. PVC waterstops shall be manufactured from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572. Unless otherwise specified or noted on the drawings, waterstops in construction joints shall be 6-inch flat center/ribbed sides/0.375 inch thick, Greenstreak 679, Vinylex R6-38, or equal. Waterstops in expansion joints shall be 9 inch center-bulb/ribbed sides/0.375 inch thick, Greenstreak 696, Vinylex RB9-38H, or equal. All waterstop tees, crosses, and ells must be factory made; all field fabricated joints will be rejected.

B. EXPANDING (HYDROPHILIC) WATERSTOPS:

1. Expanding waterstops shall be bentonite-free and made from unvulcanized rubber. Acceptable products include Adeka. Equivalents approved by the Engineer are acceptable. These are allowable for use only where indicated on the drawings or accepted in writing by the Engineer. Provide adhesive approved by the waterstop manufacturer where required due to geometry, irregular surface conditions, or as recommended by the manufacturer. Unless otherwise shown on the drawings, use Adeka MC-2010MN at all Hydrophilic Waterstop identified locations or approved equal.

2.6 PRODUCT DATA

A. MANUFACTURER'S DATA:

1. Copies of manufacturer's data shall be provided for the following:
   a. Cement
   b. As-delivered concrete strength, slump, temperature, and air content
   c. Final laboratory report.

B. READY-MIXED CONCRETE TRUCK DELIVERY TICKETS:

1. Each load of ready-mixed concrete delivered to the job site shall be accompanied by a delivery ticket showing the information listed in ASTM C94, Section 16.

2. With each load of concrete delivered to the job there shall be furnished by the ready mixed concrete producer duplicate delivery tickets, one for the Contractor and one for the Engineer. Delivery tickets shall provide the following information:
   a. Date and serial number of ticket;
   b. Name of ready mixed concrete plant;
   c. Job location;
   d. Contractor;
   e. Type and brand name of cement;
   f. Mix number or specified cement content in bags per cubic yard of concrete;
   g. Truck number;
   h. Time dispatched stamped by a time clock;
   i. Amount of concrete in load in cubic yards;
   j. Admixtures in concrete, if any;
   k. Maximum size of aggregate;
   l. Water added at job, if any;
   m. Slump of concrete ordered

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.2 FORMS

A. Design, erect, support, brace, and maintain form work to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct form work so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain form work construction tolerances complying with ACI 347.

B. Design form work to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

E. Provide temporary openings where interior area of form work is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary

openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

G. Provisions for Other Trades: Provide openings in concrete form work to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retightening forms and bracing after concrete placement if required to eliminate mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER INSTALLATION

A. Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.

B. Lap joints 6" and seal with manufacturer's recommended mastic or pressure-sensitive tape.

3.4 PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports, and as herein specified.

1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement by form work, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in longest lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.5 JOINTS

A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer.

1. Provide a roughen interface with a 1/4", min, amplitude at construction joints in walls, slabs, and between walls and footings.
2. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.

B. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.

C. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

1. Joint filler and sealant materials are specified in Section 030000.02 of these specifications.

D. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4 of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic strips into fresh concrete until top surface of strip is flush with slab surface.
2. Follow the directions of Insert Manufacturer for finishing the slab and joints.

E. If joint pattern not shown, provide joints not exceeding 15' in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third-bays).

1. Joint sealant material is specified in Section 030000.02 of these specifications.

3.6 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto. Electrical conduit shall not be embedded in concrete.

B. Install reglets to receive top edge of foundation sheet waterproofing, and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.

C. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support screed strips using strike-off templates or compacting type screeds.

3.7 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with an approved, nonresidual, low-VOC, from-coating compound before placing reinforcement.

C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel form work is not acceptable.

3.8 CONCRETE PLACEMENT

A. Preplacement Inspection: Before placing concrete, inspect and complete form work installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.

B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

C. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
3. Maintain reinforcing in proper position on chairs during concrete placement operations.

E. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (27 deg C) at point of placement.

    a. The concrete shall be maintained within this temperature range for not less than seven (7) days.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials or against cold reinforcing steel.
3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

F. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineers.

3.9 FINISH OF FORMED SURFACES

A. Rough Form Finish: For formed concrete surfaces not exposed-to- view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed; provide smooth rubbed finish to smooth form finish. Refer to "Concrete Surface Repairs."

C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment.

1. Scarify or roughen entire surface by grinding or similar effective means.
2. Combined one part Portland cement to 1-1/2 parts fine sand by volume and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency

of thick paint. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.

3. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.
4. Repeat the above process if necessary to fill voids or bug holes and obtain a consistent match to adjacent surfaces, subject to acceptance of the Engineer.

D. Grout Cleaned Finish: Provide grout cleaned finish on scheduled concrete surfaces which have received smooth form finish treatment.

1. Scarify or roughen entire surface by grinding or similar effective means.
2. Apply Thoroseal plaster mix coating by Thoro System Products or approved equivalent with an approximate thickness of 1/8-inch to ¼-inch.
3. Follow the manufacturer's recommendations and guidelines regarding surface preparation, application methods and curing.
4. Repeat the above process if necessary to fill voids or bug holes and obtain a consistent match to adjacent surfaces, subject to acceptance of the Engineer.

E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.10 MONOLITHIC SLAB FINISHES

A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated.

1. After placing slabs, plane surface to tolerances for floor flatness F(F) 15 and floor levelness F(L) 13, measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms, or rakes.

B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both, Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of F(F) 18 F(L) 15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.

1. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of F(F), 20 and F(L) 17, measured according to ASTM E1155. Grind smooth surface defects which would telegraph through applied floor covering system.

D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.

E. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

F. Non-slip Aggregate Finish: Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and elsewhere as indicated.

1. After completion of float finishing, and before starting trowel finish, uniformly spread 25 lbs. of dampened non-slip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.
2. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose non-slip aggregate.

G. Colored Wear-Resistant Finish: Provide colored wear-resistant finish to monolithic slab surface indicated.

1. Apply dry shake materials for colored wear-resistant finish at rate of not less than 100 lbs. per 100 sq. ft., unless greater amount is recommended by material manufacturer.
2. Immediately following first floating operation, uniformly distribute approximately 2/3 of required weight of dry shake material over concrete surface, and embed by means of power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material with overlapping applications, and embed by power floating.
3. After completion of broadcasting and floating, apply trowel finish as herein specified. Cure slab surface with curing compound recommended by dry shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.11 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Protect concrete from rapid moisture loss before and during finishing operations.
1. The evaporation graph, Figure 1, of ACI 308 - Curing Concrete, shall be used to determine the evaporation rate during concrete placement. If the rate of evaporation equals or exceeds 0.2 lbs/sq.ft./hr., steps shall be taken to prevent excessive evaporation from the surface.
2. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.

a. Initial curing may be any of the methods listed herein that maintain a satisfactory moisture content and temperature.

3. Begin final curing procedures, if they differ from initial curing, immediately following initial curing and before concrete has dried. Continue curing for at least seven (7) days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

B. Curing Methods: Perform curing of all structural concrete as herein specified.

1. Provide moisture curing by following methods.

a. Keep concrete surface continuously wet by covering with water.
b. Continuous water-fog spray.
c. Cover concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

2. Provide moisture-cover curing as follows:

a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

C. Provide curing and sealing compound to pavement, walks, and curbs only, as follows:

1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours) and after surface water sheen has disappeared. Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within three (3) hours after initial application. Maintain continuity of coating and repair damage during curing period.

D. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

E. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by moist curing methods.

1. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

3.12 SHORES AND SUPPORTS

A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.

B. Extend shoring from ground to roof for structures four (4) stories or less, unless otherwise permitted.

C. Extend shoring at least three (3) floors under floor or roof being placed for structures over four (4) stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.

D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.

1. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.13 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for five (5) days after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members. Lab cured cylinders will not be considered.

C. Form facing material may be removed five (5) days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.14 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new form work.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Engineer.

3.15 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment with template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

1. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and finish concrete surfaces as scheduled. Cure concrete as herein specified.

E. Reinforced Masonry: Provide concrete grout conforming to ASTM C476 for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

3.16 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Engineer.

1. Saw-cut out honeycomb, rock pockets, voids over 1/4" in any dimension, down to solid concrete but, in no case to a depth of less than 1." Make edges of cuts slightly undercut to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
2. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with Portland Cement patching mortar, or precast cement cone plugs secured in place with bonding agent. When other materials are used, apply them in accordance with manufacturer's recommendations.

1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
2. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness using a template having required slope.
3. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate

to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

4. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Engineer.
6. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
8. Perform structural repairs with prior approval of Engineer or Structural Engineer for method and procedure, using specified epoxy adhesive and mortar.
9. Repair methods not specified above may be used, subject to acceptance of Engineer.
10. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material.

3.17 THROUGH SECTION CONCRETE CRACK REPAIRS

A. Sealing through wall or slab cracks.

1. Seal cracks for a water-tight or structurally bonded repair with epoxy or chemical grouting procedures.

    a. The Contractor shall make proper repairs with epoxy injection or chemical injection with a moisture reactive hydrophilic polyurethane foam grout, as directed by the Engineer.

ADDENDUM
EXAMPLE FORM A

CONCRETE SUPPLIER:_____

PROJECT:_____ CONTRACTOR:_____

MIXTURE ID:_____ SPECIFIED f'c:_____PSI

MATERIAL MIXTURE PROPORTIONS lbs-mass/cu.yd. (pcy)

1.0 Cement Type_____ Source:_____

Sp. Gr._____ _____pcy _____cu. ft.

1.1 Other Cementitious Materials:_____ Class:_____ Source:_____

Sp. Gr._____ _____pcy _____cu. ft.

2.0 Aggregate (No. 1) Type:_____ Size:_____ Source:_____

SSD Sp. Gr._____ _____pcy _____ cu. ft.

Dry Rodded Unit Wt.: _____pcf

Alternate (No. 1) Lightweight Aggregate Type:_____ Size:_____Source:_____

Sp. Gr. Factor _____ over dry pcy _____ cu. ft.

Loose Unit Wt._____pcf Estimated Wet _____pcf

2.1 Aggregate (No. 2) Type:_____ Size:_____ Source:_____

SSD Sp. Gr._____ _____pcy _____cu. ft.

Dry Rodded Unit Wt.: _____pcf (If Fine Sized - FM _____)

2.2 Aggregate (Nos. 3, 4, n) Type:_____ Size:_____ Source:_____

SSD Sp. Gr._____ _____pcy_____cu. ft.

Dry Rodded Unit Wt.: _____pcf

3.0 Water: _____gal. _____pcy _____cu. ft.

EXAMPLE FORM A (CONTINUED)

4.0 Admixtures expressed as fluid ounces/cubic yard, and estimated range

Source:_____ Name:_____ Type_____ _____oz

Source:_____ Name:_____ Type_____ _____oz

Source:_____ Name:_____ Type_____ _____oz

Total Admixture Liquid Vol. _____ cu. ft.

(*) Note: Show volume in 4.0 if not included in cubic feet of air or water.

5.0 Other Materials - fibers, color pigment or other additions

Sp. Gr._____ _____pcy _____cu. ft.

Total Mixture Mass and Volume: _____pcy _____cu. ft.

Fresh Concrete Properties

Slump _____ +/-_____ in.

Unit Weight _____ pcf

Air Content _____+/-_____%

If Trail Batch Data -

Identify Batch No. _____

Batch Date _____

Concrete Temp._____°F

Comp. Strength-Average _____°F

Coarse & Fine Aggregate Gradation

Percent Passing

Sieve Size	Aggregate No. 1	2	3	4	Combined
2 in.	____	____	____	____	_____
1-1/2 in.	____	____	____	____	_____
1 in.	____	____	____	____	_____
3/4 in.	____	____	____	____	_____
1/2 in.	____	____	____	____	_____
3/8 in.	____	____	____	____	_____
No. 4	____	____	____	____	_____
No. 8	____	____	____	____	_____
No. 16	____	____	____	____	_____
No. 30	____	____	____	____	_____

EXAMPLE FORM A (CONTINUED)

7 day avg. _____psi

28 day avg. _____psi

No. 50 ____ ____ ____ ____ _____

No. 100____ ____ ____ ____ _____

No. 200____ ____ ____ ____ _____

Comments:_____

_____

Signature: _____ Date:_____

Title: _____

Organization: _____

EXAMPLE FORM B

CONCRETE SUPPLIER:_____

MATERIAL	TRAIL BATCH NUMBER - proportions per cubic yard			
	1	2	3	4
1.0 Cement Source: _____				
Type ____	_____lb	_____lb	_____lb	_____lb
1.1 Other Cementitious Material Sources:_____				
Type ____	_____lb	_____lb	_____lb	_____lb
2.0 Aggregate No. 1 Size_____ Source:_____				
SSD ____	_____lb	_____lb	_____lb	_____lb
Alternate No. 1 Lightweight Aggregates Type _____ Source: _____				
Sp. Gr. Factor _____				
Oven Dry	_____lb	_____lb	_____lb	_____lb
Wet	_____lb	_____lb	_____lb	_____lb
2.1 Aggregate No. 2 Size_____ Source:_____				
SSD ____	_____lb	_____lb	_____lb	_____lb
2.2 Aggregate Nos. 3, 4, n) Size_____Source:_____				
SSD ____	_____lb	_____lb	_____lb	_____lb
3.0 Water	_____lb	_____lb	_____lb	_____lb
4.0 Admixtures Source: _____				
_____ Type _____	_____oz	_____oz	_____oz	_____oz
_____ Type _____	_____oz	_____oz	_____oz	_____oz
_____ Type _____	_____oz	_____oz	_____oz	_____oz

EXAMPLE FORM B (CONTINUED)

5.0 Other Materials

_____ Type _____ _____lb _____lb _____lb _____lb

_____

Total Mass: _____lb _____lb _____lb _____lb

Total Mass/cy: _____pcy _____pcy _____pcy _____pcy

Relative Cubic Yard Volume:
_____cy _____cy _____cy _____cy

Water-Cementitious Material Ratio:

Fresh Concrete Properties

_____

TRAIL BATCH NUMBER

	## -1	## -2	## -3	## -4
Slump-inches	_____	_____	_____	_____
Air-Content %	_____	_____	_____	_____
Unit Wt. pcf	_____	_____	_____	_____
Concrete Temp. °F	_____	_____	_____	_____

Compressive Strength Results (ASTM C192, C39) or Other Specified Test Requirements

7 days	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Average (7 day)	_____	_____	_____	_____

EXAMPLE FORM B (CONTINUED)

28 days	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Average (28 day)	_____	_____	_____	_____
Water-Cementitious Material Ratio:				
	_____	_____	_____	_____

Signature: _____Date:_____

Title:_____

Organization: _____

END OF SECTION 030000

SECTION 030000.02 - EXPANSION AND CONSTRUCTION JOINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

1.2 DESCRIPTION OF WORK

A. This work includes furnishing and installing all joints where necessary.

B. In general, the work may include the following types of joints:

1. Types A, D, E, F, H and J Expansion Joint
2. Types B and L Waterstop Construction Joint
3. Types C and G Isolation Joints
4. Type K Construction Joint
5. Type CJ Control Joint

C. Refer to the contract drawings and specifications for locations and details of the joints to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The non-extruding preformed filler for joint Types A, C, D, E, F, J, L, and M shall conform to the requirements of "Standard Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction" ASTM D 1752, Type I, Sponge Rubber. Preformed filler shall be "Sponge Rubber" as manufactured by W.R. Meadows Company, Everlastic 1300 Series concrete gray sponge by Williams Products, Inc. or equal.

B. The preformed filler for joint Type H shall conform to the requirements of ASTM D 1752, Type III, self-expanding cork. Self-expanding cork shall be as manufactured by W.R. Meadows Company, or equal.

C. Preformed filler strips up to one (1) inch thickness shall be made as a single piece. Strips greater than one (1) inch thickness shall be fabricated by cementing together a minimum number of pieces. All cementing or vulcanizing shall be done at the point of manufacture.

D. The joint sealer shall be cold applied in accordance with manufacturer's recommendations.

1. Where the joint is not in contact with water, "No-Trak" as manufactured by A.C. Horn, Inc., "Gardox" by W.R. Meadows, Inc., or equal, shall be used.
2. Where the joint is in contact with water, "Sikaflex-IA" as manufactured by Sika Corporation, or equal shall be used.

E. Extruded polyvinyl chloride (PVC) waterstops for Type "C" joint shall be nine (9) inches in width, not less than three-eighths (3/8) inch in thickness; Type "L" joint shall be four (4) inches wide, not less than three-sixteenths (3/16) inch in thickness; Types "G" and "J" joint shall be six (6) inches in

width, not less than three-eighths (3/8) inch in thickness and all waterstops shall be of corrugated construction. Types "C", "G", and "J" shall have a center bulb and corrugated ends. The waterstops shall be made continuous by use of factory made fittings and field jointing by heat welding in accordance with the manufacturer's recommendations. PVC waterstops shall be as manufactured by Vinylex Corporation, Greenstreak Products, or equal. Provide a test report for each lot of waterstops shipped to the job site.

F. Type "B" joints shall be as detailed on the drawings. The preformed plastic waterstops shall meet or exceed all requirements of Federal Specifications SS-S-210A, "Sealing Compound for Expansion Joints". Such preformed plastic waterstop shall be "Snyko-Flex" waterstop manufactured by Synko-Flex Products, 2100 Travis Street, Houston, Texas, or an approved equivalent.

G. Elastomeric bearing pad in joint Type "G" shall be 50 durometer Everlastic 1200 Series Neoprene as manufactured by William Products, Inc., or equal.

H. Type "K" joint shall be constructed as detailed on the drawings.

I. Type "CJ" premolded insert shall be "Speed-E-Joint" by W.R. Meadows, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Form work shall be designed to hold the preformed filler in alignment within the joint during and after concrete is poured. General description of the joints are as follows:

1. Type "A", "D", "E" and "F" expansion joints shall consist of non-extruding preformed filler only to separate the adjoining faces of concrete without the use of a waterstop. The top shall be finished by a joint sealer for slabs. Unless otherwise shown, preformed filler shall be three-fourths (3/4) inch thick and shall be of a width equal to the faces of concrete which it is separating. Where required, the preformed filler shall be attached to concrete by the use of an approved adhesive. Apply bond breaker to edge of preformed filler material only, prior to placing joint sealer. The joint sealer shall bond only to the concrete surfaces.
2. Type "B" waterstop construction joint shall consist of a standard construction joint and waterstop as detailed on the drawings.
3. Types "C" and "J" joint shall consist of preformed filler material, waterstop and joint sealer as detailed on the drawings.
4. Type "G" joint shall consist of an elastomeric bearing pad and waterstop as detailed on the drawings.
5. Type "H" joint shall consist of self-expanding cork to separate the adjoining faces of concrete without the use of a waterstop. The top shall be finished by a joint sealer.
6. Type "CJ" Control joints shall be made by inserting a removable preformed insert to create a joint which is then filled with a joint sealer, if required.
7. Type "K" joint shall consist of a standard construction joint, a saw cut, and joint sealer as detailed on the drawings.

B. PVC waterstops shall be wired to the reinforcing steel every 12" to prevent misalignment during concreting.

END OF SECTION 030000.02

SECTION 033100 - CAST-IN-PLACE CONCRETE FOR PRECAST POST-TENSIONED CONCRETE TANK BASE SLABS

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 form materials, reinforcement, accessories, cast-in-place concrete, and slab finishing and curing for the base slabs of the precast post-tensioned concrete tanks for the entire project. The work performed under this Section includes all labor, material, equipment, related services, and supervision required for the mixing, placing and finishing of cast-in-place concrete.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Material test reports shall show compliance with the required standards and be less than one year old.

B. Design Mixtures: For each concrete mixture. Include minimum required compressive strength and field experience records or trial mix data.

1.4 QUALITY ASSURANCE

A. Construct and erect concrete formwork and accessories in accordance with ACI 301, ACI 347 and ACI 350.

B. Perform concrete reinforcing work in accordance with ACI 301 and ACI 350.

C. Perform cast-in-place concrete work in accordance with ACI 301 and ACI 350.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306R when concreting during cold weather.

F. Referenced Standards:

1. ACI 117, “Standard Specifications for Tolerances for Concrete Construction and Materials”
2. ACI 301, “Specifications for Structural Concrete”
3. ACI 305R, “Guide to Hot Weather Concreting”
4. ACI 306R, “Guide to Cold Weather Concreting”
5. ACI 350, “Code Requirements for Environmental Engineering Concrete Structures”
6. ACI 350.5, “Specifications for Environmental Concrete Structures”

7. ASTM A 615, “Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement”
8. ASTM A 775, “Standard Specification for Epoxy-Coated Steel Reinforcing Bars”
9. ASTM A 934, “Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars”
10. ASTM A 1064, “Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete”
11. ASTM C 31, “Standard Practice for Making and Curing Concrete Test Specimens in the Field”
12. ASTM C 33, “Standard Specification for Concrete Aggregates”
13. ASTM C 39, “Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens”
14. ASTM C 94, “Standard Specification for Ready-Mixed Concrete”
15. ASTM C 143, “Standard Test Method for Slump of Hydraulic-Cement Concrete”
16. ASTM C 150, “Standard Specification for Portland Cement”
17. ASTM C 172, “Standard Practice for Sampling Freshly Mixed Concrete”
18. ASTM C 231, “Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method”
19. ASTM C 260, “Standard Specification for Air-Entraining Admixtures for Concrete”
20. ASTM C 295, “Standard Guide for Petrographic Examination of Aggregates for Concrete”
21. ASTM C 494, “Standard Specification for Chemical Admixtures for Concrete”
22. ASTM C 595, “Standard Specification for Blended Hydraulic Cements”
23. ASTM C 618, “Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete”
24. ASTM C 881, “Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete”
25. ASTM C 920, “Standard Specification for Elastomeric Joint Sealants”
26. ASTM C 989, “Standard Specification for Slag Cement for Use in Concrete and Mortars”
27. ASTM C 1012, “Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution”
28. ASTM C 1067, “Standard Practice for Conducting a Ruggedness Evaluation or Screening Program for Test Methods for Construction Materials”
29. ASTM C 1116, “Standard Specification for Fiber-Reinforced Concrete”
30. ASTM C 1157, “Standard Performance Specification for Hydraulic Cement”
31. ASTM C 1218, “Standard Test Method for Water-Soluble Chloride in Mortar and Concrete”
32. ASTM C 1260, “Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
33. ASTM C 1567, “Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
34. ASTM C 1778, “Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete”
35. ASTM D 4397, “Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications”
36. CRSI, “Manual of Standard Practice”

PART 2 – PRODUCTS

2.1 FORM MATERIALS AND ACCESSORIES

A. Form Materials: At discretion of Tank Supplier.

B. Formed Construction Joints: Keyed joints as indicated on the tank Shop (Erection) drawings provided by the Tank Supplier. Provide holes in formwork to receive reinforcing across the joint.

C. Vapor Retarder: ASTM D 4397, 6 mil thick, clear polyethylene film.

2.2 NON-PRESTRESSED REINFORCING STEEL

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Welded Wire Reinforcement: ASTM A 1064, plain or deformed, flat sheet.

C. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for support of reinforcing.

D. Fabricate concrete reinforcement in accordance with ACI 301, ACI 350 and CRSI Manual of Standard Practice.

2.3 CONCRETE MATERIALS

A. Hydraulic Cement:
   a. Portland Cement: ASTM C 150, Type II or Type I/II.
   b. Blended Cement: ASTM C 595 with (MS) designation for moderate sulfate resistance, excluding Type IS ≥70). Blended cements that include ASTM C 1157 cements shall not be permitted.
   c. Concrete mixtures shall include either fly ash or slag as shown below, but within the limits stipulated in 2.4.C, unless the proposed combination of cementitious materials has been tested in accordance with ASTM C 1012 and resulted in expansion of not more than 0.10 percent at 6 months.
      i. At least 15 percent fly ash replacement by mass, or
      ii. At least 50 percent slag replacement by mass.
   d. Different types of cement shall not be mixed or used alternately without specific written approval by the Precast Tank Engineer. Different brands of cement may be used when authorized in writing by the Precast Tank Engineer. A resubmittal will be required if different brands are proposed during the Project.

B. Supplementary Cementitious Materials

   1. Fly Ash: ASTM C 618, Class F with alkali content ($\%Na_2O_{eq}$) less than 3.0%.
   2. Slag: ASTM C 989, Grade 100 or 120, ground granulated blast furnace slag.

C. Fine and Coarse Aggregates: ASTM C33, 1-inch maximum size.

a. All aggregates shall be evaluated in accordance with ASTM C 1778 for potential alkali-silica reactivity (ASR). All aggregates shall be considered reactive unless they have been examined in accordance with ASTM C 295 and found to be non-reactive.
b. Concrete mixtures using potentially reactive aggregates, except as permitted by 2.3.C.c, shall include either fly ash or slag as shown below, but within the limits stipulated in 2.4.C.
    i. At least 25 percent fly ash replacement by mass where Portland cement alkali content is less than 1.00%, or at least 35 percent fly ash replacement by mass where Portland cement alkali content is 1.00 to 1.25%, or
    ii. At least 50 percent slag replacement by mass where Portland cement alkali content is less than 1.00%, or at least 65 percent slag replacement by mass where Portland cement alkali content is 1.00% to 1.25%.
    iii. Portland cement alkali loading shall not exceed 3.0 lb/yd^3 (LBA). Alkali loading shall be calculated as shown below:
        1. LBA = Portland cement content (lbs) x alkali content (% Na_2O_{eq}) / 100.
c. Aggregates meeting the requirements below may be considered non-reactive.
    i. ASTM C 1260, Potential Alkali Reactivity of Aggregates (Mortar-Bar Method). Average expansion of less than 0.10 percent at 16 days after casting.
    ii. ASTM C 1567, Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregates (Accelerated Mortar-Bar Method). Average expansion of less than 0.10 percent at 16 days after casting.

D. Concrete Reinforcing Fibers: ASTM C 1116, high-strength industrial-grade fibers.

E. Water: Potable; free from deleterious material that may affect setting or strength of concrete.

F. Air Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride or more than 0.15 percent chloride ions or other salts by weight of admixture.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. Water-Reducing and Accelerating Admixture ASTM C494, Type E.
5. High Range, Water-Reducing Admixture: ASTM C 494, Type A and F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.

2.4 CONCRETE MIXTURES

A. Mix and deliver concrete in accordance with ASTM C 94, Option C.

B. Select proportions for normal weight concrete in accordance with ACI 301, Method 1 or Method 2.

C. Prepare design mixtures for each type of concrete required.

1. The inclusion of either fly ash or slag in the concrete mix is mandatory.
2. Where fly ash is used:
    i. The minimum fly ash content shall be 15 percent replacement of cementitious material by weight, and the maximum content shall be 35%.
    ii. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.
3. Where slag is used:
    i. The minimum slag content shall be 15 percent replacement of cementitious material by weight, and the maximum content shall be 65%.
    ii. Additional slag shall not be included in concrete mixed with Type IS or IP cement.
4. The inclusion of both fly ash and slag shall not be permitted without specific written approval by the Precast Tank Engineer.
5. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 350 when tested in accordance with ASTM C 1218.

D. Furnish concrete as indicated below:

1. Compressive Strength (28 Days): 4,500 psi minimum
2. Maximum Water-Cementitious Materials Ratio: 0.42
3. Slump: 7 inches, ±1 inch utilizing high-range, water-reducing admixture.
4. Minimum cementitious content: 564 pounds per cubic yard

E. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 6%, ±1-1/2%.

F. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

G. Do not use calcium chloride or admixtures containing calcium chloride.

2.5 WATERSTOPS

A. Flexible PVC Waterstops: Corp of Engineers CRD-C 572 for embedding in concrete construction joints to prevent the passage of fluids through joints. Factory-fabricate corners, intersections and directional changes.

1. Profile: Ribbed without center bulb.
2. Dimensions: 6 inches by 3/8-inch-thick, non-tapered.
3. Acceptable Products:
    a. Greenstreak PVC Waterstop #679, or equal.

B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free, hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete.

1. Acceptable Products:
    a. Greenstreak Hydrotite® CJ-1030-4M, or equal.

C. Self-Expanding Extrudable Waterstops: Extrudable, swelling, bentonite-free, one-part polyurethane.

1. Acceptable Products:
    a. SikaSwell® S-2, or equal

2.6 RELATED MATERIALS

A. Crack Filler: ASTM C 881, two-part, moisture-tolerant, very-low-viscosity, epoxy injection adhesive for filling cracks.

1. Acceptable Products:
    a. Sikadur® 52, or equal

B. Crack Sealer: ASTM C 920, Type S, Grade NS, Class 35 one-part polyurethane, elastomeric sealant, for sealing cracks.

1. Acceptable Products:
    a. Sikaflex®-1a, or equal

PART 3 – EXECUTION

3.1 PREPARATION

A. Proceed with base slab construction only after unsatisfactory conditions have been corrected in accordance with Section 034200, “Precast Post-tensioned Concrete Tanks.”

3.2 FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements.

B. Provide bracing to ensure stability of formwork.

3.3 EMBEDDED COMPONENTS AND OPENINGS

A. Coordinate work of other sections in forming and setting openings, slots, keyways, sleeves, bolts, anchors, pipe sleeves and other embedded components.

B. Install concrete accessories straight, level and plumb.

C. Install water stops continuous without displacing reinforcing. Heat seal joints watertight.

D. Place construction joint forms in accordance with base slab pouring sequence.

3.4 REINFORCEMENT PLACEMENT

A. Place reinforcement, supported and secured against displacement.

B. Ensure reinforcing is clean, free of loose scale, dirt or other foreign coatings.

C. Space reinforcement bars with minimum clear spacing in accordance with ACI 350, but not less than 1-1/2 inches.

D. Place reinforcement bars and maintain cover in accordance with tolerances listed in ACI 117 and ACI 350.

3.5 PLACING CONCRETE

A. Install vapor retarder under base slab as indicated on the tank Shop (Erection) drawings provided by the Tank Supplier.

B. Ensure reinforcement, embedded components and formwork is not displaced during concrete placement.

C. Deposit concrete as closely as practicable to final position. Prevent segregation of mix.

D. Place concrete continuously between predetermined construction joints. Subsequent placements shall use the same concrete mix as the initial placement.

E. Consolidate concrete.

F. Maintain records of concrete placement. Record date, location, quantity, air temperature and test samples taken.

G. Screed base slab level. Maintain slab flatness meeting the Conventional floor surface classification as measured using the Manual Straightedge Method per ACI 117, Table 4.8.6.1, unless indicated otherwise on the tank Shop (Erection) drawings provided by the Tank Supplier.

3.6 FINISHING

A. Steel-trowel finish unformed surfaces.

B. In areas with floor drains, maintain slab level at walls and slope uniformly to drains.

3.7 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

1. Concrete, except high-early strength concrete, shall be maintained above 50° F and in a moist condition for at least the first three days after placement.

2. When concrete could be exposed to more than one freezing and thawing cycle during construction, protect concrete from freezing until concrete strength of 3,500 psi is achieved. Strength shall be verified using field-cured cylinders.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3.8 FIELD QUALITY CONTROL

A. Place no concrete for the base slab until the subgrade has been inspected and approved by the Owner's Geotechnical Engineer.

B. Perform field inspection and testing in accordance with ACI 301.

C. Testing: Owner will engage accredited independent testing and inspecting agency to perform field tests and prepare reports.

1. Testing agency will report test results promptly and in writing to Contractor, Engineer of Record and Tank Supplier.

D. Strength Test Samples:

1. Sampling Procedures: ASTM C 172
2. Cylinder Molding and Curing Procedures: ASTM C 31, cylinder specimens, standard cured.
   a. When there are early-age strength requirements, strength shall be evaluated using field-cured cylinders.
3. Sample concrete and make one set of five 4" x 8" cylinders for every 50 cubic yards or less of each class of concrete placed each day and for every 5,000 square feet of surface area.
   a. Make additional sets of three 4" x 8" cylinders at the discretion of the Tank Supplier when required to verify early-age strength.

E. Field Testing:

1. Slump Test Method: ASTM C 143
2. Air Content Test Method: ASTM C 231
3. Temperature Test Method: ASTM C 1067
4. Measure slump and temperature for each compressive strength concrete sample.
5. Measure air content in air entrained concrete for each compressive strength concrete sample.

F. Cylinder Compressive Strength Testing:

1. Test Method: ASTM C39
2. Evaluation and Acceptance of Concrete: In accordance with ACI 350.
3. Test three 4" x 8" cylinders at 28 days.
4. Retain two cylinders for 56 days for testing when requested by Engineer.

5. Dispose of remaining cylinders when testing is not required.

3.9 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replace defective concrete. Repairs will be permitted provided structural adequacy, serviceability and durability of concrete elements comply with requirements of this section.

END OF SECTION 033100

SECTION 034300 - PRECAST POST-TENSIONED CONCRETE TANKS – CIRCULAR

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the performance criteria, materials, design, production, and erection of circular precast post-tensioned concrete tanks for the entire project. The work performed under this Section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the circular precast post-tensioned concrete tanks shown on the Contract Drawings.

B. Work includes:
   1. Final Clarifier

C. Related Requirements:
   1. Section 310000 “Earthwork” for preparing the subgrade to support the tanks and for backfilling requirements.
   2. Section 033100 “Cast-in-Place Concrete for Precast Post-tensioned Concrete Tank Base Slabs” for concrete for the base slab.
   3. Section 0550000 “Metal Fabrications” for furnishing and installing loose hardware items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Material test reports shall show compliance with the required standards and be less than one year old.

B. Design Mixtures: For each concrete mixture. Include minimum required compressive strength and field experience records or trial mix data.

C. Shop (Erection) Drawings:
   1. Indicate configuration, thickness, dimensions and details of cast-in-place concrete base slab.
   2. Indicate size, spacing and details of all necessary base slab reinforcing.
   3. Indicate plan views, elevations, sections, and details necessary to install the tank.
   4. Indicate locations of all post-tensioned tendons.
   5. Indicate tendon stressing sequence and force, and theoretical elongations for all post-tensioned tendons.
   6. Include and locate all pipe penetrations. Indicate all penetration styles.
   7. Coordinate and indicate openings required by other trades.

8. Indicate location of each precast concrete member by same identification mark placed on unit.
9. Indicate relationship of structural precast concrete members to adjacent materials.
10. Indicate locations and details of joint treatment.
11. Indicate shim sizes and grout requirements.
12. Indicate bearing pad sizes and materials.

D. Comprehensive engineering design signed and sealed by a qualified professional engineer responsible for its preparation licensed in **Ohio.**

1.3 SUBMITTALS

A. Qualification Data: For Tank Supplier and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.

B. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements.
1. Cementitious materials.
2. Aggregates.
3. Reinforcing materials and post-tensioning strands.
4. Post-tensioning duct and anchorages.
5. Admixtures.
6. Bearing pads.
7. Other components specified in Contract Documents with applicable standards.

C. Provide handling procedures, erection sequences, and temporary bracing as required for special conditions.

D. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Tank Supplier Qualifications: A firm that complies with the following requirements and is experienced in producing circular precast post-tensioned concrete tanks that have a record of successful in-service performance.

1. Assumes responsibility for engineering circular precast post-tensioned concrete tanks to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

2. Precast Tank Engineer Qualifications: A professional engineer licensed in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for designs and installations of circular precast post-tensioned concrete tanks.

3. Participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group C, Category C3.

   a. Certification shall be maintained throughout the production of the precast concrete units. Production shall immediately stop if at any time the fabricator's certification is revoked, regardless of the status of completion of contracted work. Production will not be allowed to re-start until the necessary corrections are made and certification has been re-established. In the event certification cannot be re-established in a timely manner to avoid project delays, the fabricator, at no additional cost, will contract out the remainder of the units to be manufactured at a PCI certified plant.

4. Has sufficient production capacity to produce required members to meet the project schedule.

B. Tank Supplier: Subject to compliance with requirements, provide circular precast post-tensioned concrete tanks by Dutchland, Inc. located in Gap, Pennsylvania, or approved equal.

C. Alternate Tank Supplier Pre-approval Qualifications: Alternate Tank Suppliers wishing to become pre-approved shall comply with the Tank Supplier Qualifications listed above, and the following requirements.
   1. The firm shall have a minimum of 5 consecutive years in designing, producing and installing tanks of similar arrangement, size and complexity using the precast, post-tensioned concrete system.
   2. The firm shall document the successful installation and performance of a minimum of ten similar facilities and certify compliance of those structures will all applicable provisions of ACI 350 for a precast post-tensioned concrete structure.
   3. The firm shall employ a full-time engineer on staff who meets the Precast Tank Engineer Qualifications listed above and who has served as the engineer in responsible charge of at least ten similar structures.
   4. The firm shall submit with its bid a summary sheet documenting compliance with these qualifications.
   5. The firm shall submit with its bid a reference sheet listing contact names and telephone numbers of at least five similar structures built by the firm.

D. Post-Tensioning Installer Qualifications: A qualified installer whose full-time Project superintendent has successfully completed PTI's Level 1 Bonded PT - Field Installation course.

1. Superintendent must receive training from post-tensioning supplier in the operation of stressing equipment to be used on Project.

E. Post-Tensioning Inspector Qualifications: Personnel performing field inspections and measuring elongations shall have successfully completed PTI's Level 1 Bonded PT – Field Installation course.

F. Design Standards: Comply with ACI 350, "Tendon-Prestressed Concrete Water Tanks" and the design recommendations of PCI MNL 120, "PCI Design Handbook – Precast and Prestressed Concrete," applicable to types of structural precast concrete members indicated.

G. Quality-Control Standard: For manufacturing procedures and testing requirements and quality control recommendations for types of members required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Concrete Products."
   1. Comply with dimensional tolerances of PCI MNL 135, "Tolerance Manual for Precast and Prestressed Concrete Construction."

H. Plant Quality Control Manager Qualifications: The plant quality control manager shall be currently certified as a PCI Level 2 Plant Quality Control Technician.

I. Plant Manager Qualifications: The plant manager shall be currently certified as a PCI Level 2 Plant Quality Control Technician.

J. Referenced Standards:
   1. AASHTO M 251, "Standard Specification for Plain and Laminated Elastomeric Bridge Bearings"
   2. ACI 117, "Standard Specifications for Tolerances for Concrete Construction and Materials"
   3. ACI 301, "Specifications for Structural Concrete"
   4. ACI 318, "Building Code Requirements for Structural Concrete"
   5. ACI 350, "Code Requirements for Environmental Engineering Concrete Structures"
   6. ACI 350.1, "Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures"
   7. ACI 350.3, "Seismic Design of Liquid-Containing Concrete Structures"
   8. ACI 350.4R, "Design Considerations for Environmental Engineering Concrete Structures"
   9. ACI 350.5, "Specifications for Environmental Concrete Structures"
   10. ASCE 7, "Minimum Design Loads for Buildings and Other Structures"
   11. ASTM A 36, "Standard Specification for Carbon Structural Steel"
   12. ASTM A 108, "Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished"

13. ASTM A 123, “Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products”
14. ASTM A 276, “Standard Specification for Stainless Steel Bars and Shapes”
15. ASTM A 416, “Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete”
16. ASTM A 615, “Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement”
17. ASTM A 666, “Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar”
18. ASTM A 706, “Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement”
19. ASTM A 775, “Standard Specification for Epoxy-Coated Steel Reinforcing Bars”
20. ASTM A 780, “Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings”
21. ASTM A 934, “Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars”
22. ASTM A 1064, “Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete”
23. ASTM C 31, “Standard Practice for Making and Curing Concrete Test Specimens in the Field”
24. ASTM C 33, “Standard Specification for Concrete Aggregates”
25. ASTM C 39, “Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens”
26. ASTM C 42, “Standard Test Method for Obtaining and Testing Drilled Cores and sawed Beams of Concrete”
27. ASTM C 94, “Standard Specification for Ready-Mixed Concrete”
28. ASTM C 143, “Standard Test Method for Slump of Hydraulic-Cement Concrete”
29. ASTM C 150, “Standard Specification for Portland Cement”
30. ASTM C 172, “Standard Practice for Sampling Freshly Mixed Concrete”
31. ASTM C 231, “Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method”
32. ASTM C 260, “Standard Specification for Air-Entraining Admixtures for Concrete”
33. ASTM C 295, “Standard Guide for Petrographic Examination of Aggregates for Concrete”
34. ASTM C 494, “Standard Specification for Chemical Admixtures for Concrete”
35. ASTM C 595, “Standard Specification for Blended Hydraulic Cements”
36. ASTM C 618, “Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete”
37. ASTM C 881, “Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete”
38. ASTM C 920, “Standard Specification for Elastomeric Joint Sealants”
39. ASTM C 989, “Standard Specification for Slag Cement for Use in Concrete and Mortars”

40. ASTM C 1012, “Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution”
41. ASTM C 1067, “Standard Practice for Conducting a Ruggedness Evaluation or Screening Program for Test Methods for Construction Materials”
42. ASTM C 1107, “Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)”
43. ASTM C 1116, “Standard Specification for Fiber-Reinforced Concrete”
44. ASTM C 1157, “Standard Performance Specification for Hydraulic Cement”
45. ASTM C 1218, “Standard Test Method for Water-Soluble Chloride in Mortar and Concrete”
46. ASTM C 1240, “Standard Specification for Silica Fume Used in Cementitious Mixtures”
47. ASTM C 1260, “Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
48. ASTM C 1567, “Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)”
49. ASTM C 1610, “Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique”
50. ASTM C 1611, “Standard Test Method for Slump Flow of Self-Consolidating Concrete”
51. ASTM C 1621, “Standard Test Method for Passing Ability of Self-Consilidating Concrete by J-Ring”
52. ASTM C 1778, “Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete”
53. ASTM D 412, “Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension”
54. ASTM D 2240, “Standard Test Method for Rubber Property-Durometer Hardness”
55. ASTM F 593, “Standard Specification for Stainless Steel Bolts, Hex Cap Screw, and Studs”
56. AWS D1.4, “Structural Welding Code – Reinforcing Steel”
57. PCI MNL-116, “Manual for Quality Control for Plants and Production of Structural Concrete Products”
58. PCI MNL-120, “PCI Design Handbook – Precast and Prestressed Concrete”
59. PCI MNL-135, “Tolerance Manual for Precast and Prestressed Concrete Construction”
60. PTI TAB.1, “Post-Tensioning Manual”
61. PTI M50.1, “Acceptance Standards for Post-Tensioning Systems”
62. PTI M55.1, “Specification for Grouting of Post-Tensioned Structures”

K. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

L. Convene minimum one week prior to commencing Work of this Section.

M. Tank designs that rely on bolted or welded connections, or ship-lap joints, for primary, fluid-retaining walls shall not be allowed.

N. Shotcrete shall not be allowed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle post-tensioning materials in accordance with PTI.

B. Deliver all precast concrete members in such quantities and at such times to assure compliance with the agreed upon project schedule and setting sequence to ensure continuity of installation.

C. Handle and transport precast concrete members in a manner to avoid excessive stresses that could cause cracking or other damage.

D. Store precast concrete members with adequate dunnage and bracing, and protect units to prevent contact with soil, staining, and to control cracking, distortion, warping or other physical damage.

PART 2 – PRODUCTS

A. Structural Performance: Provide circular precast post-tensioned concrete tanks capable of withstanding the design loads under conditions indicated in the Geotechnical Report.

B. General Tank Design Criteria:
   1. Wall thickness shall be as required by ACI 350.
   2. Backfill shall not be used to offset fluid loads.
   3. The tank walls shall be prestressed in accordance with ACI 350.
      a. Tank walls shall have horizontal post-tensioned tendons to provide residual compression stress.
      b. Minimum residual compression shall be 125 psi after allowance for all prestress losses.
   4. Comply with ACI 350 requirements including, but not limited to:
      a. Load factors.
      b. Limits on stresses at transfer of prestress and under service load.
      c. Minimum bonded reinforcement.
      d. Concrete cover over reinforcement.
   5. The tank structure shall be designed to resist low to medium strength residential wastewater.
   6. The tank structure shall be designed for normal environmental exposure.

7. Design circular precast post-tensioned concrete tanks to allow for fabrication and construction tolerances, and to accommodate deflection, shrinkage and creep of primary tank structure. Maintain structural precast concrete deflections within limits of ACI 350.
8. Flotation ~~safety~~ factors:
    a. Maximum groundwater elevation is 569.
9. Refer to Geotechnical Engineering Report by CT Consultants, dated August 5, 2024 for additional foundation design recommendations.
10. Minimum reinforcement in each orthogonal direction shall be in accordance with ACI 350.
11. Frost depth: 42 inches.

2.1 MANUFACTURERS

A. Source Limitations: Obtain post-tensioning materials and equipment from single source.

2.2 FORM MATERIALS

A. Forms: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required surface finishes.
    1. Form-Release Agent: Commercially produced form-release agent that will not bond with, stain or affect hardening of precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

2.3 NON-PRESTRESSED REINFORCING STEEL

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed.

C. Welded Wire Reinforcement: ASTM A 1064, plain or deformed, flat sheet.

D. Supports: Use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.4 PRESTRESSING TENDONS

A. Bonded Prestressing Strand: ASTM A 416, Grade 270, 7-wire, low-relaxation, 0.6-inch-diameter strand.

B. Anchorage Device and Coupler Assembly: Assembly of strand, wedges, and anchorage device or coupler complying with static and fatigue testing requirements and capable of developing 95 percent of actual breaking strength of strand.

2.5 ACCESSORIES

A. Duct: Flexible, corrugated, high-density polyethylene.

2.6 CONCRETE MATERIALS

A. Hydraulic Cement:
   a. Portland Cement: ASTM C 150, Type II or Type I/II.
   b. Blended Cement: ASTM C 595 with (MS) designation for moderate sulfate resistance, excluding Type IS ≥70). Blended cements that include ASTM C 1157 cements shall not be permitted.
   c. Portland cement alkali loading shall not exceed 3.0 lb/yd^3 (LBA). Alkali loading shall be calculated as shown below:
      i. LBA = Portland cement content (lbs) x alkali content (% Na_2O_{eq}) / 100.
   d. Concrete mixtures shall include either fly ash or slag as shown below, but within the limits stipulated in 2.12.A, unless the proposed combination of cementitious materials has been tested in accordance with ASTM C 1012 and resulted in expansion of not more than 0.10 percent at 6 months.
      i. At least 15 percent fly ash replacement by mass, or
      ii. At least 50 percent slag replacement by mass.
   e. Different types of cement shall not be mixed or used alternately. Different brands of cement may be used when authorized in writing by the Precast Tank Engineer. A resubmittal will be required if different brands are proposed during the Project.

B. Supplementary Cementitious Materials
   1. Fly Ash: ASTM C 618, Class F with alkali content (%Na_2O_{eq}) less than 3.0%.
   2. Slag: ASTM C 989, Grade 100 or 120, ground granulated blast furnace slag.
   3. Silica Fume: ASTM C 1240.

C. Fine and Coarse Aggregates: ASTM C33, 3/4-inch maximum size.
   a. All aggregates shall be evaluated in accordance with ASTM C 1778 for potential alkali-silica reactivity (ASR). All aggregates shall be considered reactive unless they have been examined in accordance with ASTM C 295 and found to be non-reactive.
   b. Concrete mixtures using potentially reactive aggregates, except as permitted by 2.3.C.c, shall include either fly ash or slag as shown below, but within the limits stipulated in 2.4.C.
      i. At least 25 percent fly ash replacement by mass where Portland cement alkali content is less than 1.00%, or at least 35 percent fly ash replacement by mass where Portland cement alkali content is 1.00 to 1.25%, or

ii. At least 50 percent slag replacement by mass where Portland cement alkali content is less than 1.00%, or at least 65 percent slag replacement by mass where Portland cement alkali content is 1.00% to 1.25%.

c. Aggregates meeting the requirements below may be considered non-reactive.
   i. ASTM C 1260, Potential Alkali Reactivity of Aggregates (Mortar-Bar Method). Average expansion of less than 0.10 percent at 16 days after casting.
   ii. ASTM C 1567, Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregates (Accelerated Mortar-Bar Method). Average expansion of less than 0.10 percent at 16 days after casting.

d. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

E. Air Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride or more than 0.15 percent chloride ions or other salts by weight of admixture.
   1. Water-Reducing Admixture: ASTM C 494, Type A.
   2. Retarding Admixture: ASTM C 494, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
   4. Water-Reducing and Accelerating Admixture ASTM C494, Type E.
   5. High Range, Water-Reducing Admixture: ASTM C 494, Type A and F.
   6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
   7. Plasticizing Admixture for Flowable Concrete: ASTM C 1017.

2.7 STEEL EMBEDDED MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M

B. Carbon-Steel Headed Studs: ASTM A 108, Grades 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with the minimum mechanical properties of PCI MNL 116, Table 3.2.3.

C. Deformed-Steel Wire or Bar Anchors: ASTM A 1064 or ASTM A 706/A 706M.

D. Zinc-Coated Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123, after fabrication.
   1. Galvanizing Repair Paint: Zinc paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

2.8 STAINLESS-STEEL EMBEDDED MATERIALS

A. Stainless-Steel Plate: ASTM A 666, Type 304, Type 316, or Type 201, of grade suitable for application.

B. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.

C. Stainless-Steel Headed Studs: ASTM A 276, with minimum mechanical properties for studs as indicated under MNL 116, Table 3.2.3.

2.9 BEARING PADS AND OTHER ACCESSORIES

A. Provide one of the following bearing pads for structural precast concrete members as recommended by tank supplier for application:
   1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer according to ASTM D 2240, minimum tensile strength 2250 psi per ASTM D 412.
   2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 3000 psi with no cracking, splitting or delaminating in the internal portions of the pad.
   3. High-Density Plastic: Multimonomer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.

B. Erection Accessories: Provide steel plates and brackets, clips, hangers, high density plastic shims, and other accessories required to install precast concrete members.

2.10 GROUT MATERIALS

A. Grout for Bonded Tendons: Provide cement grout for bonded tendons as indicated below:
   1. Maximum Water-Cementitious Materials Ratio: 0.43
   2. Limit use of fly ash to 15 percent replacement of portland cement by weight.
   3. Limit use of slag to 20 percent replacement of portland cement by weight.
   4. Add High-Range, Water-Reducing admixture on-site as necessary for placement.
   5. Provide admixtures to prevent bleeding and grout settlement. Material shall be added to the mix on-site.
      a. Acceptable Products: Sika Intraplast-N®, or equal.
   6. Grout shall not contain water-soluble chloride ions in excess of 0.06 percent by weight of cementitious materials.

B. Nonshrink Grout: Premixed, prepackaged, non-metallic, shrink-resistant grout complying with ASTM C 1107, Grade C. Grout shall not contain chlorides.
   1. Acceptable Products:
      a. SikaGrout 212®, or equal.
      b. SikaGrout 328®, or equal.

2.11 PATCHING MATERIALS

A. One-component, polymer-modified, premixed patching material containing selected silica aggregates and portland cement, suitable for vertical and overhead applications. Do not use material containing chlorides or other chemicals known to be deleterious to prestressing steel or material that is reactive with prestressing steel, anchorage device material, or concrete.
   1. Acceptable Products:
      a. ProSpec® BlendCrete, or equal.

2.12 CONCRETE MIXTURES

A. Prepare design mixtures for each type of concrete required.
   1. The inclusion of either fly ash or slag in the concrete mix is mandatory.
   2. Where fly ash is used:
      i. The minimum fly ash content shall be 15 percent replacement of cementitious material by weight, and the maximum content shall be 35%.
      ii. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.
   3. Where slag is used:
      i. The minimum slag content shall be 15 percent replacement of cementitious material by weight, and the maximum content shall be 65%.
      ii. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.
   4. The inclusion of both fly ash and slag shall not be permitted without specific written approval by the Precast Tank Engineer.
   5. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 350 when tested in accordance with ASTM C 1218.
   6. Limit use of silica fume to 10 percent replacement of Portland cement by weight.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at Tank Supplier's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 350 or PCI MNL 116 when tested in accordance with ASTM C 1218/C 1218M.

D. Normalweight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normalweight concrete.

E. Furnish precast concrete as indicated below:
   1. Compressive Strength (28 Days): 5,000 psi minimum.
   2. Maximum Water-Cementitious Materials Ratio: 0.40.
   3. Slump Flow: 24 inches, ±4 inches
   4. Minimum cementitious content: 610 pounds per cubic yard

F. Self-Consolidating Cast-in-Place Concrete for Vertical Wall Joints:
   1. Compressive Strength (28 Days): 5,000 psi minimum.
   2. Maximum Water-Cementitious Materials Ratio: 0.40.
   3. Provide High-Range, Water-Reducing, polycarboxylate-based admixture to achieve a spread of 18 to 24 inches.

G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 6%, ±1-1/2%.

H. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

I. Concrete Mixture Adjustments: Concrete mixture design adjustments may be made if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.13 FORM FABRICATION

A. Form: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placement and vibration operations and temperature changes, and for prestressing and detensioning operations. Coat contact surfaces of forms with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

B. Maintain forms to provide completed structural precast concrete members of shapes, lines, and dimensions within fabrication tolerances specified.
   1. Edge and Corner Treatment: Uniformly chamfered or as built-in on standard forms.

2.14 FABRICATION

A. Cast-in Plates, Inserts, Angles, and Other Hardware: Fabricate hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware and secure in place during precasting

operations. Locate hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy coated reinforcing exceeds limits specified in ASTM A 775, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Locate and support reinforcement by plastic tipped or corrosion resistant metal or plastic chairs, runners, bolsters, spacers, hangers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.
3. Provide cover requirements in accordance with ACI 350. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete.
4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces in accordance with ACI 350 and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

C. Reinforce structural precast concrete members to resist handling, transportation, and erection stresses, and specified in-place loads, whichever governs.

D. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

E. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete members.

F. Place self-consolidating concrete with minimal vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

G. Comply with PCI MNL 116 procedures for hot and cold-weather concrete placement.

H. Identify pickup points of precast concrete members and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast concrete member on a surface that will not show in finished structure.

I. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure members until compressive strength is high enough to ensure that stripping does not have an effect on the performance of final product.

2.15 WATERSTOPS

A. Flexible PVC Waterstops: Corp of Engineers CRD-C 572 for embedding in concrete construction joints to prevent the passage of fluids through joints. Factory-fabricate corners, intersections and directional changes.
   1. Profile: Ribbed without center bulb.
   2. Dimensions: 9 inches by 3/8-inch-thick, non-tapered.
   3. Acceptable Products:
      a. Greenstreak PVC Waterstop #646, or equal.

B. Self-Expanding Rubber Strip Waterstops: Manufactured circular or trapezoidal strip, bentonite-free, hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete.
   1. Acceptable Products:
      a. Greenstreak Hydrotite® CJ-1030-4M, or equal.

C. Self-Expanding Extrudable Waterstops: Extrudable, swelling, bentonite-free, one-part polyurethane.
   1. Acceptable Products:
      a. SikaSwell® S-2, or equal

2.16 RELATED MATERIALS

A. Joint/Crack Filler: ASTM C 920, Type S, Grade NS, Class 35 one-part polyurethane, elastomeric sealant, for sealing precast panel joints and minor cracks.
   1. Acceptable Products:
      a. Sikaflex®-1a, or equal

B. Sealant/Adhesive Primer: Specially-formulated primer to promote adhesion of sealants and adhesives to concrete.
   1. Acceptable Products:
      a. Sikaflex® 429/202, or equal

C. Joint Sealant, Epoxy: High-build, two-part, protective, solvent-free epoxy.
   1. Acceptable Products:
      a. Sikagard® 62, or equal

D. Joint Sealant, Urethane: Liquid-applied, elastomeric, urethane.
   1. Acceptable Products:
      a. CIM 1000, or equal

E. Epoxy Injection Adhesive: Two-part, moisture-tolerant, epoxy injection adhesive.

1. Acceptable Products:
    a. Sikadur® 52, or equal

F. Chemical Grout: Expanding, polyurethane, chemical grout.
    1. Acceptable Products:
        a. SikaFix® HH+, or equal
        b. SikaFix® HH Hydrophilic, or equal

2.17 FABRICATION TOLERANCES

A. Fabricate structural precast concrete members of shapes, lines and dimensions indicated, so each finished member complies with PCI MNL 135 product tolerances as well as position tolerances for cast-in items.

2.18 FINISHES

A. Form Finish:
    1. Standard Grade: Normal plant-run finish produced in forms that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are acceptable. Fill air holes greater than 1/4 inch in width that occur in high concentration (more than one per 2 square inches). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Allowable joint offset limited to 1/8 inch.

B. Smooth steel-trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float and trowel to a smooth, uniform finish.

2.19 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements. If using self-consolidating concrete also test and inspect according to ASTM C 1610, ASTM 1611, and ASTM C 1621.

B. Strength of precast concrete members will be considered deficient if units fail to comply with ACI 350 concrete strength requirements.

C. Testing: If there is evidence that strength of precast concrete members may be deficient or may not comply with ACI 350 requirements, fabricator shall employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42 and ACI 350.
    1. Test results shall be reported in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports shall include the following:
        a. Project identification name and number.

b. Date when tests were performed.
c. Name of Tank Supplier.
d. Name of concrete testing agency.
e. Identification letter, name, and type of precast concrete member(s) represented by core tests; design compressive strength; type of failure; actual compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

D. Patching: If core test results are satisfactory and precast concrete members comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture or repair material, and finish to match adjacent precast concrete surfaces.

E. Acceptability. Structural precast concrete members that do not comply with acceptability requirements in PCI MNL 116, including concrete strength, and manufacturing tolerances, are unacceptable. Chipped, spalled or cracked members may be repaired. Replace unacceptable units with precast concrete members that comply with requirements.

PART 3 – EXECUTION

3.1 PREPARATION

A. General Contractor shall prepare subgrade in accordance with recommendations in the Specification Section 310000 “Earthwork.”

3.2 EXAMINATION

A. Owner’s Geotechnical Engineer shall inspect and approve the subgrade supporting the tank.

B. Unsatisfactory conditions shall be corrected to the satisfaction of the Owner’s Geotechnical Engineer.

C. General Contractor shall notify Tank Supplier in writing that supporting subgrade has been approved by the Owner’s Geotechnical Engineer.

D. Proceed with base slab construction only after unsatisfactory conditions have been corrected.

E. The stone sub-base shall be prepared, leveled, and graded to within ± one inch of stone grade, as indicated on the approved Tank Supplier’s Shop (Erection) drawings.

F. Excavation shall include a minimum of five feet in plan beyond the perimeter of the approved exterior wall line.

G. Site access roads:
   1. Shall be provided and maintained by the General Contractor throughout the installation of the base slab and precast tank structure.
   2. Shall be cleared, leveled, stoned, and free of mud to provide 14-feet of vertical clearance and 14-feet of horizontal clearance.
   3. Shall be capable of handling 80,000 pounds GVWR.
   4. Shall support live loaded trucks operating under their own power.
   5. Shall allow drop-deck, spread axle combinations with 53-ft trailers. This includes a 60-foot-long sweep radius for corners and egress/regress to roadways.

H. Crane and concrete pump pads:
   1. Shall be provided and maintained by the General Contractor.
   2. Shall be cleared, leveled, stoned, and free of mud.
   3. Tank Supplier shall communicate the required locations and sizes of the pads with the General Contractor.

3.3 CAST-IN-PLACE CONCRETE BASE SLAB

A. Install the base slab in accordance with Section 033100 “Cast-in-Place Concrete for Precast Post-Tensioned Concrete Tanks.”

3.4 ERECTION

A. Erect structural precast concrete level, plumb and square within the specified allowable erection tolerances. Provide temporary bracing as required to maintain position, stability, and alignment of members until permanent connections are completed.
   1. Install temporary plastic spacing shims as necessary as precast concrete members are being erected.
   2. Use patching material to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.

B. Install post-tensioning tendons as soon as practical.

C. Place concrete in the vertical wall joints after installing post-tensioning tendons and duct connectors between wall panels.

D. Grouting or Dry-Packing Connections and Joints: Indicate joints to be grouted and any critical grouting sequences on Shop (Erection) Drawings. Grout open spaces at keyways where required or indicated with non-shrink, non-metallic grout. Retain flowable grout in place until it gains sufficient strength to support itself. Fill joints completely without seepage to other surfaces. Alternatively, pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Promptly remove grout material from exposed surfaces before it hardens.

E. Field cutting of precast concrete members is not permitted without approval of the Precast Tank Engineer.

3.5 ERECTION TOLERANCES

A. Erect structural precast concrete members level, plumb, square and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

3.6 TENDON INSTALLATION

A. Inspect for damage before installing tendons.

B. Immediately replace tendons that have damaged strand.

3.7 TENDON STRESSING

A. Stressing jacks and gauges shall be individually identified and calibrated to known standards at intervals not exceeding six months. Exercise care in handling stressing equipment to ensure that proper calibration is maintained.

B. Stress tendons only under supervision of a qualified post-tensioning superintendent.

C. Tendon stressing shall not begin until concrete strength in the vertical wall joints has attained at least 2,500 psi compressive strength.

D. Tendon stressing shall be performed in the sequence indicated on the Shop (Erection) Drawings.

E. Mark and measure elongations to closest 1/8-inch.

F. Tendon elongations shall be recorded and compared to the theoretical elongations indicated on the Shop (Erection) Drawings. Prestressing will be considered acceptable if gage pressures shown on stressing record correspond to required stressing force and theoretical and measured elongations agree.

G. In the event that measured elongations exceed the tolerances indicated on the Shop (Erection) Drawings, the Precast Tank Engineer shall be notified for resolution.

3.8 TENDON FINISHING

A. Strand tails may be cut once prestressing has been deemed acceptable.

B. Do not cut strand tails or cover anchorages of tendons where elongations exceed tolerances until all discrepancies have been resolved to the satisfaction of the Precast Tank Engineer.

C. Cut tendon tails using hydraulic shears as soon as possible after approval of elongations.

3.9 GROUTING OF BONDED TENDONS

A. Execute grouting within 10 days after approval of tendon elongations. If grouting will not be performed within this time period, provide weather protection for the jacking access pockets.

B. Pump grout through ports into the ducts under pressure.

C. Temperature of concrete walls at time of grouting shall be above 35° F and shall be maintained above 35° F until field-cured 2-inch grout cubes reach a minimum of 800 psi.

D. Grout temperatures shall not be above 90° F during mixing and pumping.

E. Coat tendon anchor plates with epoxy coating after grouting is complete.

F. Patch jacking access pockets.

3.10 FIELD QUALITY CONTROL

A. Place no concrete for the base slab until the subgrade has been inspected and approved by the Owner's Geotechnical Engineer.

B. Testing: Owner will engage accredited independent testing and inspecting agency to perform field tests and prepare reports.
   1. Testing agency will report test results promptly and in writing to Contractor, Engineer of Record and Tank Supplier.

C. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

3.11 PROTECTION OF PRESTRESSED REINFORCEMENT

A. Do not expose tendons to electric ground currents, welding sparks, or temperatures that would degrade components.

B. Prevent water from entering tendons during installation and stressing.

C. Provide weather protection to stressing-end anchorages if strand tails are not cut within 10 days of stressing the tendons.

3.12 REPAIRS

A. Repairs will be permitted provided structural adequacy, serviceability and durability of members are not impaired.

B. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.

C. Repair base slab shrinkage cracks as required for watertightness. Rout a ¼-inch vee-notch along the crack and fill the crack with epoxy injection adhesive.

D. Surface chips or spalls shall be cleaned and then patched with patching material.

E. Damage that occurs during the shipping, installation or construction process shall be brought to the attention of the Precast Tank Engineer for resolution.

F. Additional repairs, if necessary, shall be performed as directed by the Precast Tank Engineer.

G. Remove and replace damaged structural precast concrete members when repairs do not comply with specified requirements.

3.13 CLEANING

A. Clean grout and any other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete members after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
   1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect adjacent work from staining or damage due to cleaning operations.
   2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

3.14 TIGHTNESS TESTING

A. Each cell of multi-cell tanks shall be considered a single containment structure and shall be tested individually, unless otherwise specified.

B. The General Contractor shall commence tightness testing within five business days of notification that the structure is ready for testing.

C. Testing shall be performed using the hydrostatic tightness test, which consists of two parts. Part 2 may be waived if approved by the Project Engineer-of-Record.
   1. Part 1 shall be a qualitative criterion.
   2. Part 2 shall be a quantitative criterion expressed as a maximum allowable volume loss of 0.05 percent per 24-hour period.

D. No backfill may be placed against the walls or on the wall footings of the containment structures to be tested, unless otherwise specified.

E. The initial filling of a new containment structure shall not exceed four feet per hour. Filling shall be continued until the water surface is at the design maximum liquid level, or either one inch below any fixed overflow level in covered containment structures or four inches in open containment structures, whichever is lower.

F. Water for the initial filling shall be provided by the General Contractor. Use potable water unless otherwise specified.

G. Part 1 – Qualitative criteria
   1. If any water is observed on the containment structure exterior wall surfaces where moisture can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the hydrostatic test.
   2. Wet areas on top of the wall footing shall not be cause to fail Part 1 unless the water can be observed to be flowing.
   3. Although Part 2 of the test may begin prior to completion of repairs for Part 1, all defects causing the failure of Part 1 shall be repaired before acceptance of the containment structure.
   4. The standard repair procedure for areas failing Part 1 is to inject chemical grout into the affected area. Consult with the Precast Tank Engineer before commencing any such repairs.

H. Part 2 – Quantitative criteria
   1. Part 2 of the hydrostatic tightness test shall not be scheduled for a period when the forecast is for a difference of more than 35°F between the ambient temperature readings at the times of the initial and final level measurements of the water surface. The test shall also not be scheduled when the weather forecast indicates the water surface could freeze before the test is completed.
   2. The vertical distance to the water surface shall be measured to within 1/16 inch from a fixed point on the containment structure above the water surface. The initial measurement shall not be taken until at least 24 hours after the tank is completely filled. Measurements shall be recorded at 24-hour intervals.
   3. The test period shall be the theoretical time required to lower the water surface 3/8 inch, assuming a loss of water at the maximum allowable rate. However, the test period shall not be longer than five days.

4. In uncovered containment structures, evaporation and precipitation shall be measured.
5. At the end of the test period, the water surface shall be recorded to within 1/16 inch at the location of the original measurements. The water temperature and precipitation measurements shall be recorded.
6. The change in water volume in the containment structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature. If the loss exceeds the required criterion, the containment shall be considered to have failed Part 2 of the test.

I. Retesting
1. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.
2. It shall be permitted to immediately retest a containment structure failing Part 2 of the hydrostatic test when Part 1 is passed. If the containment structure fails the second test or if not immediately retested after the first test failure, the interior of the containment structure shall be observed for probable problem areas by the Tank Supplier. The containment structure shall only be retested after the probable problem areas are repaired.
3. Containment structures shall be retested until they meet the required Part 1 and Part 2 criteria. Repairs shall be made before each retest.

J. The containment structure shall be deemed substantially complete upon successful completion of tightness testing. All final payments, including retainage, for all structural elements related to the circular precast post-tensioned concrete tank, including the foundation system and cast-in-place base slab, shall be made at this time. This clause supersedes any conflicting clauses in the contract documents.

3.15 SPECIAL WARRANTY

A. The Tank Supplier shall provide a two-year structural warranty to the Owner. The warranty shall at minimum include the following items:
1. The Tank Supplier shall provide a corporate guarantee not covered by any form of insurance or bond as a warranty for the precast tank that warrants the tank is free from structural defect due to faulty design, workmanship, or structural materials.
2. The Tank Supplier shall warrant the structural aspects of the tank for a period of two years from the substantial completion date of the precast tank.
3. The Owner must report in a timely manner any claim to the warranty in writing to the tank manufacturer within the effective coverage dates of the warranty.
4. The Tank Supplier shall furnish, without charge to the Owner, all necessary labor and materials required to repair all structural defects subject to this warranty with a maximum cost of repair not exceeding the Tank Supplier’s contract value of the tank and under the condition that the Tank Supplier has been paid in full for the project.

B. Specific Exclusions from Warranty:
   1. Maintenance items (sealants, coatings, equipment, plumbing, etc.), all non-structural items.
   2. Consequential damages, punitive damages, incidental costs, bodily injury, death, and damage to the property other than the tank.
   3. Emptying of tanks, inspection of tanks, processing of the water/wastewater, drying or cleaning of the tanks, filling of tanks, etc. complete in preparation for, and completion of repairs.
   4. Defects or issues caused by accident, abuse, misuse, storage or processing of corrosive liquids, improper maintenance, negligence, modifications, additions, or deletions not made by tank manufacturer, improper or defective application, acts of God, force majeure, untimely action by Owner to minimize damage or losses, unstable or improperly designed or constructed soil/subgrade, or defects caused by work supplied by any party other than the Tank Supplier.
   5. A loss or defect that is covered by insurance.

C. All materials and labor for work performed by the Tank Supplier which is not covered under the standard two-year limited structural warranty shall be warranted for a period of one (1) year from substantial completion of the tank per the Contract Documents.

3.16 BACKFILL

A. General Contractor shall place and compact backfill in accordance with Section 02200 “Earthwork.”

B. Do not commence backfilling around the tank until the tank has been examined and approved by the Engineer of Record.

C. The General Contractor shall be responsible to protect the tank from damage by construction activity, equipment and vehicles. Repair or replace damaged structures to the satisfaction of the Tank Supplier.

D. When backfilling around the tank, place backfill material in equal lifts and to similar elevations on opposite sides of structures in order to equalize opposing horizontal pressures, except where required for final grading.

E. The excavation shall be kept free of water by the General Contractor at all times.

END OF SECTION 034300

SECTION 040110 - MASONRY CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. The Contractor shall furnish the material and equipment for, and clean all face brick, cut stone, concrete and concrete block exposed on the exterior of the building; and the concrete exposed on the interior of the building.

1.3 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 CLEANING

A. On face brick and cut stone, a liquid restoration cleaner shall be used. The Contractor shall examine the existing building and be responsible for performing all required work such as tuckpointing after removal of loose mortar, tuckpointing cracks, relaying or replacement of loose or damaged brick and cut stone, removing and replacement of all caulking around doors and elsewhere, pointing of joints in wall coping stones, etc.; to refurbish the building exterior.

B. All non-masonry surfaces should be protected from exposure to the cleaning materials. Test panels, minimum 4 feet by 4 feet, should be cleaned prior to beginning full scale cleaning operations to determine the effectiveness of the cleaning compound and precise cleaning procedures. Tests should be conducted on each type of masonry surface and be available for inspection and approval by the Engineer.

C. All exposed masonry surfaces shall be cleaned free of all atmospheric dirt, mildew, and carbon formations so as to restore the masonry surface to its original appearance. Sandblasting, wet aggregate blasting or use of other abrasive materials will not be permitted.

D. Cleaning materials shall be by ProSoCo. Inc.; or equal. Use Sure Klean Restoration Cleaner for brick and Sure Klean Limestone Restorer for cut stone, both applied in strict accordance with manufacturer's printed instructions.

E. The Contractor shall examine the existing interior walls of the structure and be responsible for performing all required work such as removing paint or other coatings, removing defective or damaged surfaces and patching, repairing or replacing same, relaying or replacement of loose or damaged block, concrete steps, etc., removing and replacement of faulty caulking or flashing, etc.; to refurbish the building interior.

PART 3 - EXECUTION

3.1 INTERIOR CONCRETE WALLS

A. All interior concrete wall surfaces shall receive the following treatment:

1. Surface Preparation: After the surface is clean and dry, acid etch in accordance with the paint manufacturer's recommendations or light sandblast to a grainy surface.
2. Finish: 2 Coats Koppers 200 Hi-Build Epoxy; Tnemec No. 66 Hi-Build Epoxoline; or equal.

B. The interior concrete wall surfaces of the wet well shall be treated with a material designated as Type A.

1. Type A material shall be a bituminous material in a liquid form that is suitable for cold application.
2. It shall be of such a nature as to bond firmly to the concrete surface without the use of primers and to maintain sufficient elasticity to perform its protective function permanently in spite of cracks which develop.
3. Where its use is required in tanks or conduits containing drinking water, it shall be nontoxic and shall not impart tastes and odors to the water which may come into contact with it. Type A shall be Bitumastic Super Tank Solution by Koppers; 46-272 Topox by Tnemec; or equal.
4. In a nonpotable water situation, Type A shall be "Super Service Black" by Koppers; "450 Heavy Tnemecol" by Tnemec; or equal.
5. The Contractor shall use application equipment as recommended by the manufacturer. Type A shall be applied in two coats. Each coat shall have a coverage rate of 60 to 80 square feet per gallon.

3.2 EXTERIOR MASONRY WATERPROOFING

A. For exterior brick and block surfaces above grade, the waterproofing shall be clear, colorless liquid silicone polymer by Sonneborn "Hydrocide S-X"; Standard Dry Wall Products "Thoroclear 777"; Grace "Daracone"; or equal.

B. It shall not alter the appearance of the surface. It shall penetrate the brick and block surface pores and deposit silicone which will retard water absorption.

C. The Contractor shall submit complete descriptive literature from the manufacturer for the type of coating he proposes to use. If requested by the Engineer, the Contractor shall submit the manufacturer's complete formula for the special coating if different from those mentioned in the Specifications, in order that the Engineer may determine that the proposed coating is equal to those specified.

END OF SECTION 040110

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Concrete unit masonry.
2. Concrete brick.
3. Face brick.
4. Mortar and grout.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Masonry-cell insulation.

B. Products installed but not furnished under this Section include the following:

1. Steel shelf angles for unit masonry specified in Division 5 Section "Metal Fabrications."
2. Wood nailers and blocking built into unit masonry specified in Division 6 Section "Rough Carpentry."
3. Hollow metal frames in unit masonry openings specified in Division 8 Section " Steel Doors and Frames."

1.3 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops the following installed compressive strengths (f'm) at 28 days.

1. For Concrete Unit Masonry: As follows, based on net area:

a. f'm = 2,000 psi.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each different masonry unit, accessory, and other manufactured product specified.

C. Shop drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315 "Details and Detailing of Concrete Reinforcement"

showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement.

D. Samples for initial selection of the following:

1. Unit masonry samples in small-scale form showing the full range of colors and textures available for each different exposed masonry unit required.
2. Colored-masonry mortar samples showing the full range of colors available.

E. Samples for verification of the following:

1. Full-size units for each different exposed masonry unit required showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction.
2. Colored-masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Make samples using the same sand and mortar ingredients to be used on the Project. Label samples to indicate type and amount of colorant used.
3. Weep holes/vents in color to match mortar color.
4. Accessories embedded in the masonry.
5. Material certificates for the following, signed by manufacturer and Contractor, certifying that each material complies with requirements.
6. Each different cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
7. Each material and grade indicated for reinforcing bars.
8. Each type and size of joint reinforcement.
9. Each type and size of anchors, ties, and metal accessories.

F. Material test reports from a qualified independent testing agency, employed and paid by Contractor or manufacturer, indicating and interpreting test results relative to compliance of the following proposed masonry materials with requirements indicated:

1. Mortar complying with property requirements of ASTM C 270.
2. Mortar complying with BIA M1.
3. Grout mixes. Include description of type and proportions of grout ingredients.
4. Masonry units.

G. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

B. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one source and by a single manufacturer for each different product required.

C. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Certified efflorescence test reports shall be provided on masonry units that are to be exposed to weathering. Schedule tests far enough in advance of starting masonry work to permit retesting if necessary. Test three pairs of specimens of each type of masonry unit for efflorescence in accordance with ASTM C67. If any pair is rated "effloresced," the units represented by the samples will be rejected.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not install until they are in an air-dried condition.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three (3) days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt on completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit masonry damaged by frost or freezing conditions. Comply with the following requirements:

1. Cold-Weather Construction: When the ambient temperature is within the limits indicated, use the following procedures:

    a. 40 to 32 deg F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F.
    b. 32 to 25 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry.
    c. 25 to 20 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F if grouting. Use heat on both sides of walls under construction.
    d. 20 deg F and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F. Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 32 deg F within the enclosures.

2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection:

    a. 40 to 25 deg F: Cover masonry with a weather-resistant membrane for 48 hours after construction.
    b. 25 to 20 deg F: Cover masonry with insulating blankets or provide enclosure and heat for 48 hours after construction to prevent freezing. Install wind breaks when wind velocity exceeds 15 mi./h.
    c. 20 deg F and Below: Provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after construction.

3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried out, but not less than 7 days after completion of cleaning.

E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and above.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. General: Provide shapes indicated and as follows for each form of concrete masonry unit required.

1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners, unless otherwise indicated.

B. Concrete Masonry Units: ASTM C 90 and as follows:

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength indicated below:

    a. Not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

2. Weight Classification: Normal weight.
3. Aggregates: Do not use aggregates made from pumice, scoria, or tuff.
4. Provide Type I, moisture-controlled units.
5. Size: Manufactured to the actual dimensions listed below (within tolerances specified in the applicable referenced ASTM specification) for the corresponding nominal sizes indicated on Drawings:

    a. 4 inch nominal: 3-5/8 inch actual.
    b. 6 inch nominal: 5-5/8 inch actual.
    c. 8 inch nominal: 7-5/8 inch actual.
    d. 10 inch nominal: 9-5/8 inch actual.
    e. 12 inch nominal: 11-5/8 inch actual.

6. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

C. Concrete Building Brick: ASTM C 55 and as follows:

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength indicated below:

    a. Not less than the unit compressive strengths required to produce concrete unit masonry construction of compressive strength indicated.

2. Weight Classification: Normal weight.
3. Provide Type I, moisture-controlled units.
4. Size: Manufactured to specified dimensions within tolerances specified in the applicable referenced ASTM specification as follows:

    a. Modular: 3-5/8 inches thick by 2-1/4 inches high by 7-5/8 inches long.

5. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

2.2 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I/II, except Type III may be used for cold-weather construction. Cement shall containing less than 0.60 percent alkalies. Provide natural color or white cement as required to produce mortar color indicated.

B. Masonry Cement: ASTM C 91.

1. For pigmented mortars, use premixed, colored masonry cements of formulation required to produce color indicated, or if not indicated, as selected from manufacturer's standard

formulations. Pigments shall not exceed 5 percent of masonry cement by weight for mineral oxides nor 1 percent for carbon black.

C. Mortar Cement: U.B.C. Standard No. 21-14.

1. For pigmented mortars, use premixed, colored mortar cements of formulation required to produce color indicated, or if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 5 percent of mortar cement by weight for mineral oxides nor 1 percent for carbon black.

D. Grout: Provide a 3,000-psi pea gravel concrete mix. Reference specification 030000 for addition information.

E. Hydrated Lime: ASTM C 207, Type S.

F. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.

1. For pigmented mortars, use colored portland cement-lime mix of formulation required to produce color indicated, or if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 10 percent of portland cement by weight for mineral oxides nor 2 percent for carbon black.

G. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch, use aggregate graded with 100 percent passing the No. 16 sieve.

1. Colored-Mortar Aggregates: Natural-colored sand or ground marble, granite, or other sound stone, as required to match Architect's sample.

H. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortars.

I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMU, containing integral water repellent by same manufacturer.

J. Water: Potable.

2.3 REINFORCING STEEL

A. Steel Reinforcing Bars: Material and grade as follows:

1. Billet steel complying with ASTM A 615.

2.4 JOINT REINFORCEMENT

A. General: Provide joint reinforcement formed from the following:

1. Galvanized carbon-steel wire, coating class as follows:

a. ASTM A 641, Class 1, for interior walls; and ASTM A 153, Class B-2, for exterior walls.

B. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with prefabricated corner and tee units, and complying with requirements indicated below:

1. Wire Diameter for Side Rods: 0.1875 inch.
2. Wire Diameter for Cross Rods: 0.1483 inch.

C. For single-wythe masonry, provide type as follows with single pair of side rods:

1. Ladder design with perpendicular cross rods spaced not more than 16 inches o.c.

2.5 TIES AND ANCHORS, GENERAL

A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of this Article, unless otherwise indicated.

B. Wire: As follows:

1. Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
2. Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating for wire ties and anchors in exterior walls.
3. Wire Diameter: 0.1875 inch.

2.6 ADJUSTABLE MASONRY-VENEER ANCHORS

A. General: Provide 2-piece assemblies allowing vertical or horizontal differential movement between wall and wall framing parallel to plane of wall but resisting tension and compression forces perpendicular to it, for attachment over sheathing to metal studs, and with the following structural performance characteristics:

1. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in either tension or compression without deforming over, or developing play in excess of, 0.05 inch.

B. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie section and a metal anchor section complying with the following requirements:

1. Wire Tie Shape: Triangular.
2. Wire Tie Length: As required to extend 1-1/2 inches into masonry wythe of veneer face.
3. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive tie section and to serve as head for drilling fastener into metal stud. Barrel length to suit sheathing thickness, allowing screw to seat directly against metal stud with flanged head covering hole in sheathing.

2.7 EMBEDDED FLASHING MATERIALS

A. Reinforced Plastic Flashing: Manufacturer's standard composite plastic flashing as described below:

1. Polyester film bonded to fiberglass scrim reinforcement and 1.25-mil black-vinyl ethylene film, with a total thickness of 8 mils.
2. Joint Tape: Reinforced plastic flashing manufacturer's standard polyester tape, 2 inches wide by 2.0 mils thick.
3. Application: Use where flashing is fully concealed in masonry.

B. Adhesive for Flashings: Of type recommended by manufacturer of flashing material for use indicated.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Preformed Control-Joint Gaskets: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

1. Styrene-Butadiene Rubber Compound: ASTM D 2000, Designation M2AA-805.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

C. Weep Holes: Provide the following:

1. Plastic Weep Hole/Vent: One-piece, flexible extrusion manufactured from ultraviolet-resistant polypropylene copolymer, designed to weep moisture in masonry cavity to exterior, sized to fill head joints with outside face held back 1/8 inch from exterior face of masonry, in color selected from manufacturer's standard.

2.9 INSULATION

A. Loose-Granular Perlite Insulation: ASTM C 549, Type II or (surface treated for water repellency and limited moisture absorption) or IV (surface treated for water repellency and to limit dust generation); r-value of 3.3 - 2.8 BTU/(hr x sf x deg F) for densities of 4.1 - 7.4 lbs. per cu.ft. at 75 deg F (24 deg C).

2.10 MASONRY CLEANERS

A. Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.

B. Acidic Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

1. For masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface-acting acids, chelating, and wetting agents.

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:

1. For masonry below grade, in contact with earth, and where indicated, use type indicated below:

a. Type: S.

2. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions, and for other applications where another type is not indicated, use type indicated below:

a. Type: S.

C. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required.

1. Limit pigments to the following percentages of cement content by weight:

a. For mineral oxide pigments and portland cement-lime mortar, not more than 10 percent.

D. Grout for Unit Masonry: Comply with ASTM C 476. Use grout of consistency indicated or, if not otherwise indicated, of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.

1. Use fine grout in grout spaces less than 2 inches in horizontal dimension, unless otherwise indicated.
2. Use coarse grout in grout spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of unit masonry. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of thickness indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections of the Specifications.

C. Leave openings for equipment to be installed before completion of masonry. After installing equipment, complete masonry to match construction immediately adjacent to the opening.

D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting, where possible. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Mix units for exposed unit masonry from several pallets or cubes as they are placed to produce uniform blend of colors and textures.

3.3 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces of columns, walls, and arrises, do not exceed 1/4 inch in 10 feet, nor 3/8 inch in 20 feet, nor 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet, nor 1/2 inch maximum.

B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more. For top surface of bearing walls, do not exceed 1/8 inch in 10 feet, nor 1/16 inch within width of a single unit.

C. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls, and partitions, do not exceed 1/2 inch in 20 feet, nor 3/4 inch in 40 feet or more.

D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4 inch nor plus 1/2 inch.

E. Variation in Mortar-Joint Thickness: Do not vary from bed-joint thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary bed-joint thickness from bed-joint thickness of adjacent course by more than 1/8 inch. Do not vary from head-joint thickness indicated by more than plus or minus 1/8 inch. Do not vary head-joint thickness from adjacent head-joint thickness by more than 1/8 inch. Do not vary from collar-joint thickness indicated by more than minus 1/4 inch or plus 3/8 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.

B. Lay walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
   1. One-half running bond with vertical joint in each course centered on units in courses above and below.

D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

E. Stopping and Resuming Work: In each course, rack back 1/2-unit length for one-half running bond or 1/3-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar prior to laying fresh masonry.

F. Built-in Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.

G. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

I. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

J. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above and as follows:

   1. Install compressible filler in joint between top of partition and underside of structure above.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units as follows:

   1. With full mortar coverage on horizontal and vertical face shells.
   2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
   3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
   4. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 3/8-inch joints.

B. Lay solid brick-size masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not furrow bed joints or slush head joints.

1. At cavity walls, slope beds toward cavity to minimize mortar protrusions into cavity. As work progresses, trowel mortar fins protruding into cavity flat against cavity face of brick.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.6 CAVITIES

A. Keep cavities clean of mortar droppings and other materials during construction. Strike joints facing cavities flush.

1. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings, and replace in cavity.

B. Tie exterior wythe to back-up with individual metal ties. Stagger alternate courses.

3.7 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities as shown to fill void spaces completely. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close ports after complete coverage has been confirmed. Limit fall of insulation to 1 story in height, but not to exceed 10 feet.

3.8 HORIZONTAL-JOINT REINFORCEMENT

A. General: Provide continuous horizontal-joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcing a minimum of 6 inches.

1. Provide reinforcement in mortar joint 1 block course above and below wall openings and extending 12 inches beyond opening.

a. Reinforcement above is in addition to continuous reinforcement.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.9 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to metal studs with masonry-veneer anchors to comply with the following requirements:

1. Fasten anchors through sheathing to metal studs with metal fasteners of type indicated.

2. Embed tie section in masonry joints. Provide not less than 1-inch air space between back of masonry veneer and face of sheathing.
3. Locate anchor section relative to course where tie section is embedded to allow maximum vertical differential movement of tie up and down.
4. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 18 inches (457 mm) o.c. horizontally. Install additional anchors within 12 inches (305 mm) of openings and at intervals around perimeter not exceeding 8 inches (203 mm).

3.10 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joints in unit masonry where indicated. Build-in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Install preformed control-joint gaskets designed to fit standard sash block.

3.11 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick size units and 24 inches for block size units are shown without structural steel or other supporting lintels.

1. Provide prefabricated or built-in-place masonry lintels. Use specially formed bond beam units with reinforcement bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.

B. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer before covering with mortar.

C. Install flashing as follows:

1. At masonry-veneer walls, extend flashing from exterior face of veneer, through the veneer, up face of sheathing at least 8 inches, and behind air-infiltration barrier/building paper.
2. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. At heads and sills, extend flashing 4 inches at ends and turn up not less than 2 inches to form a pan.
3. Cut off flashing flush with face of wall after masonry wall construction is completed.

D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing and as follows:

1. Form weep holes with product specified in Part 2 of this Section.
2. Space weep holes 16 inches o.c.
3. In cavities, place pea gravel to a height equal to height of first course, but not less than 2 inches, immediately above top of flashing embedded in the wall, as masonry construction progresses, to splatter mortar droppings and to maintain drainage.
4. Place cavity drainage material immediately above flashing in cavities.

3.13 INSTALLATION OF REINFORCED UNIT MASONRY

A. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

1. Do not exceed the following pour heights for fine grout:

a. For minimum widths of grout spaces of 3/4 inch or for minimum grout space of hollow unit cells of 1-1/2 by 2 inches, pour height of 12 inches.
b. For minimum widths of grout spaces of 2 inches or for minimum grout space of hollow unit cells of 2 by 3 inches, pour height of 60 inches.
c. For minimum widths of grout spaces of 2-1/2 inches or for minimum grout space of hollow unit cells of 2-1/2 by 3 inches, pour height of 12 feet.
d. For minimum widths of grout spaces of 3 inches or for minimum grout space of hollow unit cells of 3 by 3 inches, pour height of 24 feet.

2. Do not exceed the following pour heights for coarse grout:

a. For minimum widths of grout spaces of 1-1/2 inches or for minimum grout space of hollow unit cells of 1-1/2 by 3 inches, pour height of 12 inches.
b. For minimum widths of grout spaces of 2 inches or for minimum grout space of hollow unit cells of 2-1/2 by 3 inches, pour height of 60 inches.
c. For minimum widths of grout spaces of 2-1/2 inches or for minimum grout space of hollow unit cells of 3 by 3 inches, pour height of 12 feet.
d. For minimum widths of grout spaces of 3 inches or for minimum grout space of hollow unit cells of 3 by 4 inches, pour height of 24 feet.

3. Provide cleanout holes at least 3 inches in least dimension for grout pours over 60 inches in height.

a. Provide cleanout holes at each vertical reinforcing bar.
b. At solid grouted masonry, provide cleanout holes at not more than 32 inches o.c.

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units; install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point-up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for application of sealants.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears prior to tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
4. Wet wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean brick by bucket and brush hand-cleaning method described in BIA Technical Note No. 20 Revised, using the following masonry cleaner:

    a. Job-mixed detergent solution.
    b. Proprietary acidic cleaner, applied in compliance with directions of acidic cleaner manufacturer.

6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain present on exposed surfaces.

E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.15 MASONRY WASTE DISPOSAL

A. Recycling: Undamaged, excess masonry materials are Contractor's property and shall be removed from the Project site for his use.

END OF SECTION 042000

SECTION 047200 - CAST STONE MASONRY

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. Cast-stone trim including the following:
   a. Exterior window sills

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For cast-stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details for cast-stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include building elevations showing layout of units and locations of joints and anchors.

C. Samples for Initial Selection: For colored mortar.

D. Samples for Verification:

1. For each color and texture of cast stone required, 10 inches square in size.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

1. Include copies of material test reports for completed projects, indicating compliance of cast stone with ASTM C1364.

B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C1364**,** including test for resistance to freezing and thawing.

1. Provide test reports based on testing within previous two years.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast-stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute or the Precast/Prestressed Concrete Institute for Group A, Category AT.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

B. Pack, handle, and ship cast-stone units in suitable packs or pallets.

1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast-stone units if required, using dollies with wood supports.
2. Store cast-stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.7 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Cast Stone: Obtain cast-stone units from single source from single manufacturer.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

2.2 CAST-STONE MATERIALS

A. General: Comply with ASTM C1364.

B. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce cast-stone color indicated.

C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C33/C33M; gradation and colors as needed to produce required cast-stone textures and colors.

D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required cast-stone textures and colors.

E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

F. Admixtures: Use only admixtures specified or approved in writing by Architect.

1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
3. Air-Entraining Admixture: ASTM C260/C260M. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
5. Water-Reducing, Retarding Admixture: ASTM C494/C494M, Type D.
6. Water-Reducing, Accelerating Admixture: ASTM C494/C494M, Type E.

G. Reinforcement: Deformed steel bars complying with ASTM A615/A615M, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast-stone material.

1. Epoxy Coating: ASTM A775/A775M.
2. Galvanized Coating: ASTM A767/A767M.

H. Embedded Anchors and Other Inserts: Fabricated from steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M.

2.3 CAST-STONE UNITS

A. Cast-Stone Units: Comply with ASTM C1364.

1. Units shall be manufactured using the wet-cast method.
2. Units shall be resistant to freezing and thawing as determined by laboratory testing according to ASTM C666/C666M, Procedure A, as modified by ASTM C1364.

B. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
3. Provide drips on projecting elements unless otherwise indicated.

C. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

D. Cure Units as Follows:

1. Cure units in enclosed, moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:

    a. No fewer than five days at mean daily temperature of 70 deg F or above.
    b. No fewer than six days at mean daily temperature of 60 deg F or above.
    c. No fewer than seven days at mean daily temperature of 50 deg F or above.
    d. No fewer than eight days at mean daily temperature of 45 deg F or above.

E. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

F. Colors and Textures: As selected by Architect from manufacturer's full range.

G. Colors and Textures: Provide units with fine-grained texture and buff color resembling smooth-finished Indiana limestone.

H. Colors and Textures: Provide units with fine texture and red-brown color resembling brownstone on adjacent buildings.

2.4 MORTAR MATERIALS

A. Provide mortar materials that comply with Section 042000 "Unit Masonry."

B. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

C. Hydrated Lime: ASTM C207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

E. Masonry Cement: ASTM C91/C91M.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

G. Colored Cement Product: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix

2. Colored Masonry Cement

3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments shall not exceed 10 percent of portland cement by weight.
5. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.

H. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Water: Potable.

2.5 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M.

B. Dowels: 1/2-inch- diameter round bars, fabricated from steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M.

C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast-stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

2.6 MORTAR MIXES

A. Comply with requirements in Section 042000 "Unit Masonry" for mortar mixes.

B. Do not use admixtures including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use masonry cement or mortar cement mortar unless otherwise indicated.

C. Comply with ASTM C270, Proportion Specification.

1. For setting mortar, use Type N.
2. For pointing mortar, use Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
3. Insert materials and proportions used for sample in first subparagraph below if known.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Application: Use colored-aggregate mortar for exposed mortar joints.

2.7 SOURCE QUALITY CONTROL

A. Engage a qualified independent testing agency to sample and test cast-stone units according to ASTM C1364.

1. Include one test for resistance to freezing and thawing.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 SETTING CAST STONE IN MORTAR

A. Install cast-stone units to comply with requirements in Section 042000 "Unit Masonry."

B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Coordinate installation of cast stone with installation of flashing specified in other Sections.

C. Wet joint surfaces thoroughly before applying mortar or setting in mortar.

D. Set units in full bed of mortar with full head joints unless otherwise indicated.

1. Set units with joints 3/8 to 1/2 inch wide unless otherwise indicated.
2. Build anchors and ties into mortar joints as units are set.
3. Fill dowel holes and anchor slots with mortar.
4. Fill collar joints solid as units are set.
5. Build concealed flashing into mortar joints as units are set.
6. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
7. Keep joints at shelf angles open to receive sealant.

E. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

F. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

G. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.

H. Rake out joints for pointing with sealant to depths of not less than 3/4 inch. Scrub faces of units to remove excess mortar as joints are raked.

I. Point joints with sealant to comply with applicable requirements in Section 079200 "Joint Sealants."

1. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

J. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.

1. Keep joints free of mortar and other rigid materials.
2. Build in compressible foam-plastic joint fillers where indicated.
3. Form joint of width indicated, but not less than 3/8 inch.
4. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.3 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of cast-stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with sealant.

1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast-stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open joint of width indicated, but not less than 3/8 inch.

F. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.4 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.5 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.

1. Remove mortar fins and smears before tooling joints.
2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 047200AIA 06/14

SECTION 055000 - METAL FABRICATIONS

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. Steel framing and supports for overhead doors.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Metal bollards.
5. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete and masonry for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 033053 "Miscellaneous Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 042000 "Concrete Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Metal bollards.
5. Loose steel lintels.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.

D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

E. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

F. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm).
2. Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B; 0.0677-inch (1.7-mm) minimum thickness; unfinished .

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1).

D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

F. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

H. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting." and Section 099123 Interior Painting."

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

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 4000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface].

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where exposed to the exterior.

2.7 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

B. If required, fabricate bollards with 3/8-inch- (9.5-mm-) thick steel baseplates for bolting to concrete slab/footing. Drill baseplates at all four corners for 3/4-inch (19-mm) anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

2.8 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with zinc-rich primer.

2.9 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

2.10 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.11 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.12 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

3.3 INSTALLING METAL BOLLARDS

A. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.

1. Embed anchors at least 4 inches (100 mm) in concrete.

B. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

C. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting." and Section 099123 "Interior Painting."

END OF SECTION 055000

SECTION 055119 - METAL GRATING STAIRS

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 industrial-type, straight-run stairs with steel-grating treads and railings attached to metal grating stairs.

1.3 COORDINATION

A. Coordinate installation of anchorages for metal stairs. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For metal grating stairs and the following:

1. Grout

B. Shop Drawings: Include plans, elevations, sections, details, and attachments. Shop drawings shall be signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated-Design Submittal: For stairs, guardrail, handrail and platforms submit the structural analysis and design calculations signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01400 "Quality Requirements," to design all metal stairs as required for the project.

B. Structural Performance: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360.
6. Stairs and attached Guardrails (Railings) shall conform to the governing building code and OSHA requirements.

C. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE 7.

1. Component Importance Factor: 1.5.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates and Bars: ASTM A 36/A 36M.

C. Hot Rolled-Steel W-shapes and T-shapes: ASTM A 992/A 992M

D. Hot Rolled-Steel C-shapes, M-shapes, S-shapes, and Angles: ASTM A 36/A 36M

E. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

F. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

G. Wire Rod for Grating Crossbars: ASTM A 510 (ASTM A 510M).

H. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

I. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Mechanically deposited zinc coating.

E. Threaded Rods: ASTM A 36/A 36M.

1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened or ASTM A 36/A 36M carbon steel.
3. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

F. Anchor Rods: ASTM A 1554, Grade 36.

1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened or ASTM A 36/A 36M carbon steel.
3. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.4 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Form exposed work with accurate angles and surfaces and straight edges.

C. Weld connections to comply 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. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 4 welds: good quality, uniform undressed weld with minimal splatter.

D. Fabricate joints that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.6 STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel plates or channels.

    a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than 3/4 inch (19 mm) in least dimension.
2. Surface: Plain.
3. Finish: Galvanized.
4. Fabricate grating treads with rolled-steel floor plate or cast-abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
5. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.7 STAIR RAILINGS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

1. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
2. Connect posts to stair framing by direct welding unless otherwise indicated.

2.8 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel-stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, nonshrink grout unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05514

SECTION 055213 - PIPE AND TUBE RAILINGS

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. Steel pipe and tube railings (at stairs).
2. Aluminum pipe and tube railings (unless noted otherwise).

B. Related Requirements:

1. Section 055119 "Metal Grating Stairs" for steel tube railings associated with metal stairs.

1.3 COORDINATION

A. Coordinate installation of anchorages for railings. 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.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout and anchoring cement.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

D. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

E. Evaluation Reports: For post-installed anchors , from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Steel Pipe and Tube Railings:

1. Manufacturers: Subject to compliance with requirements, provide product, or comparable product by one of the following:

a. Wagner, R & B, Inc.

B. Aluminum Pipe and Tube Railings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ATR Technologies, Inc.
b. Blum, Julius & Co., Inc.
c. Braun, J. G., Company; The Wagner Companies.
d. CraneVeyor Corp.
e. Hollaender Manufacturing Company.
f. Kee Industrial Products, Inc.
g. Moultrie Manufacturing Corporation.
h. Sterling Dula Architectural Products, Inc. / KaneSterling.
i. Superior Aluminum Products, Inc.
j. Thompson Fabricating, LLC.
k. Tri Tech, Inc.
l. Tubular Specialties Manufacturing, Inc.
m. Tuttle Railing Systems.
n. Wagner, R & B, Inc.

C. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C, material surfaces).

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt or predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

2.4 STEEL AND IRON

A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.

B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.5 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.

C. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

D. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.

E. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.

F. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.

G. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.6 FASTENERS

A. General: Provide the following:

1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
2. Aluminum Railings: Type 304 stainless-steel fasteners.
3. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
2. Provide Phillips or square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations: Alloy Group (1) A1 stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.7 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

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

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.8 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

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 flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

J. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

K. Form Changes in Direction as Follows:

1. By bending or by inserting prefabricated elbow fittings.
2. By flush bends or by inserting prefabricated flush-elbow fittings.
3. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

L. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

M. Close exposed ends of railing members with prefabricated end fittings.

N. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

P. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

Q. For railing posts set in concrete, provide steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.9 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize steel railings, including hardware, after fabrication.
2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
4. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

2.10 ALUMINUM FINISHES

A. Mill Finish: AA-M12, nonspecular as fabricated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.3 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post.

D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
2. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.4 ATTACHING RAILINGS

A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.

C. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For steel-framed partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
4. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
5. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.5 ADJUSTING AND CLEANING

A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.6 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

SECTION 055316 - PLANK GRATINGS

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 extruded-aluminum plank gratings and metal frames and supports for gratings.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
2. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.3 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded-aluminum plank gratings.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For gratings, including manufacturers' published load tables and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.

B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors: Uniform load of 125 lbf/sq. ft. (6.00 kN/sq. m) or concentrated load of 2000 lbf (8.90 kN), whichever produces the greater stress.
2. Limit deflection to L/360 or 1/4 inch (6.4 mm), whichever is less.

2.2 EXTRUDED-ALUMINUM PLANK GRATINGS

A. 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. Alabama Metal Industries Company; a Gibraltar Industries company.
2. Harsco Industrial IKG, a division of Harsco Corporation.
3. Ohio Gratings, Inc.
4. Seidelhuber Metal Products; Brodhead Steel.

B. Provide extruded-aluminum plank gratings in type, size, and finish indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.

1. Type: Extruded-aluminum planks approximately 6 inches (152 mm) wide with multiple flanges approximately 1.2 inches (30 mm) o.c., acting as bearing bars

connected by a web that serves as a walking surface. Top surface has raised ribs to increase slip resistance.
2. Depth: 1-1/2 inches (38 mm).
3. Perforations: Rectangular, 19/32 by 3 inches (15 by 76 mm), with adjacent rows staggered or 19/32 inch (15 mm) square, with adjacent rows aligned.
4. Finish: Mill finish, as fabricated.

2.3 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group (1) A1.

C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

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

2.6 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Fit exposed connections accurately together to form hairline joints.

C. Welding: Comply with AWS recommendations and 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.

D. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

E. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than 1/8 inch (3.2 mm) thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

2.7 GRATING FRAMES AND SUPPORTS

A. Frames and Supports: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6.4 mm) thick by 8 inches (200 mm) long.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with AWS recommendations and 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.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL PLANK GRATINGS

A. General: Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.

B. Attach aluminum units to steel supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

END OF SECTION 055316

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

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. Wood blocking, cants, and nailers.
2. Plywood backing panels.

1.3 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NHLA: National Hardwood Lumber Association.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Cants.

B. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.3 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exterior, AC, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.

D. Do not splice structural members between supports unless otherwise indicated.

E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening sheathing, gypsum board, or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

F. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

G. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

I. Use steel screws unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Install screws snug but do not countersink heads unless otherwise indicated.

3.2 WOOD

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

3.3 PROTECTION

A. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 072100 - THERMAL INSULATION

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. Foam-plastic board insulation.

B. Related Sections:

1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Type X, 15 psi (104 kPa).

B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce

thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical footing and foundation wall surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.

3.4 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

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. Adhered ethylene-propylene-diene-monomer (EPDM) roofing system.
2. Roof insulation.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of roofing and fastening spacings and patterns for mechanically fastened roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of complying with performance requirements.

C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.

D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.

E. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, roofing accessories, and other components of roofing system.
2. Warranty Period: 15 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering Work of this Section, including all components of roofing system such as membrane roofing, base flashing, roof insulation, fasteners, and walkway products, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.

1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-60.
2. Hail-Resistance Rating: SH.

2.3 EPDM ROOFING

A. EPDM: ASTM D 4637, Type II, scrim or fabric internally reinforced, uniform, flexible EPDM sheet.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlisle SynTec Incorporated.
b. Firestone Building Products.
c. GAF Materials Corporation.
d. Johns Manville; a Berkshire Hathaway company.

2. Thickness: 60 mils (1.5 mm), nominal.
3. Exposed Face Color: Black.

2.4 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: 60-mil (1.5-mm) thick EPDM, partially cured or cured, according to application.

C. Bonding Adhesive: Manufacturer's standard.

D. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3 inch (75 mm) wide minimum, butyl splice tape with release film.

E. Lap Sealant: Manufacturer's standard, single-component sealant.

F. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

G. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.5 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by EPDM roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.

B. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density, square edged.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. DiversiFoam Products.
b. Dow Chemical Company (The).
c. Kingspan Insulation.
d. Owens Corning.

C. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Atlas EPS; a Division of Atlas Roofing Corporation.
b. Firestone Building Products.
c. GAF Materials Corporation.
d. Homasote Company.
e. Hunter Panels.
f. Insulfoam-a division of Carlisle Construction Materials Inc.
g. Johns Manville; a Berkshire Hathaway company.

D. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

E. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread spray-applied, low-rise, two-component urethane adhesive.

2.7 ASPHALT MATERIALS

A. Roofing Asphalt: ASTM D 312, Type III or Type IV.

B. Asphalt Primer: ASTM D 41/D 41M.

2.8 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.

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

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

Retain first paragraph below if tapered insulation is required.

C. Install tapered insulation, where required, under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:

1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m), and allow primer to dry.
2. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
3. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
4. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.5 ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.

B. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Apply roofing with side laps shingled with slope of roof deck where possible.

D. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.

1. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.

E. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.

F. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

G. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal membrane roofing in place with clamping ring.

3.6 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.7 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.8 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075323

SECTION 076200 - SHEET METAL FLASHING AND TRIM

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. Coping

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.

1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.

5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of roof-penetration flashing.
8. Include details of connections to adjoining work.

C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

D. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

1. Exposed Coil-Coated Finish:

    a. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Color: As selected by Architect from manufacturer's full range.
3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed; with smooth, flat surface.

1. Finish: 2D (dull, cold rolled).

D. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation; prepainted by coil-coating process to comply with ASTM A 755/A 755M.

1. Surface: Smooth, flat.
2. Exposed Coil-Coated Finish:

    a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As selected by Architect from manufacturer's full range.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
4. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

C. Solder:

1. For Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane or silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Obtain field measurements for accurate fit before shop fabrication.
3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

G. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof-Penetration Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.019 inch (0.48 mm) thick.
2. Galvanized Steel: 0.028 inch (0.71 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
4. Torch cutting of sheet metal flashing and trim is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.

C. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

E. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not solder aluminum sheet.
2. Do not use torches for soldering.
3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
4. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

1. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.
2. Loosely lock front edge of scupper with conductor head.
3. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.

3.3 ROOF FLASHING INSTALLATION

A. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric or butyl sealant and clamp flashing to pipes that penetrate roof.

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean off excess sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 079200 - JOINT SEALANTS

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. Silicone, nonstaining joint sealants.
2. Urethane joint sealants.
3. Butyl joint sealants.
4. Latex joint sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Owner/Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 791.
b. GE Construction Sealants; SCS2000 SilPruf.
c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 265 LTS.
d. Pecora Corporation; PCS.
e. Sika Corporation U.S.; Sikasil WS-295.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.

B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 756 SMS or 795.
b. GE Construction Sealants; SilPruf NB.
c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 295 FPS NB.
d. Pecora Corporation; 864NST.
e. Tremco Incorporated; Spectrem 2.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Construction Chemicals, LLC, Building Systems; Sonalastic TX1.
b. Bostik, Inc.; Chem-Calk GPS1.
c. ER Systems, an ITW Company; Pacific Polymers Elasto-Thane 230 MP.
d. Pecora Corporation; Dynatrol I-XL.
e. Polymeric Systems, Inc.; Flexiprene 1000.
f. Schnee-Morehead, Inc., an ITW company; Permathane SM7108.
g. Sherwin-Williams Company (The); Stampede-1.
h. Sika Corporation U.S.; Sikaflex Textured Sealant.
i. Tremco Incorporated; Dymonic.

B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Construction Chemicals, LLC, Building Systems; Sonolastic SL 1.
b. Pecora Corporation; NR-201.
c. Polymeric Systems, Inc.; Flexiprene 952.
d. Schnee-Morehead, Inc.; an ITW company; Permathane SM7101.
e. Sherwin-Williams Company (The); Stampede 1SL.

C. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 50, Uses T and NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. LymTal International, Inc.; Iso-Flex 888QC.

2.5 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Bostik, Inc.; Chem-Calk 300.
b. Pecora Corporation; BC-158.

2.6 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Construction Chemicals, LLC, Building Systems; Sonolac.
b. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex 600.
c. Pecora Corporation; AC-20.
d. Sherwin-Williams Company (The); 850A.
e. Tremco Incorporated; Tremflex 834.

2.7 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:

    a. Isolation and contraction joints in cast-in-place concrete slabs.

2. Joint Sealant: Urethane, M, P, 50, T, NT.
3. Joint-Sealant Color: As selected by Owner/Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Joints between plant-precast architectural concrete units.
    b. Control and expansion joints in unit masonry.
    c. Joints between metal panels.
    d. Joints between different materials listed above.
    e. Perimeter joints between materials listed above and frames of doors, windows, and louvers.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
3. Joint-Sealant Color: As selected by Owner/Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

    a. Isolation joints in cast-in-place concrete slabs.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
3. Joint-Sealant Color: As selected by Owner/Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Control and expansion joints on exposed interior surfaces of exterior walls.
    b. Vertical joints on exposed surfaces of unit masonry, walls, and partitions.
    c. Joints on underside of plant-precast structural concrete planks.

2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Owner/Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:

    a. Perimeter joints between interior wall surfaces and frames of interior doors and windows.

2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: As selected by Owner/Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Concealed mastics.

1. Joint Locations:

    a. Aluminum thresholds.
    b. Sill plates.

2. Joint Sealant: Butyl-rubber based.

END OF SECTION 079200

SECTION 081113 - STEEL DOORS AND FRAMES

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 steel work.

B. Related Requirements:

1. Section 087100 "Door Hardware" for door hardware for steel doors.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

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

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

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

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of steel door and frame assembly, for tests performed by a qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amweld International, LLC.
2. Ceco Door Products; an Assa Abloy Group company.
3. Curries Company; an Assa Abloy Group company.
4. Steelcraft; an Ingersoll-Rand company.

B. Source Limitations: Obtain steel work from single source from single manufacturer.

2.2 EXTERIOR STEEL DOORS AND FRAMES

A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.

1. Physical Performance: Level B according to SDI A250.4.
2. Doors:

    a. Type: As indicated in the Door and Frame Schedule.
    b. Thickness: 1-3/4 inches (44.5 mm.)
    c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm), with minimum A40 (ZF120) coating.
    d. Edge Construction: Model 1, Full Flush.
    e. Core: Manufacturer's standard polystyrene, polyurethane, or polyisocyanurate, core at manufacturer's discretion.

        1) Thermal-Rated Doors: Provide doors fabricated with minimum thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu (0.370 K x sq. m/W) when tested according to ASTM C 1363.

3. Frames:

    a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
    b. Construction: Face welded.

4. Exposed Finish: Prime.

2.3 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.4 MATERIALS

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

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

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

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

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

G. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 FABRICATION

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

B. Steel Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
3. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.

4. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
5. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

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

1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor.

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

    a. Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:

        1) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

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

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
3. Provide loose stops and moldings on inside of hollow-metal work.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.6 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

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

2.7 ACCESSORIES

A. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

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

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install steel work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Steel Frames: Install frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

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

    a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    b. Install frames with removable stops located on secure side of opening.
    c. Install door silencers in frames before grouting.
    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    f. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. Installation Tolerances: Adjust steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Steel Doors: Fit steel doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm) to 1/4 inch (6.3 mm) plus or minus 1/32 inch (0.8 mm).
c. At Bottom of Door: 5/8 inch (15.8 mm) plus or minus 1/32 inch (0.8 mm).
d. Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).

D. Glazing: Comply with manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

3.4 ADJUSTING AND CLEANING

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

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

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

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

END OF SECTION 081113

SECTION 083323 - OVERHEAD COILING DOORS

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. Service doors.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Curtain slats.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

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

1. Obtain operators and controls from overhead coiling door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward.
2. Testing: According to ASTM E 330 or DASMA 108 for garage doors and meeting the acceptance criteria of DASMA 108.
3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.

2.3 DOOR ASSEMBLY

A. Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

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. ACME Rolling Doors.
b. Amarr Garage Doors.
c. C.H.I. Overhead Doors, Inc.
d. Clopay Building Products.
e. Cookson Company.
f. Cornell Iron Works, Inc.
g. McKeon Rolling Steel Door Company, Inc.
h. Overhead Door Corporation.
i. Raynor.
j. Wayne-Dalton Corp.

B. Operation Cycles: Door components and operators capable of operating for not less than 20,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

C. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h) when tested according to ASTM E 283 or DASMA 105.

D. Door Curtain Material: Galvanized steel.

E. Door Curtain Slats: Curved or Flat profile slats of 1-7/8-inch (48-mm) to 2-5/8-inch (67-mm) center-to-center height.

F. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from hot-dip galvanized steel, and finished to match door.

G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

H. Hood: Match curtain material and finish.

1. Shape: Manufacturer’s standard round or square.
2. Mounting: Face of wall.

I. Locking Devices: Equip door with locking device assembly.

1. Locking Device Assembly: Single-jamb side locking bar, operable from inside with thumb turn.

J. Electric Door Operator:

1. Usage Classification: Medium duty, up to 12 cycles per hour and up to 50 cycles per day.
2. Operator Location: Top of hood, Front of hood, or Wall per manufacturer's recommendations.
3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 feet (2.44 m) or lower.
4. Motor Exposure: Exterior, wet, and humid.
5. Emergency Manual Operation: Push-up type.
6. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar or pneumatic sensor edge on bottom bar; self-monitoring type.

    a. Sensor Edge Bulb Color: Black.

7. Control Station(s): Interior mounted.

K. Curtain Accessories: Equip door with weatherseals, astragal, and push/pull handles with pull-down strap.

L. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.

2.4 MATERIALS, GENERAL

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.

2.5 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm); and as required.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

2.6 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

2.7 LOCKING DEVICES

A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: Cylinders specified in Section 087100 "Door Hardware" or as standard with manufacturer and keyed to building keying system.
2. Keys: Three for each cylinder.

B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.8 CURTAIN ACCESSORIES

A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

1. At door head, use 1/8-inch (3-mm) thick, replaceable, continuous-sheet baffle secured to inside of hood or field- installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch (3-mm) thick seals of flexible vinyl, rubber, or neoprene.

B. Push/Pull Handles: Equip each emergency-operated door with lifting handles on each side of door, finished to match door.

C. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches (2130 mm) high.

2.9 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless or welded carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.10 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Provide manufacturers door operator, or an approved compatible operator, complying with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door, as recommended by manufacturer.

1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.

1. Electrical Characteristics:

    a. Phase: Single phase.
    b. Volts: 115 V.
    c. Hertz: 60.

2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
3. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
4. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

1. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

    a. Self-Monitoring Type: Four-wire configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

2. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

1. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N).

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

2.11 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine locations of electrical connections.

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

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

D. Power-Operated Doors: Install according to UL 325.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

1. Adjust exterior doors and components to be weather-resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

SECTION 085113 - ALUMINUM WINDOWS

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 aluminum windows for exterior locations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.

B. Shop Drawings: Include plans, elevations, sections, and details of installation, including anchor, flashing, and sealant installation.

C. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes, and prepared on Samples of size indicated below:

1. Exposed Finishes: 2 by 4 inches (50 by 100 mm).

D. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.

C. Sample Warranties: For manufacturer's warranties.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations.

B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
c. Deterioration of materials and finishes beyond normal weathering.
d. Failure of insulating glass.

2. Warranty Period:

a. Window: 2 years from date of Substantial Completion.
b. Glazing Units: Five years from date of Substantial Completion.
c. Aluminum Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. All Seasons Window & Door Mfg., Inc.; All Seasons Commercial Division, Inc.
2. Boyd Aluminum Manufacturing.
3. Custom Window Company.
4. DeSCo Architectural Inc.
5. EFCO Corporation; a Pella company.
6. EXTECH Exterior Technologies, Inc.
7. Fleetwood Windows & Doors.
8. Gerkin Windows and Doors.
9. Graham Architectural Products Corp.
10. Kawneer North America; an Alcoa company.

11. Mannix Exterior Wall Systems, Inc.
12. Peerless Products Inc.
13. Quaker Windows Products Co.Thermal Windows, Inc.
14. Wausau Window and Wall Systems.
15. Winco.
16. YKK AP America Inc.

B. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AMMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: CW.
2. Minimum Performance Grade: 50.

C. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.

D. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces.

2.3 ALUMINUM WINDOWS

A. Operating Types: Fixed.

B. Frames: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

C. Insulating-Glass Units: ASTM E 2190, certified through IGCC as complying with requirements of IGCC.

1. Glass: ASTM C 1036, Type 1, Class 1, q3.

a. Tint: Clear.
b. Kind: Fully tempered.

2. Lites: Two.
3. Filling: Air.

D. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

E. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

A. Interior Trim: Extruded-aluminum profiles in sizes and configurations required.

B. Panning Trim: Extruded-aluminum profiles in sizes and configurations required.

C. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

2.5 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

D. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.6 GENERAL FINISH REQUIREMENTS

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

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering 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.

2.7 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.

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

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 CLEANING AND PROTECTION

A. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 085113

SECTION 087100 - DOOR HARDWARE

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. Mechanical door hardware for all swinging doors.

B. Related Sections:

1. Section 081113 "Steel Doors and Frames" for door silencers provided as part of hollow-metal frames.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
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, size, and material of each door and frame.

2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
4) Fastenings and other pertinent information.
5) Explanation of abbreviations, symbols, and codes contained in schedule.
6) Mounting locations for door hardware.
7) List of related door devices specified in other Sections for each door and frame.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

B. Source Limitations: Obtain each type of door hardware from a single manufacturer.

C. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

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 (22.2 N).
2. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
3. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

E. Keying Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." In addition to Owner, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Address for delivery of keys.

1.7 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 coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to Owner.

1.8 COORDINATION

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

B. Security: Coordinate installation of door hardware and keying with Owner's security consultant.

1.9 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 doors 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, unless otherwise indicated.

a. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled on Drawings to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products, complying with BHMA designations referenced.
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 on Drawings. 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 Schedule" Article.
2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide heavy weight, anti-friction bearing, template-produced hinges for hinges installed on doors and frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allegion plc.
    b. Baldwin Hardware Corporation.
    c. Bommer Industries, Inc.
    d. Hager Companies.
    e. McKinney Products Company; an ASSA ABLOY Group company.
    f. PBB, Inc.
    g. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.3 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.

C. Lock Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

D. Lock Trim:

1. Levers: Wrought, forged, or cast.
2. Escutcheons (Roses): Wrought, forged, or cast.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

F. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000. Install mortised locks on all exterior doors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allegion plc.
    b. Best Access Systems; Stanley Security Solutions, Inc.
    c. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
    d. Hager Companies.
    e. SARGENT Manufacturing Company; ASSA ABLOY.
    f. Stanley Commercial Hardware; a division of Stanley Security Solutions.
    g. Yale Security Inc; an ASSA ABLOY Group company.

2.4 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturer: Same manufacturer as for locking devices.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1; permanent cores that are removable; face finished to match lockset.

2.5 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. Existing System:

a. Master key or grand master key locks to Owner's existing system.

2. Keyed Alike: Key all cylinders to same change key.

B. Keys: Nickel silver.

2.6 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. 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.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allegion plc.
b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
c. DORMA Americas.
d. Hager Companies.
e. Norton Door Controls; an ASSA ABLOY Group company.
f. Rixson Specialty Door Controls; an ASSA ABLOY Group company.
g. SARGENT Manufacturing Company; ASSA ABLOY.
h. Stanley Commercial Hardware; a division of Stanley Security Solutions.
i. Yale Security Inc; an ASSA ABLOY Group company.

2.7 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as

tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Hager Companies.
    b. National Guard Products, Inc.
    c. Pemko Manufacturing Co.
    d. Reese Enterprises, Inc.
    e. Zero International, Inc.

2.8 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Hager Companies.
    b. National Guard Products, Inc.
    c. Pemko Manufacturing Co.
    d. Reese Enterprises, Inc.
    e. Rixson Specialty Door Controls; an ASSA ABLOY Group company.
    f. Zero International, Inc.

2.9 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of stainless steel, 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.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with 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. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.10 FINISHES

A. Provide finishes complying with BHMA A156.18. Hardware shall be stainless steel (630).

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, 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: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

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. 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. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.
2. Furnish permanent cores to Owner for installation.

E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

F. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

G. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

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: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

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 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.7 HARDWARE SET

Hardware Set #1:

3	Hinges	AB700 4 ½" x 4 ½"	26D
1	Lockset	8205 LNJ	26D
1	Closer	350 PSH	EN
1	Threshold	884 V	AL
1	Door Sweep	102 VA x 36	28D
1	Weatherstripping	160 VA 36 x 84	28D

Door Cylinders: Match Owner's Existing System

END OF SECTION 087100

SECTION 099113 - PAINTING

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 surface preparation and the application of paint systems on the following exterior substrates:

1. Steel.
2. Galvanized metal.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for shop priming of metal substrates with primers specified in this Section.

1.3 DEFINITIONS

A. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
3. VOC content.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Behr Process Corporation.
2. Benjamin Moore & Co.
3. California Paints.
4. Coronado Paint.
5. ICI Paints.
6. Kelly-Moore Paints.
7. M.A.B. Paints.
8. PPG Architectural Finishes, Inc.
9. Pratt & Lambert.
10. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

C. Colors: As selected by Owner/Architect from manufacturer's full range.

2.3 METAL PRIMERS

A. Primer, Alkyd, Anti-Corrosive for Metal.

B. Primer, Galvanized: As recommended in writing by topcoat manufacturer.

2.4 SOLVENT-BASED PAINTS

A. Alkyd, Exterior, Semi-Gloss (Gloss Level 5)

2.5 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer [but not less than the following:

1. SSPC-SP 3, "Power Tool Cleaning."

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Steel Substrates:

1. Alkyd System:

a. Prime Coat: Primer, alkyd, anticorrosive for metal.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Alkyd, exterior enamel, semi-gloss (Gloss Level 5).

B. Galvanized-Metal Substrates:

1. Alkyd System:

a. Prime Coat: Primer, galvanized metal, as recommended in writing by topcoat manufacturer for exterior use on galvanized-metal substrates with topcoat indicated.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Alkyd, exterior enamel, semi-gloss (Gloss Level 5).

END OF SECTION 099113

SECTION 099600 - HIGH-PERFORMANCE COATINGS (INTERIOR)

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 surface preparation and application of high-performance coating systems on the following substrates:

1. Interior Substrates:

a. Concrete, vertical surfaces.
b. Concrete masonry units (CMU).
c. Galvanized metal.

B. Related Requirements:

1. Section 099113 "Exterior Painting" for special-use coatings and general field painting.

1.3 DEFINITIONS

A. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Label each coat of each Sample.
3. Label each Sample for location and application area.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Behr Process Corporation.
2. Benjamin Moore & Co.
3. Dulux (formerly ICI Paints); a brand of AkzoNobel.
4. General Paint.
5. Glidden Professional.
6. Kelly-Moore Paint Company Inc.
7. M.A.B. Paints.
8. PPG Architectural Coatings.
9. Pratt & Lambert.
10. Sherwin-Williams Company (The)

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
3. Provide products of same manufacturer for each coat in a coating system.

B. Colors: As selected by Architect from manufacturer's full range.

2.3 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior

2.4 METAL PRIMERS

A. Primer, Epoxy, Anti-Corrosive, for Metal

2.5 EPOXY COATINGS

A. Epoxy-Modified Latex, Interior, Gloss (Gloss Level 6)

2.6 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

a. Concrete and Masonry (CMU): 12 percent.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm).

E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) at 6 to 12 inches (150 to 300 mm).

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Vertical Surfaces:

1. Epoxy-Modified Latex System:

a. Prime Coat: Epoxy-modified latex, interior, gloss (Gloss Level 6).
b. Topcoat: Epoxy-modified latex, interior, gloss (Gloss Level 6).

B. CMU Substrates:

1. Epoxy-Modified Latex System:

a. Block Filler: Block filler, latex, interior/exterior.
b. Topcoat: Epoxy-modified latex, interior, gloss (Gloss Level 6).

C. Galvanized-Metal Substrates:

1. Epoxy-Modified Latex System:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal.
b. Topcoat: Epoxy-modified latex, interior, gloss (Gloss Level 6).

END OF SECTION 099600

SECTION 099635 - CHEMICAL-RESISTANT COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Field application of chemical-resistant coatings.

B. Related Requirements:

1. Section 055000 - Metal Fabrications: Shop-primed items.

1.2 DEFINITIONS

A. Refer to ASTM D16 for definitions of terms used in this Section.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
2. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. California Department of Public Health:

1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

C. Green Seal:

1. GC-3 - Environmental Criteria for Anti-Corrosive Paints.
2. GS-11 - Paints and Coatings.

D. Master Painters Institute:

1. MPI - Approved Products List.

E. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.

F. South Coast Air Quality Management District:

1. SCAQMD Rule 1113 - Architectural Coatings.

G. SSPC: The Society for Protective Coatings:

1. SSPC-PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
2. SSPC-SP 6 – Commercial Blast Cleaning
3. SSPC-SP 10 - Near-White Metal Blast Cleaning.

1.4 SEQUENCING

A. Section 011000 - Summary: Requirements for sequencing.

B. Do not apply finish coats unless coatable sealant has been applied.

C. Back prime wood trim before installation of trim.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer data.
2. Include MPI - Approved Products Lists with proposed products highlighted.

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

D. Manufacturer Instructions: Submit special surface preparation procedures and substrate conditions requiring special attention.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.

1.6 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: Submit information on cleaning, touchup, and repair of coated surfaces.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.8 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF 61.

B. Surface Burning Characteristics:

1. Fire-Retardant Finishes: Maximum 25/450 flame-spread/smoke-developed index when tested according to ASTM E84.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Container Labeling: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Inspection:

1. Accept materials on Site in manufacturer's sealed and labeled containers.
2. Inspect for damage and to verify acceptability.

D. Store materials in ventilated area and otherwise according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Storage Conditions:

1. Minimum Ambient Temperature: 45 degrees F (7 degrees C).
2. Maximum Ambient Temperature: 90 degrees F (32 degrees C)

C. Application Conditions:

1. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by coating manufacturer.
2. Do not apply exterior coatings during rain or snow, when relative humidity is outside humidity ranges, or when moisture content of surfaces exceeds those required by coating manufacturer.

1.12 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for coatings.

PART 2 - PRODUCTS

2.1 COATINGS

A. Materials:

1. Coatings:

a. Ready mixed, except field-catalyzed coatings.
b. Capable of drying or curing free of streaks or sags.

2. Accessories:

a. Grade: Commercial.
b. Turpentine.
c. Thinners.
d. Other materials not specifically indicated but required to achieve specified finishes.

2.2 SUSTAINABILITY CHARACTERISTICS

A. Section 018113 - Sustainable Design Requirements specifies requirements for sustainable design compliance.

B. Indoor Environmental Quality Characteristics:

1. Interior Flat and Non-Flat Paints: Maximum VOC content according to GS-11.
2. Interior Anticorrosive Paints: Maximum VOC content according to GC-3.

3. Interior Concrete and Wood Finishes: Maximum VOC content according to SCAQMD Rule 1113.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for application examination.

B. Verify that surfaces are ready to receive Work as recommended by product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of Work, and report conditions capable of affecting proper application to Architect/Engineer.

D. Test shop-applied primer for compatibility with subsequent cover materials.

E. Moisture Content:

1. Measure moisture content of surfaces using electronic moisture meter.
2. Do not apply finishes unless moisture content of surfaces are below following maximums:

a. Plaster and Gypsum Wallboard: 12 percent.
b. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
c. Interior Wood: 15 percent, measured according to ASTM D4442.
d. Exterior Wood: 15 percent, measured according to ASTM D4442.
e. Concrete Floors: 8 percent.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for application preparation.

B. Prepare coatings as follows:

1. To soft paste consistency, capable of being readily and uniformly dispersed to homogeneous coating.
2. For smooth flow and brushing properties.

C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

D. Defects:

1. Correct defects and clean surfaces capable of affecting Work of this Section.

E. Impervious Surfaces:

1. Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach.
2. Rinse with clean water and allow surface to dry.

F. Aluminum Surfaces Scheduled for Coating:

1. Remove surface contamination by steam or high-pressure water.
2. Remove oxidation with acid etch and solvent washing.
3. Apply etching primer immediately following cleaning.

G. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Coating:

1. Remove foreign particles to permit adhesion of finishing materials.
2. Apply compatible sealer or primer.

H. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.

I. Concrete Floors:

1. Remove contamination, acid etch, and rinse floors with clear water.
2. Verify that required acid-alkali balance is achieved.
3. Allow to dry.

J. Copper Surfaces Scheduled for Coating:

1. Remove contamination by steam, high-pressure water, or solvent washing.
2. Apply vinyl-etch primer immediately following cleaning.

K. Copper Surfaces Scheduled for Natural Oxidized Finish:

1. Remove contamination by applying oxidizing solution of copper acetate and ammonium chloride in acetic acid.
2. Rub on repeatedly for required effect, and, once attained, rinse surfaces with clear water and allow to dry.

L. Gypsum Board Surfaces:

1. Fill minor defects with filler compound.
2. Spot-prime defects after repair.

M. Galvanized Surfaces:

1. Remove surface contamination and oils, and wash with solvent.
2. Apply coat of etching primer.

N. Concrete and Unit Masonry Surfaces Scheduled to Receive Coating:

1. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
2. Remove oil and grease with solution of tri-sodium phosphate, rinse well, and allow to dry.
3. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after thoroughly wetting with water, and allow to dry.

O. Plaster Surfaces:

1. Fill hairline cracks, small holes, and imperfections with latex patching plaster.
2. Make smooth and flush with adjacent surfaces.
3. Wash and neutralize high-alkali surfaces.

P. Uncoated Steel and Iron Surfaces:

1. Remove grease, mill scale, weld splatter, dirt, and rust.
2. If heavy coatings of scale are evident, remove by wire brushing or by sandblasting.
3. Clean by washing with solvent.
4. Apply treatment of phosphoric acid solution, ensuring that weld joints, bolts, and nuts are similarly cleaned.
5. Spot-prime coat after repairs.

Q. Shop-Primed Steel Surfaces:

1. Sand and scrape to remove loose primer and rust.
2. Feather edges to make touchup patches inconspicuous.
3. Clean surfaces with solvent.
4. Prime bare steel surfaces.

R. Existing Work:

1. Extend existing paint and coatings installations using materials and methods compatible with existing installations and as specified.

3.3 APPLICATION

A. Do not apply finishes to surfaces that are not dry.

B. Apply each coat to uniform appearance.

C. Apply each coat slightly darker than preceding coat, unless specified otherwise.

D. Sand surfaces lightly between coats to achieve required finish.

E. Cleaning:

1. Vacuum surfaces to remove loose particles.
2. Use tack cloth to remove dust and particles just prior to applying next coat.

F. Finishing Mechanical and Electrical Equipment:

1. Schedule of Color-Coding and Identification Banding of Equipment, Ductwork, Piping, and Conduit: Section 220553 - Identification for Plumbing Piping and Equipment, Section 230553 - Identification for HVAC Piping and Equipment, Section 260553 - Identification for Electrical Systems, and Section 270553 - Identification for Communications Systems.
2. Coat shop-primed equipment.

3. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components, and coat separately.
4. Coat insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, except where these items are shop finished.
5. Coat interior surfaces of air ducts visible through grilles and louvers with one flat black coating.
6. Coat dampers exposed behind louvers, grilles, to match face panels.
7. Coat exposed conduit and electrical equipment installed in finished areas.
8. Coat both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
9. Color-Coding:

    a. Color-code equipment, piping, conduit, and exposed duct work according to indicated requirements.
    b. Color band and identify with flow arrows, names, and numbering.

10. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings that were removed prior to finishing.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Inspecting:

1. Surface Preparation: Comply with SSPC-SP 10.

C. Testing:

1. Holiday Testing: Submerged surfaces including surfaces within vapor area.
2. Dry Film Thickness: Measure according to SSPC-PA 2.

D. Equipment Acceptance:

1. Repair or recoat areas containing holidays according to coating manufacturer instructions.
2. Retest repaired or recoated areas.

3.5 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Collect waste material that may constitute fire hazards, place in closed metal containers, and remove daily from Site.

3.6 ATTACHMENTS

A. Schedule - Ferrous Metals:

1. Application: Submerged in potable, raw, or reclaimed water, and wastewater, including surfaces within 2 feet above high water level.

    a. Surface Preparation: SSPC-SP 10.
    b. Amine-cured epoxy.
    c. Manufacturers:

        1) PPG Paints.
        2) Sherwin-Williams Company (The).
        3) Tnemec Inc.
        4) Approved equivalent.

    d. Type: High build.
    e. Minimum Solids Content: 80 percent by volume.
    f. Number of Coats: Two
    g. Dry Film Thickness per Coat: 3-5 mils

2. Application: Non-submerged, interior exposure.

    a. Surface Preparation: SSPC-SP 6.
    b. Amine-cured epoxy.
    c. Manufacturers:

        1) PPG Paints.
        2) Sherwin-Williams Company (The).
        3) Tnemec Inc.
        4) Approved equivalent.

    d. Type: High build.
    e. Minimum Solids Content: 80 percent by volume.
    f. Number of Coats: Two
    g. Dry Film Thickness per Coat: 3-5 mils

B. Schedule - Concrete:

1. Application: Submerged in water or wastewater, including surfaces within 2 feet (0.61 m) above high water level:

    a. Surface Preparation: As recommended by coating manufacturer.
    b. Filler-Surfacer:

        1) Polyamine epoxy.
        2) Manufacturers:

            a) PPG Paints.
            b) Sherwin-Williams Company (The).
            c) Tnemec Inc.
            d) Approved equivalent.

        3) Solids Content: 100 percent by volume.

c. Finish Coats:

1) Amine-cured epoxy.
2) Manufacturers:

a) PPG Paints.
b) Sherwin-Williams Company (The).
c) Tnemec Inc.
d) Approved equivalent.

3) Minimum Solids Content: 80 percent by volume.
4) Number of Coats: Two
5) Dry Film Thickness per Coat: 3-5 mils

2. Application: Floor slab and walls.

a. Surface Preparation: As recommended by coating manufacturer.
b. Filler-Surfacer:

1) Polyamine epoxy.
2) Manufacturers:

a) PPG Paints.
b) Sherwin-Williams Company (The).
c) Tnemec Inc.
d) Approved equivalent.

3) Solids Content: 100 percent by volume.

c. Finish Coats:

1) Amine-cured epoxy.
2) Manufacturers:

a) PPG Paints.
b) Sherwin-Williams Company (The).
c) Tnemec Inc.
d) Approved equivalent.

3) Minimum Solids Content: 80 percent by volume.
4) Number of Coats: Two
5) Dry Film Thickness per Coat: 3-5 mils

3. Application: Interior of sewer manholes, including metal appurtenances.

a. Surface Preparation: As recommended by coating manufacturer.
b. Filler-Sealer:

1) Amine-cured epoxy.
2) Manufacturers:

a) PPG Paints.

b) Sherwin-Williams Company (The).
c) Tnemec Inc.
d) Approved equivalent.

3) Minimum Solids Content: 68 percent by volume.
4) Number of Coats: One

c. Finish Coats:

1) Vinyl ester.
2) Manufacturers:

a) PPG Paints.
b) Sherwin-Williams Company (The).
c) Tnemec Inc.
d) Approved equivalent.

3) Total Dry Film Thickness: 40 mils

END OF SECTION 099635

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Interior signs.

1.2 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate sign styles, lettering font and size, foreground and background colors, locations, and overall dimensions of each sign.

C. Samples: Submit two signs, 6 by 8 inches in size, illustrating type, style, letter font and size, colors, and method of attachment.

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

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:

1. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 INTERIOR SIGNS

A. Manufacturers: It is desired to use a local manufacturer if possible. Listed below are other manufacturers that will meet the required specifications.
1. ACE Sign Systems, Inc.
2. Advance Corporation.
3. Allen Markings.
4. APCO Graphics, Inc.
5. ASE, Inc.
6. ASI Sign Systems, Inc.
7. Best Sign Systems, Inc.
8. Bunting Graphics, Inc.
9. Clarke Systems.
10. Diskey Architectural Signage Inc.
11. Erie Landmark Company
12. Inpro Corporation.
13. Mohawk Sign Systems.
14. Nelson-Harkins Industries.
15. Poblocki Sign Company, LLC.
16. Stamprite Supersine; a division of Stamp Rite Inc.
17. Vista System.
18. Vomar Products, Inc.
19. OR Approved Equivalent

B. Cast Bronze Plaque for WWTP Entryway:

1. Material: Cast Bronze.
2. Sign Color: Solid black background with raised bronze alloy border.
3. Total Thickness: 1/8 inch.
4. Total Height: 24 inches.
5. Total Width: 18 inches
6. Edges: Square.
7. Characters:

a. Color: Raised bronze text.
b. Thickness: 1/8 inch.
c. Height: 1 inch.
d. Font: Match existing.
e. Text:

City of Conneaut Wastewater Treatment Plant NFA Improvements

Dedicated to the Citizens of Conneaut

City Officials

City Manager	Nick Sanford
Financial Director	John Williams
Chief of Police	Michael M. Colby
Fire Chief	Steven Lee

City Council

President	Terru Moisio, Jr.
Ward 1	Rick Gaugh
Ward 2	Chris Castrilla
Ward 3	Oakey Emery
Ward 4	Nic Church
Council at Large	Mariana Branch
Council at Large	Nick Peroski

Contractors
<insert contractor name>

Consulting Engineers
CT Consultants, A Verdantas Company

f. Images:

g. Reference Photo:

2.2 ACCESSORIES

A. Mounting Hardware: Brass screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use manufacturer's installation template and attachment devices.

B. Install signs after surfaces are finished.

C. Locations: As directed by Owner.

D. Locate sign on wall surface, level.

END OF SECTION 101400

SECTION 220500 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 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. Equipment installation requirements common to equipment sections.
   7. Painting and finishing.
   8. Supports and anchorages.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 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.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 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 22 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

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

F. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Dresser Industries, Inc.; DMD Div.
    c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
    d. JCM Industries.
    e. Smith-Blair, Inc.
    f. Viking Johnson.
2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. 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.

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

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Fernco, Inc.
    c. Mission Rubber Company.
    d. Plastic Oddities, Inc.

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 Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. 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. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. 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. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

E. PVC Pipe: ASTM D 1785, Schedule 40.

F. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 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 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 Sections for flashing materials and installation.
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 Sealants" for materials and installation.

M. Aboveground, Exterior-Wall Pipe 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.
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.
3. 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.

N. 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.

O. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

A. 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.

B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

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

D. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

E. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

F. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

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.

3.4 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 equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

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

3.5 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section "Painting".

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION 220500

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following meters and gages for mechanical systems:

1. Thermometers.
2. Gages.
3. Test plugs.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

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 LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Interior Locations: die-cast aluminum, brass, or molded polyester, 7 inches long. Exterior Locations: die-cast coated aluminum, weatherproof, 7 inches long.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

I. Thermowells: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.2 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type. Interior locations: drawn steel or cast aluminum, 4-1/2-inch diameter. Exterior locations: stainless steel, weatherproof, 2-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Metal.

9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.3 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Install thermometers, gages, and test plugs as indicated on the plans and other specification sections.

3.2 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install needle valve for each pressure gauge.

3.3 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.4 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 220519

SECTION 220523 – VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general-duty valves.

B. Related Sections include the following:

1. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.4 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

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 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Extended Valve Stems: On insulated valves.

G. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. DynaQuip Controls.
f. Flow-Tek, Inc.
g. Grinnell Corporation.
h. Hammond Valve.
i. Honeywell Braukmann.
j. Jamesbury, Inc.
k. Jomar International, LTD.
l. Kitz Corporation of America.
m. Legend Valve & Fitting, Inc.
n. Milwaukee Valve Company.
o. Nexus Valve Specialties.
p. NIBCO INC.
q. R & M Energy Systems (Borger, TX).
r. Red-White Valve Corp.
s. Richards Industries; Marwin Ball Valves.
t. Watts Industries, Inc.; Water Products Div.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with regular port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.4 BRONZE CHECK VALVES

A. Manufacturers:

1. Type 2, Bronze, Lift Check Valves with Nonmetallic Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Red-White Valve Corp.
e. Walworth Co.

2. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. Kitz Corporation of America.
i. Legend Valve & Fitting, Inc.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Powell, Wm. Co.
m. Red-White Valve Corp.
n. Walworth Co.
o. Watts Industries, Inc.; Water Products Div.

B. Bronze Check Valves, General: MSS SP-80.

C. Type 2, Class 125, Bronze, Lift Check Valves: Bronze body and seat, with nonmetallic disc.

D. Type 4, Class 125, Bronze, Swing Check Valves: Bronze body and seat, with nonmetallic disc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

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

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or gate valves.
2. Pump Discharge: Spring-loaded, lift-disc check valves.

B. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125 bronze.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: IN horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment.

B. Related Sections include the following:
   1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.5 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
   1. Pipe Hangers:
      a. AAA Technology and Specialties Co., Inc.
      b. B-Line Systems, Inc.
      c. Carpenter & Patterson, Inc.
      d. Empire Tool & Manufacturing Co., Inc.
      e. Globe Pipe Hanger Products, Inc.
      f. Grinnell Corp.
      g. GS Metals Corp.
      h. Michigan Hanger Co., Inc.
      i. National Pipe Hanger Corp.
      j. PHD Manufacturing, Inc.
      k. PHS Industries, Inc.
      l. Piping Technology & Products, Inc.
   2. Channel Support Systems:
      a. B-Line Systems, Inc.
      b. Grinnell Corp.; Power-Strut Unit.
      c. GS Metals Corp.
      d. Michigan Hanger Co., Inc.; O-Strut Div.
      e. National Pipe Hanger Corp.
      f. Thomas & Betts Corp.
      g. Unistrut Corp.
      h. Wesanco, Inc.
   3. Thermal-Hanger Shield Inserts:
      a. Carpenter & Patterson, Inc.
      b. Michigan Hanger Co., Inc.
      c. PHS Industries, Inc.
      d. Pipe Shields, Inc.
      e. Rilco Manufacturing Co., Inc.
      f. Value Engineered Products, Inc.
   4. Powder-Actuated Fastener Systems:
      a. Gunnebo Fastening Corp.
      b. Hilti, Inc.
      c. ITW Ramset/Red Head.
      d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. General:
    a. Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel.
    b. Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.

2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

3. All attachments to precast hollow-core concrete slabs shall comply with slab manufacturer's installation instructions.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
2. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
3. Material for Cold Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
4. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
5. Material for Hot Piping: ASTM C 552, Type I cellular glass.
6. Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate.
7. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
8. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
9. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

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

D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   2. Properties: Nonstaining, noncorrosive, and nongaseous.
   3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. General: Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel. Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.

B. All attachments to precast hollow-core concrete slabs shall comply with slab manufacturer's installation instructions.

C. Specific hanger requirements are specified in Sections specifying equipment and systems.

D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
   1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches 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 inches 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 noninsulated stationary pipes, NPS 3/4 to NPS 8.
   7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
   10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipe, 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 two 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.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification 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.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg 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 deg F piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification 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 head room is limited.

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification 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 by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support 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. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
1. Field assemble and install according to manufacturer's written instructions.

C. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.

D. Install powder-actuated drive-pin fasteners 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.

E. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. 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.

H. All piping shall be adequately supported and braced by means of adequate hangers, concrete piers, pipe supports, brackets, or as otherwise shown on the plan or recommended by the pipe and equipment manufacturer requirements. No pipe support shall fall on a pipe joint. Contactor shall provide unions and flexible couplers (not shown on plans) to provide adequate removal of valves and equipment.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

K. 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 B31.9.
   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 arc of 180 degrees.
      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 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.5 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
    1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

8SECTION 220553 – IDENTIFICATION FOR PLUMBING 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Pipe markers.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
    a. Manufacturer, product name, model number, and serial number.
    b. Capacity, operating and power characteristics, and essential data.
    c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
1. Terminology: Match schedules as closely as possible.
2. Data:
    a. Name and plan number.
    b. Equipment service.
    c. Design capacity.
    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Water heaters.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. Letter Size: Minimum 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.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Water heaters.

C. Install permanent sign of corrosion resistant materials, with pictograph, hung above hose bibb that reads as follows: “CAUTION: NONPOTABLE WATER – DO NOT DRINK.”

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
   2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

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

3.4 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION 220553

SECTION 220719 – PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes preformed, rigid pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. This Section includes requirements for plumbing piping systems.

C. Related Sections include the following:
   1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
   2. Division 22 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for insulation application.

1.6 SCHEDULING

A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   1. Mineral-Fiber Insulation:
      a. Johns Manville Corp.
      b. Knauf FiberGlass GmbH.
      c. Owens-Corning Fiberglas Corp.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
   1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
   2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
      a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
      b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
   3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
   4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
   5. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
   6. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
2. Adhesive: As recommended by insulation material manufacturer.

C. Aluminum Jacket: Comply with ASTM B209, alloy 3003 or 3105. Thickness to be 0.024 inches, corrugated (cross-crimped).

2.4 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

2.5 PAINTING

A. See Division 09.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

G. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.
   2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
   3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
   4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
   5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

H. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
   1. Seal penetrations with vapor-retarder mastic.
   2. Apply insulation for exterior applications tightly joined to interior insulation ends.
   3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal metal jacket to roof flashing with vapor-retarder mastic.

I. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

J. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

K. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
   1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."

L. Floor Penetrations: Apply insulation continuously through floor assembly.
   1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:
   1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
   2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.

3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.

C. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FINISHES

A. See Division 09.

3.6 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Drainage piping located in crawl spaces, unless otherwise indicated.
5. Below-grade piping, unless otherwise indicated.

6. Chrome-plated pipes and fittings, unless potential for personnel injury.
7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.7 INSULATION APPLICATION SCHEDULE, GENERAL

A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.8 INSULATION APPLICATION SCHEDULE

A. Service: Domestic cold water systems.
   1. Operating Temperature: 40 to 90 deg F.
   2. Insulation Material: Mineral fiber.
   3. Insulation Thickness: 1/2-inch for piping up to 1.25-inch diameter. 1-inch for piping 1.5 inch diameter and larger.
   4. Jacket: All service.
   5. Vapor Retarder Required: Yes.
   6. Finish: Painted.

B. Service: Domestic water systems (hot, tempered water, etc.).
   1. Operating Temperature: 40 to 200 deg F.
   2. Insulation Material: Mineral fiber.
   3. Insulation Thickness: 1-inch for piping up to 3/4-inch diameter. 1.25-inch for piping 1-inch and larger. Provide larger thicknesses as recommended by electric heat trace manufacturer where required.
   4. Jacket: All service.
   5. Vapor Retarder Required: Yes.
   6. Finish: Painted.

C. Service: Storm drain systems, Overflow drain systems, roof drain and overflow drain bodies.
   1. Operating Temperature: 40 to 90 deg F.
   2. Insulation Material: Mineral fiber.
   3. Insulation Thickness: 1-inch.
   4. Jacket: All service.
   5. Vapor Retarder Required: Yes.
   6. Finish: Painted.

D. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.
   1. See “Plumbing Fixture Schedules” on the plans.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes potable domestic water piping from locations indicated to fixtures and equipment inside the building. This Section also includes non-potable water piping systems served from potable domestic water piping.

B. Related Sections include the following:
   1. Division 22 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
   2. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.
   3. Division 40 Section “Process Pipe and Pipe Fittings” for water service piping.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
   1. Potable Domestic Water Service Piping: 175 psig.
   2. Potable Domestic Water Distribution Piping: 125 psig.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Water Samples: Specified in "Cleaning" Article in Part 3.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Transition Couplings for Underground Pressure Piping: AWWA C219, metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 COPPER TUBING

A. Soft Copper Tube: ASTM B 88, Types K, water tube, annealed temper.

B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
   1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint or crimped fittings. Furnish wrought-copper fittings if indicated.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint or crimped ends. Furnish Class 300 flanges if required to match piping.
   3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint, crimped, or threaded ends.
   4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

2.3 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.

   1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

2.4 VALVES

A. Refer to Division 22 Section "Valves" for bronze and cast-iron, general-duty valves.

B. Refer to Division 22 Section "Plumbing Specialties" for balancing and drain valves.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Fitting Option: Crimped joints may be used on aboveground copper tubing.

C. Underground Potable Domestic Water Service Piping: Use the following piping materials for each size range:
   1. NPS 2 and Smaller: Soft copper tube, Type K, with flared fittings.
   2. NPS 3 and Larger: Use pipe and fittings as specified in Div. 33 Utilities.

D. Aboveground Potable Domestic Water Piping: Use the following piping materials for each size range:
   1. NPS 2 and smaller: Hard copper tube, Type L; copper pressure fittings; and soldered or crimped joints.
   2. NPS 3 and Larger: Use pipe and fittings as specified in Div. 40 Process.

E. Aboveground Non-Potable Water Piping: Use the following piping materials for all sizes:
   1. PVC, Schedule 40 pipe; PVC Schedule 40 socket fittings; and solvent-cemented joints.

3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use bronze ball for piping NPS 3 and smaller.
   2. Drain Duty: Hose-end drain valves.

3.4 PIPING INSTALLATION

A. Refer to Division 33 Sections for site water distribution and service piping.

B. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping installation.

C. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.

D. Install underground copper tubing according to CDA's "Copper Tube Handbook."

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for sleeves and mechanical sleeve seals.

F. Install shutoff valve, hose-end drain valve, pressure gage, and test tee with valve, inside building at each domestic water service. Refer to Division 22 Section "Meters and

Gages" for pressure gages, and to Division 22 Section "Plumbing Specialties" for drain valves and strainers.

G. Install aboveground domestic water piping level.

H. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

I. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

J. Check plumbing specialties and verify proper settings, adjustments, and operation.

1. Water-Pressure Regulators: Set outlet pressure at 80 psig maximum, unless otherwise indicated.

3.5 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping joint construction.

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

C. PVC Pressure Piping: Join ASTM D1785 schedule 40, PVC pipe and PVC socket fittings according to ASTM D2672.

3.6 VALVE INSTALLATION

A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment.

B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops.

C. Install drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
1. Install hose-end drain valves at low points in water mains, risers, and branches.

3.7 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
   2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.

H. Install supports for vertical PVC piping every 48 inches.

I. Support ping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to water service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the following:
   1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
   3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 FIELD QUALITY CONTROL

A. Inspect potable domestic water piping, and non-potable water piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test potable domestic water piping and non-potable water piping as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping and non-potable water piping as follows:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean domestic water piping systems. Remove dirt and debris as work progresses.

END OF SECTION 221116

SECTION 221316 - STORM, SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes soil and waste, sanitary and storm drainage and vent piping inside the building and to locations indicated.

B. Related Sections include the following:
1. Division 22 Section "Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:
1. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
1. Soil, Waste, and Vent Piping: 10-foot head of water.
2. Sanitary Sewer, Force-Main Piping: 50 psig.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

C. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 PVC PIPING

A. Solid Wall PVC Pipe: ASTM D2665, Drain , Waste and Vent.
   1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit pipe.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Aboveground and Underground Storm, Soil, Waste, and Vent Piping; Exposed or in Chases: Use the following piping materials for all sizes:
   1. Solid wall, Schedule 40, PVC pipe: ASTM D2665 DWV, PVC socket fittings and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Refer to Division 33 Sections for Project-site sanitary and storm sewer piping.

B. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.

F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

H. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

J. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

K. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.

F. Install supports for vertical PVC piping every 48 inches.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect storm, soil and waste piping to exterior sanitary and storm sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Specialties."
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary and storm drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 221316

SECTION 224210 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following plumbing specialties:
   1. Backflow preventers.
   2. Thermostatic water mixing valves.
   3. Key-operation hydrants.
   4. Miscellaneous piping specialties.
   5. Flashing materials.
   6. Cleanouts.
   7. Floor drains and roof drains.

B. Related Sections include the following:
   1. Division 22 Section "Meters and Gages" for water meters, thermometers, and pressure gages.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
   1. Domestic Water Piping: 125 psig.
   2. Sanitary Waste and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
   1. Backflow preventers.
   2. Thermostatic water mixing valves.
   3. Hose bibs and hydrants.
   4. Cleanouts, floor drains, and roof drains.

B. Field test reports.

C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
   1. Backflow preventers.
   2. Thermostatic water mixing valves.
   3. Hose bibs and hydrants.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

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. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:
   1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for drain, waste, and vent piping components. Include marking "NSF-DWV" on plastic drain, waste, and vent piping.
   2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

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. Operating Key Handles: Furnish one key for each key-operated hose bibb and hydrant installed.

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 one of the manufacturers specified.

2.2 BACKFLOW PREVENTERS

A. Manufacturers:
   1. Ames Co., Inc.
   2. CMB Industries, Inc.; Febco Backflow Preventers.
   3. Conbraco Industries, Inc.
   4. Mueller Co.; Hersey Meters Div.
   5. Sparco, Inc.
   6. Watts Industries, Inc.; Water Products Div.

7. Zurn Industries, Inc.; Wilkins Div.

B. General: ASSE standard, backflow preventers.
   1. NPS 2 and Smaller: Bronze body with threaded ends.

C. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

D. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include ball valve on inlet and outlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.
   1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

2.3 THERMOSTATIC WATER MIXING VALVES

A. Manufacturers:
   1. Lawler Manufacturing Company, Inc.
   2. Leonard Valve Company.
   3. Mark Controls Corp.; Powers Process Controls.
   4. Symmons Industries, Inc.
   5. T & S Brass and Bronze Works, Inc.

B. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body, rough bronze finish. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and thermometer on outlet.
   1. Type: Liquid-filled motor, operation and pressure rating 100 psig minimum.

C. Emergency Equipment: ASSE 1071, thermostatic mixing valve to supply tepid water to emergency fixtures with cold water bypass, brass with internal check stops, paraffin filled thermostatic mixing element, and temperature gauge.

D. Lavatory Sink: ASSE 1070, adjustable temperature thermostatic mixing valve with integral checks, lead-free, cast copper silicon alloy body, advanced paraffin-based thermal actuator.

2.4 KEY-OPERATION HYDRANTS

A. Manufacturers:
   1. Josam Co.
   2. Smith, Jay R. Mfg. Co.
   3. Tyler Pipe; Wade Div.
   4. Watts Industries, Inc.; Drainage Products Div.
   5. Zurn Industries, Inc.

B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.
   1. Inlet: NPS 3/4 threaded or solder joint.
   2. Outlet: ASME B1.20.7, garden-hose threads.

3. Operating Keys: One with each key-operation hydrant.

C. Nonfreeze Exposed-Outlet Wall Hydrants: ASSE 1019, self-drainable with integral nonremovable hose-connection vacuum breaker, casing and operating rod to match wall thickness, projecting outlet, and wall clamp.
1. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.

2.5 MISCELLANEOUS PIPING SPECIALTIES

A. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral, nonremovable, vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.
1. Finish: Rough bronze.
2. Operation: Tee handle.

B. Roof Flashing Assemblies: Manufactured assembly made of 4-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.
1. Manufacturers:
a. Acorn Engineering Company; Elmdor/Stoneman Div.

C. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 CLEANOUTS, FLOOR DRAINS, AND ROOF DRAINS

A. Comply with ASME. See “DRAIN SCHEDULE” on plans.
   1. Products:
      a. Josam Co.
      b. Smith, Jay R. Mfg. Co.
      c. Tyler Pipe, Wade Div.
      d. Watts Industries, Inc., Drainage Products Div.
      e. Zurn Industries, Inc., Specification Drainage Operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 100 feet for piping NPS 4 and for larger piping.
   4. Locate at base of each vertical soil and waste stack and storm conductor.

D. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

E. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
   1. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

H. Install individual ball shutoff valve in each water supply to plumbing specialties. Install shutoff valves in accessible locations. Refer to Division 22 Section "Valves".

I. Install traps on plumbing specialty drain outlets.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect plumbing specialties to piping specified in other Division 22 Sections.

D. Ground equipment.

E. 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.

F. Connect plumbing specialties and devices that require power according to Division 26 Sections.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer and thermostatic water mixing valve.
   1. Text: Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
   2. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for nameplates and signs.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain plumbing specialties. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 224210

SECTION 230512 - BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Sleeves.
   2. Escutcheons.
   3. Equipment installation requirements common to equipment sections.
   4. Painting and finishing.
   5. Concrete bases.
   6. Supports and anchorages.

1.3 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.

1.4 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.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 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.

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

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. 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 in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: 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.

C. 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. 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 Sections for flashing materials and installation.
        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 Sealants" for materials and installation.

3.2 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.

3.3 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 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 concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete".

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION 230512

SECTION 230553 – 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Pipe markers.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

   1. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
2. Data:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Fuel-burning units, including furnaces, unit heaters, and water heaters.
   2. Compressors, condensers, and similar motor-driven units.
   3. Fans, blowers, primary balancing dampers, and mixing boxes.
   4. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. Letter Size: Minimum 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.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Fuel-burning units, including furnaces, unit heaters, and water heaters.
      b. Compressors, condensers, and similar motor-driven units.
      c. Fans, blowers, primary balancing dampers, and mixing boxes.
      d. Packaged HVAC central-station and zone-type units.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

   2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed 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 nonaccessible 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 markers.

3.4 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:
   a. Constant-volume air systems.
2. HVAC equipment quantitative-performance settings.
3. Verifying that automatic control devices are functioning properly.
4. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. TAB: Testing, adjusting, and balancing.

B. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", and this Section.

B. Take and report testing and balancing measurements in inch-pound (IP) units.

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

3.4 PROCEDURES FOR CONSTANT – VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

B. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

3.5 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, amperage, each phase.
6. Starter thermal-protection-element rating.

3.6 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings.

C. Measure outside-air dry-bulb temperatures.

3.7 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check the interaction of electrically operated switch transducers.

F. Check the interaction of interlock and lockout systems.

G. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

H. Note operation of electric actuators using spring return for proper fail-safe operations.

3.8 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 5 percent.

3.9 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

C. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.

h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

D. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
i. Number of belts, make, and size.

2. Motor Data:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.

d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

E. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Air-terminal-device make.
e. Air-terminal-device size.
f. Air-terminal-device effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Final airflow rate in cfm.
d. Final velocity in fpm.
e. Space temperature in deg F.

3.10 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes semi-rigid duct and plenum insulation; insulating cements; accessories and attachments; and sealing compounds.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 COORDINATION

A. Coordinate clearance requirements with duct Installer for insulation application.

1.6 SCHEDULING

A. Schedule insulation application after testing duct systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mineral-Fiber Insulation:

a. Johns Manville Corp.
b. Knauf FiberGlass GmbH.
c. Owens-Corning Fiberglas Corp.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Insulation: Glass fibers bonded with resin. ASTM C612, density 3.0 PCF, with factory applied all service jacket.

2.3 ACCESSORIES

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

2.4 FIELD APPLIED JACKETS

A. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3105. Thickness to be 0.016 inches, finish to be corrugated (cross-crimped).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

3.4 SYSTEM PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Terminate insulation at exterior wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall with flashing sealant.

3.5 APPLICATIONS

A. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

B. Insulate the following systems:

1. Outdoor, supply-air ducts and plenums.

C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Testing agency labels, equipment nameplates, or access panels/doors.

3.6 APPLICATION SCHEDULE

A. Service: Outdoor, supply-air ducts and plenums (at MAU Units).

1. Material: Mineral-fiber board, 2-inches thick.
2. Field Applied Jacket: Aluminum, corrugated, 0.016-inches thick.

END OF SECTION 220713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes preformed, flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:
   1. Division 23 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexible Elastomeric Thermal Insulation:
      a. Armstrong World Industries, Inc.
      b. Rubatex Corp.

2.2 INSULATION MATERIALS

A. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Adhesive: As recommended by insulation material manufacturer.
   2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
   1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
   2. Adhesive: As recommended by insulation material manufacturer.

2.4 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

G. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.
   2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
   3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
   4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
   5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

H. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

I. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

J. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."

K. Floor Penetrations: Apply insulation continuously through floor assembly.
1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:
1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to fittings and elbows as follows:
1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.5 FINISHES

A. Flexible elastomeric Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

3.6 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Flexible connectors.
2. Vibration-control devices.
3. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.7 INSULATION APPLICATION SCHEDULE, GENERAL

A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.8 INSULATION APPLICATION SCHEDULE

A. Service: Refrigerant Suction and Liquid Piping.

1. Operating Temperature: 35 to 50 deg F.
2. Insulation Material: Flexible Elastomeric.
3. Insulation Thickness: ½ inch.
4. Jacket: None.
5. Vapor Retarder Required: No.
6. Finish: Painted.

B. Service: Interior Condensate Drain Piping.
1. Operating Temperature: 35 to 75 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: ½ inches.
4. Jacket: None
5. Vapor Retarder Required: No.
6. Finish: Painted.

END OF SECTION 230719

SECTION 232113 - HYDRONIC PIPING

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 pipe and fitting materials and joining methods for the following:
   1. Plastic pipe and fittings.
   2. Joining materials.

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.
   3. Joining materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Condensate-Drain Piping: 150 deg F.

2.2 PLASTIC PIPE AND FITTINGS

A. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.
   1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D2466 for Schedule 40 pipe; ASTM D2467 for Schedule 80 pipe.

2.3 JOINING MATERIALS

A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

B. Solvent Cements for PVC Piping: ASTM D2564. Include primer according to ASTM F656.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

C. 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.

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

K. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

L. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Sections.

N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Sections.

3.3 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE JOINT CONSTRUCTION

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

B. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D2855.
   3. PVC Nonpressure Piping: Join according to ASTM D2855.

END OF SECTION 232113

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 2-inch wg. Metal ducts include the following:

1. Rectangular ducts and fittings.

B. Related Sections include the following:

1. Section 233300 "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Section 230593 “Testing, Adjusting, and Balancing”.

1.3 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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 DUCT MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts. Material thicknesses shall comply with SMACNA's "Industrial Duct Construction Standards".

C. Reinforcement Shapes and Plates: Galvanized-steel where installed on galvanized sheet metal ducts. Stainless-steel where installed on stainless-steel ducts. Where used on aluminum ducts, isolate the different metals with neoprene, butyl rubber, or EPDM gasket materials.

2.3 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

C. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

D. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

A. Hanger Materials:

1. General: All hangers, supports, rods, etc. to be corrosion resistant, hot dipped galvanized for interior, and Type 316 or 304 stainless steel for exterior, except as noted otherwise.

B. Hanger Type: Threaded rod. Straps and wires are not permitted.

1. Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports:

1. Supports for Aluminum Ducts: Aluminum support materials, or galvanized steel, or stainless steel, electrolytically separated from ducts.

2.5 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

   1. Manufacturers:

      a. Ductmate Industries, Inc.
      b. Nexus Inc.
      c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

   1. Manufacturers:

      a. Ductmate Industries, Inc.
      b. Lockformer.

   2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
   3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Duct Materials: All duct materials shall be aluminum.

B. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts: 2-inch wg with seal Class A seams and joint construction.
2. Return Ducts (Negative Pressure): 2-inch wg with seal Class A seams and joint construction.
3. Exhaust Ducts (Negative Pressure): 2-inch wg with seal Class A seams and joint construction.
4. Exhaust Ducts (Positive Pressure): 2-inch wg with seal Class A seams and joint construction.

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install ducts with fewest possible joints.

C. Install fabricated fittings for changes in directions, size, and shape and for connections.

D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

E. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

F. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

G. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

H. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

END OF SECTION 233113

SECTION 233300 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Volume dampers.
2. Turning vanes.
3. Flexible connectors.
4. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: All items specified and utilized on Project.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow Corporation.

5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
3. Bearings: Molded synthetic.
4. Tie Bars and Brackets: Aluminum.

D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.3 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Manufacturers:

a. Ductmate Industries, Inc.
b. Duro Dyne Corp.
c. METALAIRE, Inc.
d. Ward Industries, Inc.

2.4 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Duro Dyne Corp.
2. Ventfabrics, Inc.
3. Ward Industries, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.5 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

D. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators and where ducts are installed perpendicular to building structural expansion joints.

E. Adjust duct accessories for proper settings.

END OF SECTION 233300

SECTION 233423 - POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Centrifugal roof and wall ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and 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. Fan speed controllers.

B. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and penetrations.

1.7 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. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ammerman; General Resource Corp.
2. Greenheck.
3. JencoFan; Div. of Breidert Air Products.
4. Loren Cook Company.
5. Penn Ventilation.

B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and accessories. Direct-driven fans shall be provided where indicated on the plans (See Equipment Schedules).

C. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. See “Mechanical Equipment Schedules” on the plans for all construction features, coatings, motor types, and other accessories.

G. Coatings, when specified, shall be applied to all fan items and accessories.

2.2 MOTORS

1. See “HVAC Equipment Schedule” on the Plans.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with 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. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb, in accordance with manufacturer’s installation instructions.

B. Install units with clearances for service and maintenance.

C. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. 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.
2. 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.
3. Adjust belt tension.
4. Adjust damper linkages for proper damper operation.
5. Verify lubrication for bearings and other moving parts.
6. Verify that dampers in connected ductwork systems are in fully open position.
7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain power ventilators. Refer to Division 1 Sections.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 QUALITY ASSURANCE

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

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 GRILLES AND REGISTERS

A. Manufacturers
   1. Anemostat, a Mestek Company.
   2. Krueger.
   3. Price Industries.
   4. Titus.
   5. Tuttle and Bailey.

PART 3 – EXECUTION

3.1 SCHEDULES

A. See “Air Grille Schedules” on the Plans for types utilized.

3.2 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Correct unsatisfactory conditions.

3.3 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts.

D. 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.

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

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

3.4 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated.

3.5 CLEANING

A. After installation, clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

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

END OF SECTION 233713

SECTION 237423 - DIRECT-FIRED MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes direct-fired make-up air units (MAU).

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

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. Mounting Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Startup service reports.

D. Operation and Maintenance Data: For direct-fired make-up air units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of direct-fired make-up air units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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 the International Fuel Gas Code, and NFPA 70.

D. Entire unit shall be ETL Certified per ANSI Z83.4 or Z83.18 and bear on ETL mark.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

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. Filters: One set for each unit.
2. Fan Belts: One set for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Absolut Aire.
2. Engineered Air.
3. Greenheck Fan Corporation.

2.2 PACKAGED UNITS

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, outdoor air intake weather hood, supply fan, controls, filters, and direct-fired gas burner. See plans for locations of interior and exterior units.

2.3 CABINET

A. Cabinet: Double-wall 18 gauge galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. All sections shall be insulated, and be provided with 24-gauge solid galvanized steel liner.

B. Access Panels: Piano hinged for furnace, filters, damper, access sections, control panels and fan motor assemblies.

C. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C 1071, Type II;

1. Thickness: 1-inch.
2. Insulation Adhesive: Comply with ASTM C 916, Type I.
3. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.
4. Locations: Fan sections, heat sections.

D. Finish: Heat-resistant, polyester based powder resin, or air dry industrial enamel, all sections and accessories.

E. Discharge: See plans and HVAC Equipment Schedules.

2.4 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, pillow-block bearings rated for L50 or 200,000 hours with external grease fittings.

B. Motor: Premium efficiency, totally enclosed.

C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly. Direct drive arrangement acceptable when specified (See HVAC Equipment Schedules on the Plans).

D. Variable Frequency Drive: When specified (See HVAC Equipment Schedules on the Plans).

E. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with neoprene isolators.

2.5 AIR FILTERS

A. Comply with NFPA 90A. See Plans for filter type and sections at each unit.

B. Disposable Panel Filters: 2-inch thick, factory-fabricated, pleated-panel-type Merv-13, disposable air filters with holding frames.

1. Media: Interlaced non-woven and synthetic fibric media.
2. Frame: Galvanized steel.

2.6 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer’s standard hood, with materials to match cabinet, designed to inhibit wind-driven rain and snow from entering unit.

B. Aluminum Mesh: Manufacturer’s mesh, to comply with ASHRAE 62.1.

2.7 ROOF CURBS

A. Roof Curbs: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; with a height of 18-inches minimum, complying with NRCA standards. Roof curbs shall be 12-inches minimum height for units installed at grade and concrete foundations.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C 1071, Type I or Type II.
b. Thickness: 1-1/2 inches.

2.8 DIRECT-FIRED GAS FURNACE

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z83.4, "Direct Gas-Fired Make-Up Air Heaters"; ANSI Z83.18, "Direct Gas-Fired Industrial Air Heaters"; and the "International Fuel Gas Code."

B. Controls: Electronic, modulation burner control.

C. Burners: Aluminum or cast-iron burner with stainless-steel mixing plates.

1. Control Valve: Electronic modulating with minimum turndown ratio of 30:1.
2. Fuel: Natural gas.
3. Pilot: Electrically ignited by hot-surface ceramic igniter.

D. Safety Controls:

1. Gas Manifold: Safety switches and controls to comply with ANSI standards and FM Global requirements.
2. Purge-Period Timer: Automatically delays burner ignition and bypasses low-limit control.
3. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.
4. Manual-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
5. Manual-reset, low-limit control device: Stops fan and burner, closes gas valve if low-limit temperature is reached.
6. Gas Train: Redundant, automatic main gas valves, electric pilot valve, electronic-modulating temperature control valve, main and pilot gas regulators, main and pilot manual shutoff valves, main and pilot pressure taps, and high-low gas pressure switches
7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
8. Control Transformer: Integrally mounted 24-V ac.

2.9 CONTROLS

A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

B. Control Panel: Surface-mounted remote panel, Nema 4X, with engraved plastic cover, and the following lights and switches:

1. Summer-Off-Winter switch.
2. Supply-fan operation indicating light.
3. Exhaust-fan operation indicating light.
4. Heating operation indicating light.
5. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
6. Safety-lockout, flame failure (general alarm) indicating light.
7. Room override thermostat.

C. Control Devices:

1. Adjustable discharge air temperature controls unit mounted, with adjustable room override thermostat, located in the conditioned space.

E. Fan Control: The fan is intended to operate continuously 24 hours/day, 365 days/year, to provide the required air changes per hour, per NFPA 820 and the Ten States Standards. The make-up air unit shall be interlocked to operate with the exhaust fan. The make-up supply fan shall contain air flow switches, starter current sensing relays, or other means to prove fan operation. The make-up air fan shall not be permitted to operate until operation of the exhaust fan is proven. If the exhaust fan is not operating, the make-up air shall not be permitted to operate.

F. CAPACITIES, CHARACTERISTICS, AND ADDITIONAL ACCESSORIES

1. See “Mechanical Equipment Schedule” on the Plans.

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 installation of direct-fired make-up air units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

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

3.2 INSTALLATION

A. Install gas-fired units according to the "International Fuel Gas Code."

B. Install makeup air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete”, and as detailed on the plans.

C. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts". Install units on curbs and coordinate roof penetrations and flashing with roof construction specified. Secure units to upper curb rail, and secure curb base to roof framing with anchor bolts.

D. Install controls and equipment shipped by manufacturer for field installation with direct-fired make-up air units.

3.3 CONNECTIONS

A. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

1. Gas Piping: Comply with requirements in Division 33 Section "Natural Gas Distribution." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors if required by manufacturer.

B. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and outside air ducts to direct-fired make-up air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Duct Accessories."

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Provide control wiring between unit panel and remote control panel, according to Division 26 Section "Conductors and Cables."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage and integrity for all sections.
2. Verify that controls are connected and operable.
3. Verify that filters are installed.
4. Purge gas line.
5. Verify bearing lubrication.
6. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
7. Adjust fan belts to proper alignment and tension.
8. Start unit according to manufacturer's written instructions.
9. Complete startup sheets and attach copy with Contractor's startup report.
10. Inspect and record performance of interlocks and protective devices; verify sequences.
11. Operate unit for run-in period recommended by manufacturer.
12. Perform all operations for both minimum and maximum firing and adjust burner for peak efficiency. Measure gas pressure on manifold. Measure combustion-air temperature at inlet to combustion chamber. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
13. Calibrate thermostats.
14. Adjust and inspect high-temperature limits.
15. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
16. Inspect controls for correct sequencing of heating and normal and emergency shutdown.
17. Measure and record airflow.

18. Verify operation of remote panel, including pilot-operation and failure modes. Inspect high-limit heat and all alarms.
19. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

B. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.

C. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature set points. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Working 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 two visits to Project.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain direct-fired make-up air units. Refer to Division 1 Sections.

END OF SECTION 237423

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years for compressor from date of Substantial Completion, one year on remaining components.

1.7 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. Filters: One set of filters for each unit.
2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Mitsubishi Electronics America, Inc.; HVAC Division.
3. Sanyo Fisher (U.S.A.) Corp.
4. Trane Company (The); Unitary Products Group.
5. York International Corp.

2.2 EVAPORATOR-FAN COMPONENTS

A. General: Evaporator-fan unit shall be completely factory assembled including coil, condensate drain pan, fan, motor, filters, and controls in a casing.

B. Cabinet, High-wall type: Polystyrene, with a baked enamel or polyester powder coating, with removable panels on front and ends, with drain connection.

C. Cabinet, Ceiling mounted cassette type: steel cabinet, with enamel coated steel combination supply-air and return-air discharge grille.

D. Insulation: Cabinet to be completed insulated with cleanable, foil-faced, fire-retardent, fiberglass insulation.

E. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve. See plans and equipment schedules for refrigerant circuit quantities (single, dual, etc.).

F. Fan: Forward curve, centrifugal fan. Direct drive for nominal 4 tons and below. Belt drive, adjustable for nominal 5 tons and above.

G. Fan Motors: Multitapped, multispeed for nominal 4 tons and below. Single speed for nominal 5 tons and above. All to have internal thermal protection and permanent lubrication.

H. Filters: Permanent, cleanable, or 2-inch thick pleated throwaway type as indicated on the plans and equipment schedules.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Galvanized steel, finished with baked enamel or polyester powder, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor(s): Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Reciprocating or Scroll.
   2. Manual-reset high-pressure switch and automatic-reset low-pressure switch.
   3. Refrigerant Charge: R-410A.
   4. Compressor Quantities: See plans and equipment schedules for compressor quantities, as related to single or dual circuits.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Fan: Aluminum-propeller type, directly connected to motor.

E. Motor: Permanently lubricated, with integral thermal-overload protection.

F. Low Ambient Operation: Permits operation down to -22 deg F.

G. Mounting: Equipment supports for rooftop applications, and concrete base for grade applications.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection, including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. See equipment schedules on the plans for additional accessories unique for each piece of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install wall-mounted, compressor-condenser components using manufacturer’s wall-mounting assemblies.

D. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

E. Install ground-mounting, compressor-condenser components on 6-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Provide control wiring, conduits in accordance with Division 26 Sections.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 STARTUP SERVICE AND DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 1 for Closeout Procedures.

B. Operational Demonstration shall be per Division 1 Sections.

C. Instruction of the Owner’s Personnel shall be per Division 1 Sections.

END OF SECTION 238126

SECTION 260000

ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 REFERENCE

A. The provisions of the Instructions to Bidders, General Conditions, Supplementary Conditions, Alternates, Addenda, and Division 1 are a part of this specification. Contractors and Subcontractors shall examine same as well as other Divisions of the specifications which affect work under this Division.

B. The requirements of this Section shall govern all Division 25, 26, 27 and 28 work for this project. Bidders are referred to in this section as "Electrical Contractors" and all provisions apply to each contractor and their subcontractors.

C. The contractor shall be solely responsible for construction means, methods, sequences of construction and the safety of workmen.

1.02 DESCRIPTION OF WORK

A. Mechanical, Architectural, Structural, Electrical and all other project drawings, as well as the Specifications for all the Divisions, are a part of the Contract Documents. Work of this section is shown on the electrical drawings.

B. Drawings and Specifications are to be considered as supplementing each other. Work specified but not shown, or shown but not specified, shall be performed or furnished as though mentioned in both Specifications and Drawings. All systems shall be complete and fully operational upon completion of the project.

C. Contractors shall not construe any correspondence or verbal communications with or by the engineer or his representative as authorization for "extra" construction payment. All requests for additions to this contract shall be submitted in writing by the contractor to the architect for consideration by the owner's representative. Work performed without written change order from the owner will be the contractor's sole responsibility without additional compensation.

D. Contractor shall comply with and schedule work according to the schedule of construction specified in Division 1. All work shall be completed within these time constraints and the contractors for the work of this section shall provide all required temporary utilities and connections necessary to maintain the existing systems in full operation during the progress of this work. Sections of any systems may be taken out of service only when approved in writing by the owner.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1 - Project Phasing and Temporary Electrical and Telephone Service

B. Division 3 - Poured-In-Place Concrete

C. Division 9 - Finish Painting

D. Division 21 - Fire Protection

D. Division 22 - Plumbing

F. Division 23 - HVAC

E. Division 31 - Excavation and Backfill

1.04 QUALITY ASSURANCE

A. Codes and Permits:

1) Work shall be installed in full accordance with all applicable codes, rules and regulations of public authorities and/or utilities. Included shall be National Electrical Code, NEMA, U. L. Standards, OSHA, State and local Building Codes. All these Codes, Rules and Regulations are hereby incorporated into this specification.

2) Comply with specification requirements in excess of Code requirements where no conflicts exist.

3) Prior to starting any work, electrical contractors shall secure all necessary permits and inspection certificates required. All fees for permits, utility connection charges, inspections and certificates shall be paid for by electrical contractors.

4) Deliver official record of approval, by governing agencies, to architect for transmittal to owner, prior to starting work.

B. Standards:

1) Comply with applicable provisions of code approved editions of following National Standards:

NFPA 70E Electrical Safety in the Workplace
National Electrical Code
NFPA Life Safety Code and Standards under
Appendix B of Life Safety Code
Underwriters Laboratory
NFPA
NEMA
National Electrical Safety Code
ANSI
Americans with Disability Act

1.05 SUBMITTALS

A. Shop Drawings:

1) Contractor shall submit shop drawings of fixtures, distribution equipment, electrical devices, and communication systems for review. Submittals shall be made in a timely fashion, keeping with the project schedule described in Division 1.

2) Contractor shall review and indicate his approval of each shop drawing prior to submittal for review. Do not start work until shop drawings have been reviewed by the Engineer and returned to the Contractor. Submittals not indicating contractor approval will be returned without review.

3) Submittals will be reviewed only for general compliance with the contract documents and not for dimensions, quantities, etc. The submittal review shall not relieve the contractor of responsibility for purchase of the item in full compliance with the contract documents and its complete and proper installation.

4) Where submittals vary from the contract requirements, the contractor shall clearly indicate on submittal or accompanying documents the nature and reason for variations.

5) Refer to various sections for listing of shop drawings required on this project which are not listed in A.1 above.

6) Each manufacturer or his representative must check the application of his equipment and certify at time of shop drawing submittal that equipment has been properly applied and can be installed, serviced and maintained where indicated on drawings. Advise engineer in writing with submittal drawings of any potential problems. The manufacturer shall be responsible for any changes that might be necessary because of physical characteristics of equipment that have not been called to the engineer's attention at the time of submittal.

B. Record Drawings:

1) Each contractor or subcontractor shall keep one (1) complete set of the contract working drawings on the job site on which he shall regularly record any deviations or changes from such contract drawings made during construction.

2) These drawings shall record the location of all electrical equipment, junction and pull boxes, conduit routing and all below-grade service. All underground services shall be dimensioned from readily identifiable and accessible building elements.

3) Record drawings shall be kept clean and undamaged and shall not be used for any purpose other than recording deviations from working drawings and exact locations of concealed work.

4) After the project is completed, these sets of drawings shall be delivered to the Architect in good condition, as a permanent record of the installation as actually constructed.

5) Provide record drawing of one-line power diagram and mount in electrical equipment room.

1.06 COORDINATION AND SUPERVISION

A. Examine work of other trades which comes in contact with or is covered by the work. Do not attach to, cover, or finish against any defective, or install work of this Division in a manner which will prevent other trades from properly installing their work. Consult all drawings, specifications and details of other Divisions of the work.

B. Proper clearances for architectural design and equipment access and service shall be maintained for all items and components.

C. Contractors shall report any interferences between their work and other work or construction as soon as discovered. If contractor proceeds without coordination, correction shall be the responsibility of the installing contractor without cost to the owner.

D. Drawings are diagrammatic and show approximate location of conduit, devices, etc. Take all measurements and establish exact locations in the field. Adapt to construction and work of other trades as required for coordination of the work.

E. Each contractor shall be responsible for layout and coordination of openings and chases required for these installations, which are provided by other trades. Provide dimensioned drawing and fully coordinate this work with the contractor providing the openings or chase.

F. Each contractor shall provide adequate competent supervision on job during all working hours with authority and instructions to answer questions and carry out instructions of Architect or his representative.

G. All light fixtures and ceiling mounted items shall be centered with regard to ceiling grid at locations shown on the architect's reflected ceiling plan. Failure to observe these requirements shall be cause for correction to be made at the contractor's expense.

H. The owner and/or architect reserve the right to make reasonable changes in the location of electrical devices, furniture feed connection points, etc. up to the time of roughing-in, without additional cost.

I. Provide necessary coordination elements, final dimensions, equipment, working clearances, major conduit runs above and below grade etc. to the Division 250000 HVAC contractor for integration into the coordination drawings.

1.07 DRAWINGS AND SPECIFICATIONS

A. Drawings and specifications are supplemental to each other. It is intended that work covered by these specifications and drawings include everything requisite and necessary to make the various systems complete and operative, irrespective of whether or not every item is specifically provided for. Any omission of direct reference herein to any essential item shall not excuse contractor from complying with the above intent.

B. In case of error or inconsistency, specifications shall take precedence over drawings. Figured dimensions supersede scaled ones. Contractor shall take no advantage of, and shall promptly call Architect's attention to any error, omission or inconsistency in specifications and drawings.

C. Special attention is directed to requirements that equipment and materials stated in specifications and/or indicated on drawings shall be furnished, completely installed, adjusted and left in safe and satisfactory operating condition. Accessories, appliances and connections necessary for proper operation of equipment shall be provided.

D. Materials, apparatus or equipment specified or otherwise provided for on drawings, addenda, or change orders issued subsequent to award of contract, shall be same brand, type, quality and character originally specified, unless specifically approved by the architect.

E. Layout of equipment, accessories, specialties and suspended, concealed or exposed piping systems are diagrammatic, unless dimensioned. In preparing shop drawings, contractor shall check project conditions before installing work. If there are any interferences or conflicts, they shall be called to the attention of Architect immediately for clarifications.

F. The drawings indicate required size and points of termination of conduit and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets and it shall be the work of the installing contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instruction or cost to the owner.

G. It is intended that the electrical items be located symmetrical with architectural elements, and shall be installed at exact height and locations as shown on the architectural drawings. Refer to architectural details in completing and correlating work. Confirm all locations with Architect prior to rough-in.

1.08 PROVISIONS FOR LATER INSTALLATION

A. Become acquainted with nature and progress of construction against which this work attaches. Review structural drawings for coordination of openings. Cut no structural members or slabs without Architect's written approval.

B. When this work cannot be installed concurrently with the building construction, arrange for inserts, sleeves, access panels, etc., as necessary for installation at a later date.

1.09 LOCAL CONDITIONS

A. Visit site and become familiar with facilities and conditions affecting work. No additional payment will be made on claims that arise from lack of knowledge of existing condition.

B. Exercise extra care when working in areas where underground services may exist. Any costs for repair of damage to such services become responsibility of Contractor causing damage.

1.10 PROTECTION

A. When setting up equipment, protect area against staining, abrasion. Cost of correcting any such condition will be charged against the respective Contractor.

B. Protect all equipment which has been installed from construction debris and the work of other trades.

C. Protect finish floors from chips and cutting oil by use of chip receiving pan and oil proof cover.

D. Protect equipment and finished surfaces from welding and cutting spatters with baffles and spatter blankets.

E. Protect from paint droppings, insulation adhesive, by use of drop cloths.

F. Contractors shall be responsible for including and maintaining adequate precautions and safeguards related to their work during all phases of construction. Include protection, warnings and safety devices and equipment for protection of personnel, equipment and materials. Comply with all requirements of governing authorities, including OSHA.

1.11 PRODUCT HANDLING

A. Pay all costs for transportation of materials, equipment to job site.

B. Provide all scaffolding, tackle, hoists, rigging necessary for placing electrical materials and equipment in their proper place. Remove temporary work when no longer required. Comply with applicable State, Federal and local regulations.

C. Contractor shall keep materials clean and protected from weather and/or damage before and after installation until final acceptance by the owner. Protect all openings, bearings, controls, motors, etc., from dirt and moisture.

1.12 UTILITY TIE-INS

A. Make all utility tie-ins for this project in accordance with requirements of authorities having jurisdiction.

B. Fully coordinate service interruptions with all parties involved for shutdown and/or tie-ins with existing systems to minimize interruption of service. Fully coordinate and make connections to existing facilities as scheduled with the owner and governing authorities.

C. Include all necessary arrangements and overtime required to make necessary tie-ins without disrupting service to operational portions of the facility. No downtime is permissible at this facility. Include all costs for temporary power generation to enable change-overs, re-feeds, etc. as established on the drawings. All phasing and temporary outage coordination shall be coordinated with the general contractor and owner prior to initiation.

D. Contractor shall confirm all utility requirements for tie-in prior to bid and include all facilities required by utility for fully coordinated and complete installation. Pay all charges, permit fees and assessments for utility connections.

1.13 SHUTDOWNS

A. Give five (5) working days' notice to Architect or the Owner of anticipated shutdown

requirements of an operating system. Tie-ins and modifications to existing facilities and services must be done with minimum interruption of facilities operation and during hours so affecting.

1.14 EXISTING SERVICES

A. Active services encountered in work shall be protected and supported. Inactive services encountered shall be removed or deactivated as shown or directed by Architect.

B. All costs for repair of damages to active services shall be paid by the contractor causing the damage.

1.15 TEMPORARY SERVICES

A. Temporary services shall be provided as stated in Special Conditions and Division 1. Provide all temporary services and connections as required to accommodate the phasing sequence of the project.

B. Description of System: Furnish and install temporary electrical power service for construction needs throughout construction period in accordance with the special conditions as follows:

1) Provide power for miscellaneous tools and equipment, for pumping, for temporary heating and ventilating and for temporary storage and construction buildings. See General Conditions for requirements of temporary service.

2) Provide temporary lighting of minimum 5 foot candles for safe and adequate working conditions throughout the project, for security and for temporary office and construction buildings.

C. Materials (General)

1) Comply with Electrical - Basic Materials and Methods.

2) Materials may be new or used, but must be adequate in capacity for required purposes, and must not create unsafe conditions or violate requirements of applicable codes.

3) At Contractor's option, patented specialty products may be used, if UL approved.

4) Provide required facilities, including transformers, conductors, poles, conduits, raceways, breakers, fuses, switches and lighting fixtures with lamps.

5) Provide appropriate enclosures for environment in which used, in compliance with NEMA standards.

D. Installation

1) Install work in neat and orderly manner.

2) Make structurally and electrically sound throughout.

3) Maintain to give continuous service and to provide safe working conditions.

4) Modify and extend service as work progress requires.

5) Locate so that power is available at any desired point with no more than 100' (30.00 m) extension, and with no more than 5% voltage drop at full load.

6) Provide circuit breaker protection for each outlet. Provide ground fault interrupting capacity for all circuits.

7) Provide equipment grounding continuity for entire system.

8) Removal: Completely remove temporary materials and equipment upon completion of construction. Repair damage caused by installation, and restore to specified or original condition.

1.16 OPERATING INSTRUCTIONS

A. Owner's representative shall be instructed by contractor and manufacturer's representatives on system maintenance and operation requirements. Instruction shall be complete, conducted by qualified service and maintenance specialists. Notify architect of scheduled instruction session to permit his attendance at the session.

B. The following systems shall include training sessions scheduled with the owner. Allow a minimum of two (2) one-hour sessions per system, scheduled one week apart. Include initial programming of all time-of-day set points for operation. Include video record of training sessions.

1) SCADA system.

2) Generator and transfer switch system.

1.17 DAMAGE AND EMERGENCY REPAIRS

A. Contractor shall be held responsible for damage to work caused by his work or through the negligence of his workmen. All patching and repairing of damaged work and the cost of same shall be paid by the contractor causing the damage. All existing facilities and installations shall be restored to their original condition when damaged by the work of this Division, using workmen skilled in each required trade.

B. The owner reserves the right to make emergency repairs as required to keep equipment in operation, without voiding Contractor's warranty or relieving him of responsibility during warranty period.

1.18 WARRANTY

A. Electrical Contractors shall warrant all material, equipment, fixtures and workmanship for a

period of one (1) year from date of final acceptance.

B. Any equipment piping, fixture or other component part of system which fails during warranty period and all resulting damage shall be replaced or repaired by contractor without cost to owner.

C. Warranty on any repairs or replacements shall be extended from date of replacement or repair of that item for one (1) year.

D. All equipment and fixtures shall be warranted by the manufacturer thru the contract warranty period. Any extended manufacturers warranties shall be extended to the owner.

1.19 REQUIREMENTS FOR FINAL INSPECTION

A. All of the following items must be completed prior to final inspections. No exceptions will be made and no final payment will be made until all items are completed.

1) Each contractor's foreman shall perform his own punch list and, upon completion, notify the architect that project is ready for final punch list.

2) Thoroughly clean all parts of the apparatus and equipment. Exposed parts which are to be painted shall be thoroughly cleaned of cement, plaster and other materials and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out.

3) Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean.

4) All labeling of system components as required in this Section and Section 260500, the drawings and the owner shall be complete.

5) All system start ups shall be complete with written certifications submitted for all systems and major equipment.

6) Certification of test and start-up and training sessions for the systems listed in operating instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide material and labor which is neither drawn nor specified but which is obviously a component part of and necessary to complete work or comply with code, and which is customarily a part of work of similar character.

B. Provide incidental concrete, trenching and backfilling, reinforcing steel, masonry, mortar, miscellaneous steel, painting and the like required to complete electrical installations; perform in manner specified in applicable Division of General Trades Specification by workmen skilled in that particular trade.

C. All equipment and material shall be new, free from defects, U.L. listed where applicable and warranted by the manufacturer and the contractor.

D. To the greatest extent possible, provide materials and products of the same kind from the same manufacturer for this project.

2.02 MATERIAL SUBSTITUTIONS

A. All changes required by substitutions, such as revisions to foundations, bases, conduit, controls, wiring, openings and appurtenances shall be made by the substituting contractor at no additional cost to the project. Notify all other contractors affected by substitution and pay all costs related to the substitution incurred by other contractors.

1) Refer to General Conditions and Division I for requirements related to material and equipment substitutions.

B. Systems have been laid out around particular fixtures and equipment considered base items. Manufacturer **first** listed is base item. Other named manufacturers in these specifications or on the drawings who can provide equivalent equipment are acceptable and may be bid, provided performance, construction, components, quality and appearance, where applicable, are equivalent to base item and can be properly installed. Acceptable alternate makes of equipment are listed in specifications or equipment schedules; however, manufacturers other than base manufacturers are substitutions and shall comply with the following paragraphs. When distribution equipment is substituted, contractor shall submit equipment room shop drawings showing dimensions of equipment and required N.E.C. clearance. It is the contractors sole responsibility that all substituted equipment fits in the allotted space and maintains all required clearances.

C. Should the contractor propose to furnish materials or equipment other than those listed in the specification, a written request for substitution shall be submitted as an alternate to the base bid at the bid opening. Refer to General Conditions Division of this specification. It is the contractor's responsibility to fully evaluate substitutions and ascertain that the substitution is equivalent in all respects to the base specification prior to submittal.

D. Substitutions are subject to approval of Architect and his decision shall be final. In submitting substitutions, include make and model number and complete literature and performance data for evaluation.

E. Substitution of items <u>not named</u> in these specifications or drawings may be offered for consideration on the substitution sheet included in the Proposal Form of the contract, under the following conditions:

1) The proposed substitution is proven, to the satisfaction of the Project Architect and Engineer, to be equal or superior to the specified item in all respects.

2) Extended delivery schedules on specified items, which would delay timely completion of the job, will be cause for consideration of substitutions. The Contractor must show proof of delay in delivery from the manufacturer.

3) Changes required by substitution, such as revisions to foundations, bases, conduit, controls, wiring, openings and appurtenances shall be made by the Contractor at no additional cost to the project and pay all costs related to the substitution incurred by other contractors.

4) State the amount of credit to be given to the owner if the substitution is accepted prior to contract award on the proposal form substitution sheet or if after award of contract, submit a quotation stating cost reduction resulting from acceptance of a substitution if executed through a contract change order.

5) Manufacturers of items not named in these specifications or drawings may submit a written request with supporting product information to the engineer ten (10) days prior to the project bid date for consideration at the sole determination of the engineer to become a named product. If approved, the product name will be added to the list of substitute manufacturers in a written addendum issued by the architect to bidders.

PART 3 EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. Location of conduit, equipment, devices, etc., on the drawings are diagrammatic; indicated positions shall be followed as closely as possible, exact locations shall be subject to building construction and interferences with other work. Difficulties preventing the installation of any part of work as indicated shall be called to the attention of the Architect. Architect shall determine locations and changes, Contractor shall install the work accordingly. Architect reserves right to make minor changes in location of any part of the work up to the time of roughing-in without additional cost.

B. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. The installation of any materials and equipment not meeting these standards may require removal and reinstallation at no additional cost to the Owner.

C. Install, connect equipment, services, materials in accordance with best engineering practice and in conformity with manufacturer's printed instructions and U.L. Listing.

D. Take all measurements and determine all elevations at the building prior to fabrication or rough-in.

3.02 CUTTING AND PATCHING

A. Perform all cutting, framing and patching in completed construction as necessary for installation of this work. Do not cut any structural member or structural floor slab without written permission from the Architect. Have cutting done by skilled mechanics as carefully as possible, and with as little damage as possible. Have patching done by first-class mechanics, skilled in the several trades.

B. In new construction, lay out location and size of all openings to be provided by other trades in advance of their work. Set sleeves, lintels, etc., for openings and provide layout dimensioned

drawings as required for coordination with other contractors. If openings information and sleeves are not provided to other trades in advance of their work, this contractor shall provide all required openings as required for existing construction.

C. In existing construction, contractor shall perform all cutting, patching and framing of chases and openings required by this work. Properly sized structural lintels shall be provided above masonry wall openings and steel angle frames around panel walls, floor or roof openings. Size lintels and frames per schedule on architectural or structural plans.

D. Perform all excavation and backfill required for installation of below-grade conduits. Excavate to depth required to install conduits at required level and pitch. All backfill shall be compacted in maximum twelve (12) inch layers and conform to all bearing requirements of site and/or structure above. Trenches for utility services shall comply with the specifications and details of the utility company.

E. All conduits for below-grade entry of the building shall be pitched away from the building floor elevation and sealed to prevent water entry.

F. All openings shall be cut with lintels and frames installed by workmen skilled in the particular trade.

1) All patching shall be by a skilled general trades contractor and shall be performed in accordance with requirements of Division 9.

2) All roof cutting and patching installed under this contract shall be performed by the project roofing contractor at this contractor's expense.

G. Core drill round openings and neatly saw cut rectangular openings in floors or walls. Sleeves shall be grouted or patched to match existing wall or floor construction.

H. Sleeves for floor or wall penetrations shall extend 2" past opening and be grouted in place and sealed watertight with silicone caulk.

3.03 FIRE STOPPING

A. Where steel conduits pass through fire rated walls, set sleeve in wall, install non-shrinking grout between conduit and sleeve. Fire seal around wall sleeve with fire rated sealant. All penetrations shall be protected or rated construction in accordance with an approved method listed in the U.L. fire resistance directory.

B. Where conduits pass through floors, set steel sleeve in floor slab. Top of sleeve shall be 2" above finish floor and shall be grouted in place and sealed watertight to floor. Fire seal between sleeve and conduit.

C. Penetrations of fire rated walls and ceilings by exposed cabling system shall be made with steel conduit sleeves, fire stopped with U.L. listed sealant per U.L. assembly drawings.

D. Fire rated sealant shall be U.L. listed and applied in accordance with the U.L. assembly requirements and the manufacturer's recommendations to match the rating of the penetrated

structure. Sealants shall be as manufactured by Hilti, International Protective Coatings (IPC), Specified Technologies, Inc. (STI), or 3M.

3.04 ACCESS DOORS

A. Proper access for service and maintenance shall be ascertained before installation of any item. The electrical contractor shall furnish access doors adequately sized for servicing concealed items furnished under this contract. Doors shall be fire rated where installed in rated construction and shall have concealed hinge door, screw drive latch and primed painted finish. Frames shall match the construction of adjoining surfaces.

B. Doors in new construction shall be furnished to general trades contractor for installation. In existing construction, doors shall be installed by the electrical contractor with surrounding surfaces patched and painted to match existing.

C. Access doors shall be as manufactured by Milcor or approved equivalent.

3.05 PAINTING

A. Finish painting is included under Division 9 - Finishes, except where specifically called for under this Division.

B. Certain painting specified as part of the electrical Trades Work is included herein and shall comply with Division 9.

C. Materials and equipment installed under this Division shall be left free from dirt, grease and foreign matter, ready for painting.

D. No equipment or piping shall be painted before being tested.

E. Damaged surfaces of prefinished materials and equipment shall be touch-up painted to match existing finish by the contractor.

F. All items to be painted shall be primed and painted with two (2) coats of rust inhibitive paint on exterior and enamel paint on interior in accordance with the paint manufacturer's instructions. Engineer shall select a custom color.

3.06 EQUIPMENT IDENTIFICATION

A. Equipment:

Push buttons, selector switches, safety switches, motor starters, time switches, contactors, panelboards, pull boxes, cabinets, special outlets, etc., shall be identified as to function with a phenolic engraved nameplate securely attached. Identify voltage, phase, origin and load served.

B. Panelboards:

Provide typed directories for distribution and circuit breaker panels describing load fed and

location. Typed directories shall include specific load location information with final room names and numbers (i.e., Receptacles - Office 120).

C. Nameplates shall be laminated phenolic with a black surface and white core and shall be mechanically fastened with screws to each item. Use 1/16" thick material for plates up to 2"x4". For larger sizes, use 1/8" thick material. Lettering shall be minimum 1/4" height, spaced at four (4) per inch. Safety switches, motor starters, and panelboard nameplates shall include system voltage, phase and wire count, i.e. Panel "A" - 208Y/120, circuit origin and load served.

D. Wiring:

1) Color code all wiring in accordance with NEC Standards. All system and control wiring shall be labeled at each termination and splice, and continuously color coded.

2) Color coding is to be plainly labeled on all wiring diagrams submitted for approval and wire installed by this contractor shall comply with manufacturer's wiring diagram requirements.

E. Label all conduits leaving main panelboards where exposed with stick-on labels indicating circuit contained.

F. Label all junction boxes with circuits contained with indelible marker. Color code emergency and fire alarm system box covers as directed with permanent paint markings. Mark conduit at 48" intervals where visible, or use pre-finished color coded conduit, exposed or above accessible ceilings.

G. Label inside of device plates with panel and circuit number.

3.07 OPERATING AND MAINTENANCE MANUAL

A. Prepare one (1) complete operating and maintenance manual in hardback binder describing operation of the systems and recommended maintenance schedule. Turn all equipment warranties over to the Owner. Quantity of manuals shall be confirmed with the owner.

B. Manuals shall be indexed, arranged in the CSI format, and include:

1) Job name and names of contractor with address and telephone number for service. Include all major emergency service numbers for equipment and generator set particularly.

2) Manual index.

3) Identification, name, mark, number as indicated on design drawings.

4) Normal equipment operating characteristics.

5) Performance data and ratings.

6) Wiring diagrams.

7) Manufacturer's descriptive literature.

8) Manufacturer's maintenance and service manuals. Include signed copies of attendance sheets for each owner instruction session.

9) Spare parts and replacement parts list for each piece of equipment.

10) Name of service agency and installer.

11) Final accepted shop drawings.

C. Include entire manual in digital format and storage device, as required by the owner.

3.08 CLEANING UP

A. From time to time during the operations and at completion thereof, electrical contractor shall remove from the premises all debris and excess material caused by their work. Area of operation shall be left broom clean.

B. Construction materials shall be neatly stored in project areas and locations designated by the owner and architect. Construction materials must not be left scattered about construction area.

C. All electrical equipment to be painted by others shall be thoroughly cleaned by electrical contractors of grease, rust, shipping tags and construction dirt.

3.09 TEST, CHECK, START AND BALANCE

A. The electrical contractor shall test, check and start up all systems installed under this contract and place them in operating condition. Testing may be done by qualified employees of the contractor except where independent testing company is specified (see paragraph F. below).

B. All light fixtures, panels and electrical equipment shall be cleaned and labeled.

C. Circuits shall be phased out and connected to the panel or main switch in proper manner. Loads shall be distributed within 5% between phases when all loads are energized. All wires shall be entirely free from grounds and short circuits.

D. Distribution voltages shall be checked by this contractor who shall advise the engineer in writing in the event that incoming voltages are not within a tolerance of plus or minus 5% of nominal value. Adjust taps on transformer if required to correct voltage variations or coordinate with serving utility to adjust incoming service voltage.

E. Upon completion of the work, deliver to owner all special tools, keys, fuses and other detachable portions of the electrical system. Obtain written receipt from owner's representative and submit to architect with request for final payment.

F. Perform factory or field start-up and testing for all equipment as defined in various sections. Where testing is required to be performed by an independent test agency, the independent testing company shall be qualified and perform all testing to the current applicable National

Electrical Testing Association (NETA) Standard. Independent local testing company shall be one of the following:

1) Great Lakes Testing;

2) Electrical Testing Services;

3) American Power Service Company.

Test data shall be submitted with O&M Manual for tested equipment under that section.

3.10 DEMOLITION

A. This contractor shall perform all demolition of existing electrical systems as indicated on electrical and architectural plans or necessary for project. Remove from site and properly dispose of all material and debris from this work.

B. Demolition drawings are general in nature showing the scope of demolition work. Contractor shall visit the site and become familiar with the quantity of light fixtures, outlets, etc. Remove all equipment and devices no longer required for finished construction. All existing lights, conduit, wire and devices in project areas shall be removed and disposed of. Remove conduits beyond new surfaces. Remove all existing wire from conduit back to point of common use or to panels. Label existing circuit breakers "spare" if not reused for new work.

C. Disconnect existing equipment in building that is to be removed under other sections.

D. Patch all surfaces to match surrounding for devices to be removed from existing walls to be maintained.

E. The electrical contractor is to inspect existing conditions and equipment for current code violations and include in bid the amount to correct these violations.

F. The owner reserves the right of salvage for all existing electrical equipment. Prior to demolition, the contractor shall review all materials and deliver to the owner those required in their existing condition. All other material shall be removed by this contractor.

G. All circuits which are required to remain active shall be maintained or reworked as required.

END OF SECTION

SECTION 260500

BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 specification sections apply to work of this section.

B. Division 26, Section 260000, Electrical General Provisions, apply to work of this section.

C. Division 22 - Plumbing.

D. Division 23 - HVAC.

1.02 CONTENTS

A. Specified Herein: Requirements for basic electrical materials, equipment and wiring methods.

B. Described herein are the following:

Scope
Safety Switches
Motor Starters
Fuses
Wiring Devices
Wall Plates
Connectors, Lugs, Taps and Splices
Junction and Pull Boxes
Outlet and Switch Boxes
Conductors
Conduit

1.03 SCOPE

A. The work under this section shall comprise, but is not necessarily limited to the following:

1) Provide all labor and material required to install a 277/480 volt and a 120/208 volt interior wiring system, utilization outlets, motor starters, disconnect switches and fuses.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage Conditions: It is recognized that space at the project for storage of materials and products may be limited. Coordinate the deliveries of electrical materials and products with the scheduling and sequencing of the work so that storage requirements at the project are

minimized. In general, do not deliver individual items of electrical equipment to the project substantially ahead of the time of installation. Limit each shipment of bulk and multiple use materials to the quantities needed for installations within three (3) weeks of receipt.

B. Handle all electrical material carefully to prevent damage, dents or marring of the finish.

C. Protection and Identification: Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identification; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

D. Do not install damaged material. Remove from the project site.

PART 2 PRODUCTS

2.01 SWITCHES, SAFETY

A. Safety switches shall be heavy duty, sheet steel enclosed, of the type, size and electrical characteristics indicated, surface mounted, fusible rated at 250 volts on the 208 volt system and 600 volts on the 480 volt system, ampere ratings as required for the application or as noted on the drawings, 60 Hertz, 3 blades, incorporating quick-make, quick-break type switches, constructed so switch blades are visible in "OFF" position with door open; equipped with operating handle which is easily recognizable, and is padlockable in the "OFF" position; with current carrying parts constructed of high-conductivity copper and silver-tungsten type switch contact; with positive pressure type reinforced fuse clips. All switches shall be of the same manufacturer. Handle shall be interlocked so switch cannot be opened in the "ON" position.

B. Fuses: Unless indicated on the drawings as non-fused type, provide fuses for safety switches, as recommended by the switch manufacturer of class, type and rating needed to meet electrical requirements.

C. Disconnects for 120 volt, single phase equipment shall be heavy duty type suitable for the service intended. Include thermal overload protection integral with disconnect for motors or where required by code. Thermal protection in the disconnect may be deleted where motors have integral thermal protection.

D. Enclosure NEMA ratings shall be selected based on location and as noted in the General Notes of the first sheet of the electrical drawings

E. All disconnects shall have provisions for padlocking in the off position to comply with owner's lock-out tag-out procedures.

F. Switches manufactured by the following will be acceptable:

Square "D" - Type Heavy Duty
Siemens - Type HD
Eaton - Series "K"

ABB - Type TH
Submit complete shop drawings.

2.02 MOTOR STARTERS

A. Provide motor starters, combination magnetic with fused disconnect, and control equipment where shown. Magnetic starters shall be with 120 volt coils, three (3) overloads, control transformer with fused 120 volt secondary control circuit, (2) N.O. and (2) N.C.contacts hand-off-auto selector switch and push-to-test running L.E.D. pilot light (size 1 minimum), unless otherwise noted. Multi-speed starters shall be for two (2) speed single winding variable torque motors. Provide adjustable 0-10 minute time delay relay for transfer from high to low speed. Selector switch to be high-off-low with two (2) pilot lights. Wire through control devices furnished by other trades. Since motor driven equipment is furnished by other trades, the motor starters furnished by the electrical contractor as indicated on the drawings shall contain all required terminals, relays, contacts, etc., to comply with the temperature controls sequence outlined in Division 25. Fully coordinate with the mechanical contractor. Wire to conform to the actual equipment supplied and installed by the other trades. All fuses shall be dual element type. All starters shall be of the same manufacturer.

B. Each manual motor starter shall include L.E.D. pilot light and overload relays in each phase leg. Provide open construction starters for flush mounting where located in finished spaces. Cover plate to match device plates.

C. Starters shall be manufactured by Eaton, Square D, General Electric, Siemens or Allen Bradley. Submit complete shop drawings.

D. Additional normally open or normally closed auxiliary contacts in each starter may be required and shall be provided by the Electrical Contractor as determined by the Temperature Control Contractor.

E. All starters for motors 10 hp and greater shall be provided with single-phase protection relay that will shut motor down during a single-phase condition.

F. Enclosure NEMA ratings shall be selected based on location and as noted in the General Notes of the first sheet of the electrical drawings

2.03 FUSES - 600 VOLTS AND LESS

A. Fuses shall not be installed until equipment is ready to be energized. All fuses shall be of the same manufacturer to assure selective coordination.

B. The electrical contractor shall furnish and install a complete set of fuses for all fusible equipment on the job. Unless otherwise noted all fuses shall be U.L. listed, current-limiting and have an interrupting rating of 200,000 RMS amperes symmetrical.

C. All fuses rated 601 amperes or greater shall be time-delay current-limiting U.L. Class L, unless otherwise noted. They shall be:

Bussman HI-CAP-KRP-C-600V

Mersen Amptrap A4BQ

D. All fuses rated 600 amperes or less shall be time-delay current-limiting U.L. Class RK1, unless otherwise noted. They shall be:

Mersen Amptrap 2000; A2DR (250V), A6D-R (600 V)
Bussman Low Peak; LPN-RK (250V), LPS-RK (600 V)
Littel Fuse; LLNRK (250 V)

E. All fusible equipment rated 600 volts or less and 600 amperes or less shall be equipped with factory installed Class "R" rejection clips unless otherwise noted.

F. Spare fuses amounting to 20% (minimum three) of each type and rating shall be supplied by the electrical contractor. These shall be turned over to the Contracting Officer upon project completion.

2.04 GRADE ACCESSIBLE PULL BOXES (HAND HOLES)

A. Grade accessible hand holes shall be an aggregate material composed of polymer and woven glass with sand and gravel filler. The entire assembly of boxes, cover, etc., shall be by one manufacturer. Material shall conform to the following testing standards:

Chemical resistance	ASTM D-543 Section 7
Accelerated service exposure	ASTM D-756
Sunlight exposure	ASTM G-53
Water absorption	ASTM D-570
Flexural properties	ASTM D-790
Flammability	ASTM D-635

B. The complete assembly shall comply with AASHTO H-10 and have a service load of 15,000 pounds over a 10" square area and a minimum coefficient of friction of .5. Underground enclosures shall be Composolite as manufactured by Quazite or approved. Enclosures and covers shall be a custom color to match masonry sample provided by the architect. Covers shall be locking type with stainless steel penta head bolts and logo as specified. Boxes shall have open bottoms and be stackable for extra depth. Knock outs shall be factory installed or field made in a manufacturer approved method.

C. Covers shall lie true and square in their boxes without tipping or rocking when top loaded.

2.05 WIRING DEVICES

A. General: Provide factory-fabricated wiring devices, in type, color and electrical rating for the service indicated. Type and grade shall be as described in the following paragraphs and in the symbol legend on the drawings.

B. Receptacles: Comply with NEMA Standards Publication No. WD1 and Federal Specification WC 596-F, and as follows:

Heavy Duty Duplex: Provide duplex heavy-duty type receptacles, 2-pole, 3-wire grounding,

with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20-ampere, 125 volts, with metal plaster ears, back and side wired, with side screws providing clamping action of the back wiring slots, NEMA configuration 5-20R, unless otherwise indicated.

GFCI: Provide heavy-duty, duplex, ground fault circuit interrupter receptacles, feed-through type, capable of protecting connected downstream receptacles on single circuit, grounding type, UL rated Class A, Group 1, 20 ampere rating, 125 volts, 60 Hertz; with solid state ground fault sensing and signaling; with five (5) milliampere ground fault trip lever; equipped with 20-ampere plug configuration, NEMA 5-20R. When GFCI becomes inoperable, unit shall fail in the safe position (off) and interrupt power. Units that use lights or sounds are not acceptable.

C. Switches: Comply with NEMA Standards Publication No. WD1 and Federal Specification Test WS-896E, and as follows:

Snap: Provide heavy-duty flush single-pole toggle switches, 20 ampere, 120/277 volts AC, with mounting yoke insulated from mechanism, equipped with plaster ears and side-wired screw terminals.

3-Way Snap: Provide heavy-duty flush 3-way toggle switches, 20 ampere, 120/277 volts, with mounting yoke insulated from mechanism, equipped with plaster ears and side-wired screw terminals.

D. In general, all wiring device colors shall be verified with architect and have smooth finish stainless steel plates with openings to match devices. Contractor shall provide custom color receptacles and any plate material selected by architect and furnish at no additional cost to the contract.

E. Wiring devices and plates shall be as manufactured by Hubbell, P & S or Leviton

F. The contractor shall submit a device schedule for selection of colors with shop drawings, along with a sample of the manufacturer's standard device colors. Schedule shall include each room of the project and read as follows:

Room No.	Room Name	Device Color (by architect)

G. Devices with proprietary quick connect back-wiring pigtails are not permissible.

2.06 CONNECTORS, LUGS, TAPS AND SPLICES

A. Joints in #10 AWG and smaller wire shall be made with Minnesota Mining and Manufacturing Company insulated "Scotch Locks", Ideal Company "Wing Nut", or T & B Company "Piggy Connector".

B. Joints in #8 AWG and larger shall be made with pressure type mechanical connectors and insulated with electrical tape or manufacturer's insulation kit to 200% of the insulating value of the conductor insulation.

C. Straight taps to be ILSCO SPA Series or equal. Taps of multiple and parallel conductors are to be made with mechanical connectors listed for the quantity and size of conductors, ILSCO Type PTA or IPC or equal.

D. Splices may be made with long barrel compression sleeve connectors insulated to 200% of cable rating. Compression connectors to be long barrel type, ILSCO Type CTL or equal.

E. Lugs to be mechanical type connectors of size and ampacity to match service used. Provide compression lugs where required by equipment installed. Compression lugs to be long barrel, heavy duty type.

F. All materials for copper wiring shall be copper.

2.07 JUNCTION AND PULL BOXES

A. Furnish and install junction and pull boxes wherever required or otherwise necessary to facilitate installation of other equipment. Junction boxes shall be galvanized finished sheet steel of code thickness, of ample size to properly enclose the conductors terminating in or passing through them, sized in accordance with NEC 370 or as noted. Junction boxes shall not be placed in locations made inaccessible by piping, ducts or other equipment and locations shall be as approved by the A/E.

2.08 OUTLET AND SWITCH BOXES

A. Furnish and install outlet boxes of proper type and size as required at outlets where required, secured firmly in place and set true and square and flush with the finished surfaces. Boxes shall be rigidly supported from the building structure independent of the conduit system. Boxes cast into masonry or concrete are considered to be rigidly supported.

B. All boxes for lighting outlets shall be provided with fixture studs of a size suitable for the weight of the fixture to be supported. The stud shall be of integral construction with the box, or of the type which is inserted from the back of the box. In no case shall the weight of the fixture be dependent upon bolts holding the stud to the box.

C. Outlet boxes for exterior work shall be NEMA 4X, stainless steel.

D. Wiring device boxes for surface conduit work shall be FS Series cast type.

E. Outlet and switch boxes shall be four (4) inch square minimum with plaster ring as required. All communications outlets shall be 2-1/8" deep minimum.

2.09 CONDUCTORS

A. All wire shall be in strict accordance with the applicable standards and shall be delivered on site with original factory tags attached and shall be less than one (1) year old when installed.

B. Except as specifically designated otherwise, no wire smaller than No. 12 AWG copper shall be used. Generally, all wire and cable sizes are shown, either directly or by implication that no

marking designates No. 12 size. In the event that size is not indicated for a feeder or motor run, which obviously could not be interpreted as No. 12, the wire size shall conform to the sizing for the rating of the service protective device.

C. Single conductor 600 volt wire shall be copper and be equal to or better than THW, THWN/THHN or XHHW specifications. Wire shall be rated for 75 degrees C. maximum temperature in dry locations and 90 degrees C. in wet locations and below grade. Wire shall be listed by UL and conductor identification shall include size, voltage manufacturer's name and number, UL listing and wire type.

D. Wire sizes up to No. 10 AWG shall be solid, No. 8 AWG and larger, stranded.

1) Use stranded conductors for motors and other connections subjected to vibration.

2) 90 degree C. wire shall be used from outlet boxes to light fixtures.

3) Color code wiring in accordance with N.E.C. standards. In existing facilities, match facility standards.

a. Phase conductors on the 120/208 volt system shall be black, red, blue for Phase A, B, C respectively. Ground conductor shall be green and neutral shall be white.

b. Phase conductors on the 277/480 volt system shall be brown, orange, yellow for Phase A, B, and C respectively. Ground conductors shall be green with yellow stripe and neutral conductor shall be gray.

E. Conductors smaller than #12 AWG shall be allowed for use on fire alarm system and other control systems only. In general, #18 AWG shall be used for initiating devices and #14 AWG for indicating circuits.

1) Wire shall be 600 V copper Type TF or TFN solid or seven (7) strands maximum for #18 and #16 and nineteen (19) strands maximum for #14 AWG.

2) All wire types shall conform to the U.L. listing requirements of equipment connected and shall be coordinated with equipment installed.

3) All wire shall be continuously color coded for entire length of circuit. Conductor color coding shall be clearly noted on all wiring diagrams and instruction manuals. Match facility standards where applicable.

F. All ground conductors shall be green on the 120/208 volt system and green with a continuous yellow stripe on the 277/480 volt system. All neutral conductors shall be white on the 120/208 volt system and gray on the 277 volt system. Where neutrals of different voltage systems share the same conduit, they shall be of different colors (as allowed by the NEC) and labeled at all junction and outlet boxes.

G. Wire shall be manufactured by Southwire, General Cable, Pirelli, Essex, Continental or other approved manufacturer.

2.10 POWER AND CONTROL WIRING - BUILDING FACILITIES

A. Electrical Contractor shall provide all single phase and three (3) phase (unless noted) power wiring in conduit to all motors and equipment. In general, all motors 1/2 hp and larger will be rated three (3) phase, while smaller motors will be rated single phase unless otherwise noted on drawings.

B. Provide each motor with a disconnecting means as required by the National Electrical Code, unless furnished with equipment. All devices on building exterior shall be weatherproof type and conduit and supports shall be rigid galvanized steel. Where disconnect switches are furnished with mechanical equipment, the electrical contractor shall mount and wire those devices.

C. Provide all power and interlock wiring for mechanical equipment, along with conduit and wires for control system where specifically shown on electrical drawings. Mount all control devices furnished by mechanical contractor and wire per manufacturer's wiring diagrams.

D. This contractor shall review mechanical shop drawings and indicate his approval of all mechanical equipment voltages and horsepowers prior to any equipment being released. Failure to do so shall require any revisions to wiring systems, etc., to be revised at the contractor's expense.

E. The wire size and number of conductors for all control wiring shown on plans shall be as required by the manufacturer's shop drawings. No wire shall be pulled based on fill shown on plans.

F. Wire all motorized dampers at associated fans.

G. Coordinate conductor sizes shown on drawings with the required terminations on mechanical equipment. Advise mechanical contractor of required terminations. Provide lug kits to terminate conductors shown on drawings where required.

2.11 CONDUIT

A. General: All medium and low voltage wiring to be installed in metal conduit or tubing with fittings of type, grade, size and weight (wall thickness) indicated for each service. Where conduit type and grade are not indicated below, conduit shall be rigid galvanized steel and comply with National Electrical Code for electrical raceways. Minimum size conduit shall be 3/4" unless otherwise noted. No conduit shall be run in or through ductwork. All conduit shall bear the U.L. label.

B. Rigid Galvanized Steel Conduit: Conduit shall be hot dipped galvanized steel conduit.

Location: Exposed interior of all process buildings, hazardous and non-hazardous. Exterior in hazardous areas.

C. Electrical Metallic Tubing (EMT): Conduit shall be zinc coated steel electrical metallic tubing conforming to Federal Specification WW-C-563 and ANSI C80.3. All EMT conduit stubs for

communications wiring shall have a plastic bushing at both ends.

Location: In stud walls or above ceilings in conditioned, non-process buildings. Exposed interior not subject to damage.

D. Flexible Metal Conduit: Conduit shall be manufactured of heavily zinc coated sheet metal strips interlocked to form a flexible, smooth wiring channel. Federal specification WW-C-566

Location: Motor connections subject to vibration, light fixtures (six feet in length), and transformer connections.

E. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit comprised of single strip, continuous, flexible, interlocked, double-wrapped steel, galvanized inside and outside; forming smooth internal wiring channel; with liquid-tight jacket of flexible polyvinyl chloride (PVC) (maximum length 5'-0") conforming to U.L. 360. Conduit shall be Anaconda "Sealtite" or "Electri-Flex."

Location: Motor connections subject to vibration in wet areas and all connections to all outdoor equipment.

F. Underground Conduit: Schedule 40 direct burial Type PVC conforming to UL 651, NEMA TC2-1978 and Federal Specification WC-1094A. and shall include a green ground wire with the circuit conductors. Conduit to be Carlon Plus 40 or approved.

Location: Direct buried conduits.

G. Underground Conduit: Concrete encased conduit to conform to UL-651-A, NEMA TC-6 and ASTM F-512. Conduit to be Carlon Type EB or approved.

H. Rigid Aluminum Conduit: Rigid aluminum conduit conforming to Federal Specification WW-C-540c and U.L. UL-6.

Location: Exterior, unclassified locations.

2.12 CONDUIT FITTINGS

A. Conduit fittings for exposed work shall be rust resistant. Castings shall provide ample wiring space, shall have smooth round edges and full-threaded hubs.

B. Fittings shall be as manufactured by Crouse Hinds Appleton, Killark, or approved manufacturer.

C. EMT and IMC conduit fittings, connectors and couplings shall be steel set screw or compression type (no pot metal or zinc) as manufactured by OZ/Gedney, T & B or equal.

D. Rigid aluminum fittings to be threaded aluminum.

E. All conduit fittings shall be U.L. listed for conduit material, in particular, for transition from one material to another.

PART 3 EXECUTION

3.01 INSPECTION

A. Installer must examine the areas and conditions under which electrical work is to be installed and notify the contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 ELECTRICAL INSTALLATIONS

A. General: Install electrical equipment for this project as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended functions.

3.03 SAFETY SWITCHES

A. Install disconnect switches used with motor-driven appliances and motors and controllers within sight of the controller position unless otherwise indicated.

B. Do not install switches on equipment to obstruct unit nameplates or access panels. Exact locations are to be coordinated in field.

C. Install disconnect switches furnished as accessories to mechanical equipment. Where equipment is served by a variable frequency drive, provide label on switch: "Do not open when equipment is energized variable frequency drive."

3.04 MOTOR STARTERS

A. Provide minimum NEMA size 1 starters.

B. Provide all motor starters and disconnect switches except those furnished as a factory-installed, integral assembly of packaged equipment.

C. Provide all auxiliary contacts to achieve the sequence of operation described in Division 25.

D. Do not rough-in wiring for equipment by scaling drawings. Coordinate work based upon actual location of equipment.

E. Final connections to rotating equipment shall be made using flexible conduit.

F. Provide Unistrut or 2" steel galvanized angle floor stands where required to support panels, starters and disconnect switches.

G. Wall-mounted disconnect switches and starters shall be grouped together and installed on 3/4" exterior grade plywood sanded and painted with gray flameproof paint on both sides. Install with 1/2" spacers.

H. Thermal overload protection shall not exceed 105% of motor full load amperes. Heater elements for all motors shall be sized from information obtained by taking an ammeter reading of motor circuit.

I. Check phase rotation for all mechanical equipment prior to energizing.

J. Where drives are furnished with equipment, install and wire in compliance with this section.

3.05 PULL, JUNCTION, OUTLET AND SWITCH BOXES

A. Install electrical boxes as indicated, or in compliance with NEC requirements, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes.

B. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture exposure. Boxes shall be rigid aluminum.

C. Provide knockout closures to cap unused knockout holes where blanks have been removed.

D. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.

E. Avoid using round boxes where conduit must enter box through side of box, which would result in a difficult and insecure connection with a lock nut or bushing on the rounded surfaces.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.

G. Pull boxes shall be sized per code and located at maximum 100 foot centers on long runs where accessible. All wire splices shall be made in outlet or pull boxes.

H. Conduit crossings of building expansion joints shall have expansion fitting with grounding continuity.

I. Grade accessible pull boxes shall be installed flush with finished grades or paving. Boxes shall have open bottom and be installed on an 8" gravel sub-drain as detailed. All conduit penetrations of boxes shall be made with bell ends on conduits and be with an expanding mortar such as "Water Plug". The entire installation shall comply with the manufacturer's recommendations.

J. Where multiple switches are installed adjacent to one another, multiple gang boxes shall be used with single cover and barriers between 277 volt and 120 volt circuits, where required.

K. All spaces around boxes not covered by cover plate shall be filled to match surrounding finish work. Provide oversized covers on all flush devices in masonry walls.

L. Coordinate all outlet and switch locations with finish millwork so as not to cut or damage trim, as directed by architect.

3.06 WIRING DEVICES AND PLATES

A. All mounting heights shall be subject to checking with the details shown on the architectural drawings and with the A/E and locations shall be verified through the A/E before installing wiring, apparatus, etc.

B. Delay installation of devices until wiring is completed.

C. Install receptacles and switches only in electrical boxes which are clean; free from excess building materials, debris, etc.

D. Install plates after wall finish work is complete.

E. Prior to project completion, replace those items which have been damaged during construction.

F. Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements.

3.07 CONDUCTORS AND CONDUIT

A. General: Except as indicated hereinafter or on the drawings, all wiring above ceilings and in stud walls shall be done with insulated conductors in electrical metallic tubing (EMT). Wiring exposed on walls and in areas subject to damage shall be insulated conductors in intermediate metal conduit (IMC) and wiring for feeders buried in earth shall be insulated conductors in rigid Schedule 40 PVC, 24" below finished grade (minimum).

B. Conduit Installation: Conduit sizes, type and length shall be furnished and installed as required by the drawings and as specified in these specifications.

The drawings indicate generally the size and location of the conduits. Conduits not shown but obviously required shall be run where directed, of sizes as approved by the A/E. The conduit system shall connect all outlet boxes, junction boxes, panelboards, cabinets, push button stations, motors, etc.

C. Field bends and offsets shall be uniform and symmetrical, without conduit flattening or finish scarring. Minimum bend radii shall be as required by the NEC, but in no case less than six (6) times conduit diameter.

D. Conduit found unacceptable while on the job before installation shall be removed from the premises upon notice.

E. Approved pipe plugs or caps shall be installed in conduit before pouring of concrete. Conduit shall also be kept dry and free of water and debris by means of plugs or caps.

F. Where conduit enters through exterior concrete walls or below grade footings, the entrance shall be made watertight. Pipe sleeves shall be provided in the concrete with 1/2" minimum clearance around the conduit for an entrance seal similar to O.Z. Type FSK or Link Seal

mechanical seal fittings. Conduits shall be sloped away from building and sealed inside the conduit after conductor installation to eliminate water and condensation infiltration. Contractor shall use Polywater FST or Raychem “RDSS” duct sealing system or Polywater FST series sealant.

G. At all entrances to panelboards, pull boxes or outlet boxes, conduit runs shall be secured in place with galvanized lock nuts and bushings; one lock nut inside and one lock nut outside the box with the bushing on the inside. Bushings shall be of the insulating throat type. Where conduit fittings are used, a single locknut with insulated throat fitting is acceptable.

H. Field bends shall be made with standard tools and equipment manufactured specifically for conduit bending. Use factory elbows for bends in conduit larger than 2" trade size. Use conduit bodies to make sharp changes in direction.

I. Complete the installation of electrical raceways before starting installation of cables within raceways.

J. Provide flexible conduit for motor connections transformer connections and for other electrical equipment connections where subjected to movement and vibration.

K. Provide liquid-tight flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:

1) Exterior location.

2) Moist or humid atmosphere where condensate can be expected to accumulate.

L. Where possible, install horizontal raceway runs above water piping.

M. All conduit to be concealed in walls, ceiling or floor, except in the mechanical and electrical rooms where exposed conduit is permitted or where approved by architect.

N. Exposed conduit shall run parallel or perpendicular to members of the building structure, rigidly maintained and clamped with one-hole malleable iron conduit clamps or conduit supports similar to those of Steel City Electric Company or Unistrut Corporation.

O. All conduit shall be rigidly and independently supported from the structure at 7'-0" maximum spacing. No conduit shall rest on or be supported from acoustic tile ceiling support wires, ductwork or piping. Support outlet boxes directly from the structure or where not possible, within one (1) foot of box. Provide all miscellaneous steel and support framing for electrical installation.

P. Locate conduit runs to avoid equipment and items requiring service. Maintain clearance of six (6) inches minimum from water piping and twelve (12) inches minimum from heating system piping.

Q. All PVC conduits shall have bell ends. Provide expansion fittings at spacing recommended by the manufacturer.

R. All communications conduits shall have nylon bushings at both ends and pull strings.

S. All communications conduits shall have wide sweep 90° elbows and pull boxes after two (2) bends.

T. Penetrations of floor slabs shall be made with rigid galvanized steel conduit. All conduit below floor slabs shall be run in sub-floor below floor, not in floor pour. Provide expansion fitting prior to entry into first box, enclosure or conduit section.

U. Maintain 12" clearance minimum for all conduits from heat producing equipment, such as flues, heat exchangers.

V. Conductor Installation: Conductor sizes, type and quantity shall be furnished and installed as required by the drawings and as specified in these specifications.

1) All wiring shall be installed in accordance with the applicable provision of the National Electrical Code and as specified herein and shown on the drawings.

2) All branch circuit wiring involving a total length over 75' shall use the next largest wire size for the home run and/or the portion exceeding 75'.

3) Pull conductors together where more than one is being installed in a raceway.

4) Use pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

5) Keep conductor splices to a minimum.

6) Wire shall be installed only after all work that may cause injury is completed, such as the pouring of concrete.

7) Install splices and taps which have equivalent or better mechanical strength and insulation as the conductor.

8) Use splice and tap connectors which are compatible with the conductor material.

W. Provide seals when conduit is passing from cold to warm environments. Use silicone sealant around boxes and exterior of raceways and sealing system within raceways, Polywater FST or Raychem RDSS Bags.

END OF SECTION

SECTION 262400

SERVICE AND DISTRIBUTION

PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of contract including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

B. Division 26, Section 260000, Electrical General Provisions and Section 260500, Basic Materials and Methods, apply to work of this section.

1.02 CONTENTS

A. Specified herein: Requirements for electrical service and distribution.

B. Described herein are the following:

Scope.
Power Service Work and Coordination.
Circuit Breaker Panelboards.
Grounding.
Distribution transformers.

1.03 SCOPE

A. The extent of electrical service and distribution work is indicated by drawings and in schedules, in other Division 23 and 26 requirements of this division, and is hereby defined to include, not necessarily limited to:

1) Conduit, trenching and backfilling

2) Utility service coordination

3) Panelboards.

4) Grounding.

5) Metering equipment installation.

PART 2 PRODUCTS

2.01 PANELBOARDS

A. General: Except as otherwise indicated, provide panelboards, enclosures and components of types, sizes and ratings indicated, which comply with manufacturer's standard materials,

design and construction, in accordance with published product information; equip with number of unit panelboard devices as indicated for a complete installation. Where more than one type of component meets indicated requirements, selection is installer's option. Where types, sizes or ratings are not otherwise indicated, comply with NEC, UL and established industry standards for applications indicated. Panelboard ratings, current and voltage, fused switch or circuit breaker complement, interrupting ratings and mounting are indicated on the drawings. Where not noted, the minimum interrupting rating on the 480 volt system shall be 14 KAIC and 10 KAIC on the 120 volt system.

B. Circuit Breaker Distribution Panel: Provide dead-front safety type distribution panel as indicated with switching and protective devices in quantities, ratings, types and with arrangement shown; with anti-turn solderless compression type main lug connectors approved for bottom of panel. Equip with tin plated copper bus bars and full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide branch circuit switches for each circuit, connected to the main bus by "blow-on" design that grips the bus bar firmly under heavy fault conditions. Provide a bare insulated copper ground bus suitable for bolting to the enclosure. Bus bar shall be rigidly braced to comply with the specified integrated equipment rating and be 65 KAIC. Vertical bussing shall be fully rated. Branch breakers 200 amp frames and larger shall have solid state trip unit with adjustable long time, short time, instantaneous and ground fault (if applicable) settings. The LCD display on the trip unit shall provide current readings and allow adjustment of all settings.

C. Lighting and Power Panelboards: Provide dead-front safety type lighting and power panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangement shown; with anti-turn solderless pressure type lug connectors approved for copper conductors sized for conductors shown on the one line diagram; construct unit for connecting feeders at top or bottom of panel to suit field conditions; equipped with copper bus bars, full-sized neutral bar, with bolt-in type molded case branch circuit breakers for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide a bare uninsulated copper grounding bar suitable for bolting to enclosure.

D. Circuit breakers with frame sizes 1200 amps and greater shall be installed with energy reducing maintenance switch and status indicator per the NEC.

E. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters.

F. Panelboard Fronts: Provide panelboard fronts with door-in-door feature with one door over the interior and the other hinged to give access to the wiring gutter. The inner door over the interior shall have flush lock keyed to match other panels.

G. All panelboard fronts shall be equipped with interior circuit-directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Design enclosure for surface or flush mounting, as indicated on the drawings. Provide enclosures fabricated by same manufacturer as panelboards and which fit properly with panelboards to be enclosed.

Panelboard Accessories: Provide panelboard accessories and devices, including but not necessarily limited to, circuit breakers, ground-fault protection breakers, arc fault protection breakers, H.I.D., SWD and HACR rated circuit breakers etc., as recommended by panelboard manufacturer or required by code for ratings and applications indicated.

H. Panelboards shall be of the same manufacturer and the following shall be acceptable

Circuit Breaker (Panelboards)

Square D "NQOD" with QOB breakers
Eaton "Pow-R-Line" with BAB breakers
Siemens Sentron with "BQ" breakers
ABB "A" Series with THQB breakers

Circuit Breaker - Distribution

Square D I-Line
Siemens Type Sentron
G. E. Type Spectron
Eaton "EE"

I. Arc Fault study

1) Gear manufacturer shall provide arc fault study for all new equipment. Calculate fault values at new equipment including energy and PPE level required. Supply labels on all equipment per NFPA 70E and owner standards. Coordinate available fault current with utility company.

3) Field information on existing distribution equipment device times and trip settings shall be obtained directly at the site by the manufacturer's qualified personnel. Opening any energized equipment to obtain the required information shall be included. Provide any adjustments necessary to properly coordinate the new and existing equipment.

4) Printed and PDF data for device settings and fault energy values shall be submitted in the project O&M manuals.

2.03 DISTRIBUTION TRANSFORMERS

A. Provide as indicated dry type transformers as manufactured by Square D, G.E., Siemens or Cutler Hammer.

B. Three (3) phase transformers shall be 480 volt delta primary and 120/208 volt wye secondary, sized as noted with a minimum of four (4) 2-1/2% full capacity primary taps with copper windings.

C. Transformers shall be 115 degrees C. temperature rise above 40 degrees C. ambient. All

insulating materials to be in accordance with NEMA ST-20 standards for 180 degree C. UL component recognized insulation system. Efficiency rating shall meet or exceed the current Department of Energy Standards.

D. Sound levels shall be guaranteed by the manufacturer not to exceed the following when tested per NEMA and ANSI Standards.

10 to 50 KVA - 45 DB
51 to 150 KVA - 50 DB

E. Mount transformers using vibration isolation mounting hangers or floor mount as noted. Mounts to be Mason 3ON Series as required. Final connections at transformer to be made using flexible metallic conduit.

2.04 MATERIALS AND COMPONENTS, GROUNDING

A. The entire light and power system shall be permanently and effectively grounded in accordance with the latest issue of the National Electrical Code, including panels, motor frames and other exposed non-current carrying electrical parts of the electrical equipment and conductive components of the building structure and mechanical systems (i.e., piping, ductwork, etc.).

B. Article 250 of the National Electrical Code shall be complied with in its entirety with regard to this installation. Particular attention shall be paid to Article 250-45 in reference to appliance and portable equipment grounding.

C. Metallic conduit system shall be electrically continuous throughout and be grounded at the service entrance. All conduits and cable assemblies for feeders and branch circuits shall include a green ground wire. Install grounding jumper across all flexible conduit.

D. A green pigtail shall be installed from grounding slots of all grounding outlets to outlet box in each instance where the receptacle attachment bar is not in direct contact with the outlet box or outlet box plaster plate.

E. Ground mats shall be installed at utility transformer location to comply with utility company details.

F. The ground system shall be extended and connected to the incoming cold water line within the building ahead of main shut-off valve.

G. Connect to building steel with ground loop as shown on drawings. Provide "UFER" ground in building footing at service entrance.

2.05 SURGE SUPPRESSION

350,000 Amp Class (Service Entrance)

A. Surge suppression system shall be provided as an integral component of the main distribution

panel.

B. Standards. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41-1991 and C62.45-1987;
ANSI/IEEE C62.1 and C62.11;
Canadian Standards Association (CSA);
Federal Information Processing Standards Publication 94 (FIPS PUB 94);
National Electrical Manufacturer's Association (NEMA LS1-1992 Guideline);
National Fire Protection (NFPA 70 [NEC], 75 and 78);
Underwriters Laboratories (UL 1449 and 1283);
Underwriters Laboratories (UL 489 and 198)

C. The unit shall be UL 1449 listed and CSA approved as a transient voltage surge suppressor and UL 1283 listed as an electromagnetic interference filter.

D. High Performance Suppression System. The unit shall include an engineered, solid-state, high performance suppression system utilizing predetermined arrays of non-linear voltage dependent metal oxide varistors with similar operating characteristics.

E. Internal Connections. All internal wiring associated with the suppression filter system and subject to surge currents shall utilize low-impedance copper bus bar and/or #2 AWG copper conductor or larger. All internal connections associated with the suppression filter system and subject to surge currents shall be made with compression solderless type lugs and shall be bolted to the bus bars in order to reduce overall system impedance. No plug-in components modules, quick disconnect terminals, non-field replaceable fusing or printed circuit boards shall be used in surge current carrying paths.

F. Unit Status Indicators. The unit shall include long life, solid state, externally visible LED visual status indicators that monitor the on-line status of each phase of the unit.

G. Integral Test Point. The unit shall incorporate an integral test point allowing easy off-line diagnostic testing verifying the operational integrity of the unit's suppression filter system. Field testing shall permit proactive testing to ensure performance and long term reliability. Testing shall include performance and long term reliability. Testing shall include injection of an impulse into the off-line suppression filter system to verify the suppression performance values established at final factory testing and recorded on the diagnostic signature card. Indicator lights monitoring fuse condition or power available which inform the user of failure after the fact are not acceptable to meet the intent of this specification.

H. Remote Status Monitor Contacts. In order to monitor on-line status, the unit shall include form C dry contacts (N.O. or N.C.) to facilitate connection to a building management system. The contacts shall be normally open or normally closed and shall change state upon degradation of failure or the suppression system and/or fuse. The contacts shall also change upon phase reversal, power failure of any combination of all three phases or total power failure.

2.06 METERING DEVICES

A. Manufacturer shall provide an electronic power meter where indicated on the drawings. Three phase metering and power quality analysis shall be provided by a power quality meter provided by the switchboard manufacturer or Electro Industries, Inc.

B. Metering shall include A, V, W, Wh, Wcost, var, varh, VA, VAh, Hz, and PF in True RMS or displacement (fundamental) quantities.

C. Power analysis features shall include an event recorder, waveform capture, trace memory, harmonic spectrum display through the 63rd harmonic with total harmonic distortion and a data logger function. All analysis data shall be non-volatile.

D. Four switch inputs shall be provided which can be programmed for relay activation, counters, logic, demand sync, reset and alarms. Four output relays shall be provided which can be programmed to activate on alarms, setpoints, switch inputs, kWh pulse, trace memory triggers or communications control. These output relays shall also be able to use demand metering values of A, VAR, W and VA to control load shedding. Provide RS485 serial interface compatible with owner's Building Management System.

E. Local user interface shall include a keypad and display for entering all setpoints and reading all measured values, and LED indicators for output relays, communication status and alarm status.

F. Instrument Transformers

1) Current transformers with shorting terminal block shall be provided. Current ratings shall be as indicated on drawings.

2) Manufacturer shall provide potential transformers with fused primary, stationary mounted, rated and configured as indicated on drawings.

PART 3 EXECUTION

3.01 INSPECTION

A. Installer must examine areas and conditions under which electrical work is to be installed and notify contractor in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

3.02 ELECTRICAL INSTALLATIONS

A. General: Install electrical equipment for this project as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation" and in accordance with recognized industry functions.

B. Direct all other contractors to maintain required clearances from electrical equipment to piping and ductwork during construction progress.

C. All panelboards, switchboards, motor control centers and control panels shall be labeled to warn qualified persons of electric ARC flash hazards per NEC.

D. Provide 4" minimum height concrete housekeeping pads for all floor mounted electrical distribution equipment including (but not limited to) switchboards, switchgear, distribution panelboards, motor control centers and transformers.

E. Provide performance testing of service ground fault protection system on site by equipment manufacturer per the NEC.

3.03 ELECTRICAL SERVICE

A. Existing service is overhead to a pad mounted transformer with open top terminations. Modifications will be required to upgrade and replace the existing customer service entrance equipment.

B. Any installation costs assessed by utility company for service installation shall be included in bid and paid for by the electrical contractor.

3.04 PANELBOARDS

A. Coordinate installation of panelboards and enclosures with cable and raceway installation work.

B. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

C. Provide electrical connections within enclosures.

D. Fill out typed panelboard's circuit directory card upon completion of the work.

E. The system of branch circuits for power and lighting shall be connected to panel busses in such a manner as to electrically balance the connected loads as close as is practicable.

F. Panels installed on exterior building walls shall be shimmed 1/4" from wall to permit back ventilation.

3.05 DISTRIBUTION

A. Provide feeder conduits and wire from main power panel to branch panels and major mechanical equipment.

B. Conduit and wire shall be as specified in Section 260500.

C. Provide green identified ground wire sized per Table 250-95 N.E.C. in all feeder conduits.

3.06 INSTALLATION OF ELECTRICAL GROUNDING

A. General: Install electrical grounding systems (including ground rods and water line tap) where shown, in accordance with applicable portions of National Electrical Code, with National Electrical Contractors Association's "Standard of Installation" and in accordance with recognized industry practices to ensure that electrical grounding complies with requirements and serves intended purposes.

B. Coordinate with other electrical work, as necessary to interface installation of electrical grounding system with other work.

C. Install braided type bonding jumpers with ground clamps on water meter piping to electrically bypass water meter.

D. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.

E. A green pigtail shall be installed from grounding outlets to outlet box in each instance where the receptacle attachment bar is not in direct contact with the outlet box or outlet box plaster plate.

F. Green bonding jumper shall be installed in all flexible metallic conduit.

G. All metal piping systems, ductwork, and steel frames shall be bonded to the electrical system in compliance with the NEC.

END OF SECTION

SECTION 262419

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: This section includes, but shall not be limited to, requirements for a motor control center (MCC) and required control devices as shown on the Drawings and specified to be part of the MCC equipment. The MCC shall be 480 volt, 3-phase, 3-wire, 60 hertz unless otherwise indicated.

1.02 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. American National Standards Institute (ANSI):

1) ANSI Z55.1, “Gray Finishes for Industrial Apparatus and Equipment.”

C. ASTM International (ASTM):

1) ASTM B117, "Standard Practice for Operating Salt Spray (Fog) Apparatus."

D. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1) IEEE 519, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters."

E. International Electrotechnical Commission (IEC):

1) IEC 60947, “Low Voltage Switchgear and Control Gear - Part 2: Circuit Breakers.”

F. National Electrical Manufacturers Association (NEMA):

1) NEMA ICS 18, "Motor Control Centers."

G. National Fire Protection Association (NFPA):

1) NFPA 70, "National Electrical Code," hereinafter referred to as NEC.

H. Underwriters Laboratories, Inc. (UL):

1) UL 50, "Enclosures for Electrical Equipment, Non-Environmental Considerations.”

2) UL 498, "Standard for Attachment Plugs and Receptacles."

3) UL 508, "Standard for Industrial Control Equipment."

4) UL 845, "Motor Control Centers."

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 01 - General Requirements.

B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.

C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer’s standard product data.

D. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.

E. Operation and Maintenance Manuals: Submit with the delivery of the MCC an operation and maintenance manual and one copy of the manufacturer's drawings per shipping block.

1.04 QUALITY ASSURANCE

A. Qualifications:

1) Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of low voltage industrial MCCs of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years.

2) Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing low voltage industrial MCCs similar in type and scope to that required for this Project and shall be approved by the manufacturer.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

1) The MCC shall conform to UL 845, current revision, NEMA ICS 18 and the NEC. The MCC shall be manufactured in an ISO 9001 certified facility.

C. Single Source Responsibility: Obtain MCCs and required accessories from a single source with resources to produce products of consistent quality in appearance and physical properties without delaying the work. Any materials which are not produced by the manufacturer shall be acceptable to and approved by the manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING

A. The MCC shall be separated into shipping blocks no more than three vertical sections each. Shipping blocks shall be shipped on their sides to permit easier handling at the job site. Each shipping block shall include, but shall not be limited to, a removable lifting angle, which shall allow an easy means of attaching an overhead crane or other suitable lifting equipment.

B. If the MCC cannot be placed into service reasonably soon after its receipt, store it in a clean, dry, and ventilated building free from temperature extremes. Acceptable storage temperatures are from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).

1.06 WARRANTY

A. The MCC shall be warranted to be free from defects in materials and workmanship for a period of 18 months from date of invoice from manufacturer or authorized sales channel.

B. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Shall be Square D®, GE, Eaton, Siemens or equal.

B. Additions to existing MCCs shall be the same as the original manufacturer.

2.02 MATERIALS

A. Steel material shall comply with UL 845 requirements.

B. Each MCC shall consist of one or more vertical sections of heavy gage steel bolted together to form a rigid, freestanding assembly. A removable 7 gage structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. Removable 7 gage bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections shall be made of welded side-frame assembly formed from a minimum of 12 gage steel. Internal reinforcement structural parts shall be of 12 gage and 14 gage steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand normal stresses included in transit and during installation.

2.03 STRUCTURES

A. Structures shall be totally enclosed, deadfront, freestanding assemblies. Structures shall be capable of being bolted together to form a single assembly.

B. Structures shall be as shown on plans.

C. Each 20 inch (508 mm) wide standard section shall have all the necessary hardware and bussing for modular plug-on units to be added and moved around. Unused space shall be covered by hinged blank doors or appropriate cover plate and equipped to accept future units. Vertical bus openings shall be covered by manual bus shutters.

D. Each section shall include, but shall not be limited to, a top plate (single piece or two-piece). NEMA Type 12 shall also include a bottom plate. Top and bottom plates shall be removable for ease in cutting conduit entry openings.

2.04 BUSSING

A. Bussing and connectors shall be silver plated copper.

B. The main horizontal bus shall be rated at as shown on the drawings and shall extend the full length of the MCC. Bus ratings shall be based on 149 degree F (65 degree C) maximum temperature rise in a 104 degree F (40 degree C) ambient. Provisions shall be provided for splicing additional sections onto either end of the MCC.

C. The horizontal bus splice bars shall be pre-assembled into a captive bus stack. This bus stack shall be installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts shall not be required when splicing higher amperage bus. The splice bolts shall secure to self-clenching nuts installed in the bus assembly. It shall be possible to maintain any bus connection with a single tool.

D. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of the same material and plating as the main bus.

E. The system shall be rated for an available short circuit capacity of 65,000 amperes rms.

2.05 TYPICAL UNIT CONSTRUCTION

A. Units with circuit breaker disconnects through 400 ampere frame, and fusible switch disconnects through 400 amperes, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus. Circuit breakers with frame sizes 1,200 amps and greater shall be installed with energy reducing maintenance switch and status indicator.

B. Conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.

C. Unit mounting shelves shall include, but shall not be limited to, hanger brackets to support the unit weight during installation and removal. Plug-on units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.

D. A lever handle operator shall be provided on each disconnect. With the unit stabs engaged onto the vertical phase bus and the unit door closed, the handle mechanism shall allow complete on/off control of the unit. Circuit breaker operators shall include, but shall not be

limited, a separate tripped position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided, by adhering to the following operator handle positions:

1) Handle on position shall be up or to the left and within 45 degrees of being parallel to the face of the equipment.

2) Handle off position shall be down or to the right and within 45 degrees of being parallel to the face of the equipment.

3) The minimum separation between the on and off positions shall be 90 degrees.

4) On circuit breaker disconnects, the handle tripped position shall be perpendicular to the face of the equipment ±30 degrees. Minimum separation between on and tripped shall be 30 degrees. Minimum separation between tripped and off shall be 45 degrees.

E. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the on position. Another mechanical interlock shall prevent the operator from placing the disconnect in the on position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.

F. A non-defeatable interlock shall be provided to prevent installing or removing a plug-on unit unless the disconnect is in the off position.

G. The plug-in unit shall have a grounded stab-on connector which shall engage the vertical ground bus prior to, and shall release after, the power bus stab-on connectors.

H. Provisions shall be provided for locking disconnects in the off position with up to three padlocks.

I. Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.

J. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.

2.06 COMPONENTS FOR TYPICAL UNITS

A. Combination Starters:

1) Combination starters shall use a unit disconnect as described in Typical Unit Construction Article above. Magnetic starters shall be furnished in combination starter units. Starters shall utilize NEMA rated contactors. Starters shall be provided with a three-pole, external manual reset, overload relay for ambient compensated bimetallic thermal overload units.

2) When provided, control circuit transformers shall include, but shall not be limited to, two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and connected control circuit loads plus an additional spare 100VA. The transformer rating shall be fully visible from the front when the unit door is opened.

3) When a unit control circuit transformer is not provided, the disconnect shall include, but shall not be limited to, an electrical interlock for disconnection of externally powered control circuits.

4) Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.

5) NEMA Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.

B. Terminal Blocks:

1) When Type B wiring is specified, starter units shall be provided with unit control terminal blocks.

2) Terminal blocks shall be the pull-apart type with a minimum rating of 250 volts and 10 amperes. Current carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail-mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.

3) When Type C wiring is specified, starter units shall be provided with unit control terminal blocks as described for Type B wiring along with power terminal blocks for Size 1-3 units. An additional set of terminal blocks shall be provided in a terminal compartment located in each section. These terminal blocks shall be pre-wired to the unit terminals so that field control connections can be made at the terminal compartments.

C. Nameplates: Provide engraved phenolic nameplates for each MCC and unit compartment. Provide black background with white letters, measuring a minimum of 1.5 inches (38 mm) high by 6.25 inches (159 mm) wide total outside dimensions.

D. Pilot Device Panel: Each combination starter unit shall be proved with a hinged/removable control station plate, which can accommodate up to five 0.87 inch (22 mm) pilot devices or three 1.18 inch (30 mm) pilot devices. [The control station plate can be deleted if no local unit pilot devices are required.]

E. Starters for motors greater than 10HP shall be provided with single phase protection relay.

2.07 ADJUSTABLE FREQUENCY AC DRIVE UNIT CONSTRUCTION

A. The AC drive controller unit shall be a combination disconnect-drive MCC style unit. The input circuit breaker shall provide NEC required branch circuit protection. The branch circuit protection shall have an external operator. The adjustable frequency drives shall be [variable] [constant] torque AC drives. Wiring between the AC drive and the disconnect shall not be disturbed when removing or installing the AC drive controller unit from the MCC.

B. Units shall be of modular construction so that it shall be possible to readily interchange units of the same size without modifications to the MCC structure.

C. Conducting parts on the line side of the unit disconnect shall be isolated to prevent accidental contact with those parts.

D. AC drive controller units up to 50 horsepower variable torque shall be plug-on units which shall connect to the vertical bus through a spring-reinforced, stab-on connector. Units larger than 50 horsepower variable torque shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

E. AC drive controller unit interior mounting panels shall be white for better visibility.

F. A disconnect operator shall be provided per Typical Unit Construction Article above.

G. Plug-on AC drive controller units shall have a grounded stab-on connector which shall engage the vertical ground bus prior to, and shall release after, the power bus stab-on connectors engage/release.

H. AC drive controller units shall be provided with unit control terminal blocks for use in terminating field wiring. Terminal blocks shall be pull-apart type, 250 volts, and rated for 10 amperes. Current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The stationary portion of the terminal block shall be used for factory connections and shall remain attached to the unit when the portion used for field connections is removed. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components.

I. The AC drive controller unit shall incorporate a self-contained, air-based cooling system. Air exhaust vents shall be louvered to help direct air flow away from personnel operating the AC drive controller unit. Fans, ductwork, or filters shall be easily accessible for maintenance.

J. The AC drive controller unit cooling system shall be sized to cool the drive regardless of mounting location within the MCC. The AC drive controller unit shall not be restricted to a specific location in the MCC.

K. An internal overtemperature trip shall be provided to detect cooling system failure or blockage. Upon occurrence of an overtemperature trip, the cooling system fans shall continue running to provide a rapid cool down.

L. Power for the cooling system shall be provided internal to the AC drive controller unit by use of a control power transformer that shall include, but shall not be limited to, two primary fuses and one secondary fuse (in the non-ground secondary conductor).

M. Electrical Ratings:

1) The AC drive controller unit shall be designed to operate from an input voltage of 480 volts AC, ±10 percent.

2) The AC drive controller unit shall operate from an input voltage frequency range of 57 to 63 hertz.

3) The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.

4) The efficiency of the AC drive at 100 percent speed and load shall not be less than 96 percent.

5) The variable torque overtorque capacity shall be 130 percent for 1 minute.

6) The output carrier frequency of the AC drive shall be selectable between 1 kHz and 16 kHz, depending on inverter rating for low noise operation. The output carrier frequency of the AC drive shall be randomly modulated to avoid resonance.

7) AC drive controller unit feeder equipment, including, but not limited to, conductors, lugs, disconnects, contactors, etc., shall be sized per NEC Article 430 for the AC drive input current rating. An impedance range corresponding to a 22,000 to 100,000 amperes fault availability level shall be assumed for the input current rating.

N. Protection:

1) The AC drive controller unit shall be protected against fault currents up to and including 100,000 amperes rms symmetrical at 480 volts AC and shall be UL 845 listed as verification.

2) Upon power-up, the AC drive shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC-to-DC power supply, control power, and the pre-charge circuit.

3) The AC drive controller unit shall be protected against short circuits between output phases, between output phases and ground, on the internal power supplies, and on the logic and analog outputs.

4) The AC drive controller unit shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds (12 cycles). The AC drive shall have the user-defined option of frequency fold-back to increase the duration of the power-loss ride-through.

5) The AC drive shall have a selectable ride-through function which shall allow the logic to maintain control for a minimum of 1 second (60 cycles) without faulting.

6) For a fault condition other than a ground fault, short circuit, or internal fault, an auto restart function shall provide restart attempts for a period of 5 minutes and up to an unlimited amount time depending on setting. The restart attempts shall be separated by increasingly longer waiting periods to allow the condition to be cleared.

7) The deceleration mode of the AC drive shall be programmable. The stop modes shall include, but shall not be limited to, freewheel stop, ramp stop, fast stop, and DC injection braking.

8) Upon loss of the analog process follower reference signal, the AC drive shall be programmable to fault and freewheel stop, ramp stop, fast stop, stop without trip, automatically restart, run at last speed, or maintain an user-defined low speed setting.

9) The AC drive shall have solid-state I^2t protection that shall be UL listed, shall meet UL 508 as a Class 10 overload protection, and shall meet IEC 60947. The minimum adjustment range shall be from 25 to 150 percent of the nominal current rating of the AC drive controller unit.

10) The AC drive shall have three skip frequency ranges with hysteresis adjustment that can each be programmed independently, back-to-back, or overlapping.

11) The AC drive shall be include, but shall not be limited to, an adjustable thermal alarm which can be assigned to a relay or logic output to indicate the drive temperature has reached the thermal alarm setting.

O. Adjustment and Configuration:

1) The AC drive shall have an user selectable auto tune feature. The auto tune shall automatically send motor-rated current to the connected motor and store the resulting resistance data into memory. The AC drive shall automatically optimize the operating characteristics according to the stored data.

2) The AC drive motor and control parameters shall be factory preset to operate most common applications. Necessary adjustments for factory supplied unit operator controls and sequencing shall be pre-programmed and tested by the manufacturer.

3) A choice of three types of acceleration and deceleration ramps shall be available in the AC drive software; linear, S curve, and U curve, as well as custom.

4) The acceleration and deceleration ramp times shall be adjustable from 0.01 to 6000 seconds.

5) The volts per frequency ratios shall be user selectable to meet variable torque loads, normal, and high torque machine applications.

6) The memory shall retain and record run status and fault type of the past eight faults for operator review.

7) The software shall have an energy saving function that shall optimize the energy consumed. A constant volts/hertz ratio shall be maintained during acceleration. The output voltage shall then automatically adjust to meet the torque requirement of the load.

8) Slip compensations shall be a software-enabled function.

9) The AC drive shall offer programmable DC injection braking that shall brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current shall be adjustable between 10 to 110 percent of rated current and available from 0.1 to 30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50 percent of the nameplate current of the motor.

10) Sequencing logic shall coordinate the engage and release thresholds and time delays for the sequencing of the AC drive output, mechanical actuation, and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

P. Graphic Display Terminal Interface:

1) The graphic display terminal shall provide eight lines of 240 by 160 pixels in plain English to control, adjust, and configure the AC drive, including, but not limited to, electrical values, bar charts, configuration parameters, I/O assignment, application and activity function access, faults, local control, adjustment storage, self-test, and diagnostics. There shall be a standard selection of six additional languages built into the operating software as standard.

2) The AC drive model number, torque type, software revision number, horsepower, output current, motor frequency, and motor voltage shall be listed on the drive identification display as viewed on the graphic display terminal.

3) The graphic display shall be able to indicate one, two, or five digital values, or up to two values by bar graph. As a minimum, the selectable display values shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference, and machine speed.

4) The graphic display terminal shall consist of programmable function keys. The functions shall allow both operating commands and programming options to be preset by the operator.

5) The graphic display terminal shall offer levels of settings from simple start-up to advanced user menus consisting of parameter setting, I/O map, fault history, and drive configuration. Password protection shall be available to limit unauthorized access to various levels of the menus.

6) The navigation wheel shall provide the ability to scroll through menus and screens, select or activate functions, or increase the value of a selected parameter.

7) An escape key shall allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function shall also return to a previous menu display.

8) A run key and a stop key shall command normal starting and stopping as programmed when the AC drive is in keypad control mode. The stop key shall be active in all control modes.

9) A Windows based personal computer user interface shall be available.

10) The keypad shall store up to four user configuration programs in nonvolatile memory. An operator shall have the ability to download a stored configuration to multiple AC drives.

11) The operator interface shall be MCC door-mounted on the AC drive controller unit for ease of access and increased visibility.

12) Door-mounted controls shall be NEMA Type 12 rated.

Q. Control:

1) Pilot devices shall be industrial rated 1.18 inch (30 mm) type control operators and used independently of the keypad display. Software assignments for control inputs and outputs to operate factory-supplied controls shall be pre-configured from the factory. The following basic controls shall be provided:

a. Hand-off-auto selector switch. The hand mode shall allow manual operation of start, stop, and speed control. The AC drive shall start when the control operation is in the hand mode. A door-mounted, manual speed potentiometer shall be used to control speed in the hand mode. The AC drive shall run at the low speed setting or higher as required by the position of the manual speed potentiometer. This mode shall function as 2-wire control and automatically restart after a power outage or auto restart after a fault. The off position of the control operation shall stop the AC drive and prevent it from restarting. The auto (automatic) mode shall receive an [auto start contact] [serial link command] to control starting and stopping of the AC drive. This contact shall also start and stop bypass (if

used) when both the automatic and bypass modes of operation are selected. Speed control shall be from an user supplied 4–20 mAdc signal.

b. Run pilot light, green, push-to-test.

c. Note, Additional controls can be found on the equipment electrical diagrams.

2) Two-wire or 3-wire control strategy shall be defined within the software.

3) The control power for the digital inputs and outputs shall be 24 volts DC.

4) The internal power supply shall incorporate an automatic current fold-back that shall protect the internal power supply if incorrectly connected or shorted. The transistor logic outputs shall be current limited and shall not be damaged if shorted or if excess current is pulled.

5) Logic connections shall be furnished on pull-apart terminal strips.

6) There shall be two software assignable analog inputs with interference filtering. The analog inputs shall be software selectable and consisting of user defined configurations: x-y mA or x-y V.

7) There shall be five software assignable logic inputs that shall be selected and assigned in the software. The selection of assignments shall consist of forward, reverse, jog, plus/minus speed (two inputs required), setpoint memory, preset speeds (up to eight inputs), auto/manual control, controlled stop, terminal or keypad control, output contactor (two inputs required), motor switching, and fault reset.

8) There shall be two software assignable analog outputs with interference filtering. The analog outputs shall be able to be selected and assigned in the software. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power, torque, voltage, and thermal state. The output signal shall be user-defined configurations: x-y mA or x-y V.

9) Two voltage-free Form C relay output contacts shall be provided. One of the contacts shall indicate AC drive fault status. The other contact shall be user assignable.

10) Drives shall include, but shall not be limited to, network communication interface for data acquisition only over Ethernet IP. Drive control and speed control via PLC hardwired I/O shall include, but shall not be limited to, the following:

a. PLC analog output (4–20 mA) speed reference signal.

b. PLC analog input (4–20 mA) speed feedback signal.

c. PLC digital output drive start control] [PLC digital outputs for drive preset speed control.

d. PLC digital input drive run (run =1).

e. PLC digital input drive fault (fault = 1).

11) Drives shall include, but shall not be limited to, network communication interface for control and data acquisition over Ethernet IP.

a. At a minimum, drive units shall allow configuration of the following parameters:

1. Motor frequency.

2. Motor voltage.

3. Ramp profiles.

4. I/O assignments.

5. Current limitation.

b. Drive units shall be capable of making these adjustments:

1. Speed range.

2. Ramp time.

3. Thermal protection.

c. Drive units shall allow control of these parameters:

1. Start/stop.

2. Braking.

3. Frequency reference.

4. Fault resets.

R. Optional Harmonic Study:

1) A harmonic distortion analysis shall be performed by the AC drive manufacturer based upon system documentation supplied by the Contractor. The documentation shall consist of one-line diagrams, distribution transformer information (kVA, %Z, and X/R ratio), and emergency standby generator performance specifications. The harmonic distortion analysis report shall be part of the shop drawing process, submitted to the Architect/Engineer for review and acceptance. If the calculations determine that harmonic distortion values are higher than the voltage and current values specified in IEEE 519, the drive manufacturer shall provide the equipment

specified in Optional Harmonic Equipment Paragraph below to meet the IEEE specified values.

S. Optional Harmonic Equipment:

1) Three percent impedance line reactor shall be provided that shall be mounted in the MCC enclosure, factory wired and tested with the AC drive controller unit.

2) Five percent impedance line reactor shall be provided that shall be mounted in the MCC enclosure, factory wired and tested with the AC drive controller unit.

3) An active harmonic filter shall be provided to perform electronic cancellation of load produced harmonic currents such that the upstream power harmonic current and voltage shall be reduced below the IEEE 519 guidelines for load demand and voltage distortion limits. Filter shall be Square D® brand Accusine or equivalent. Performance of the filter shall be independent of the impedance of the power source, AC lines or back-up generator. Necessary current transducers, reactors, and operator interfaces shall be supplied with the MCC. A factory certified start-up technician shall be used to start up each harmonic filter to achieve optimum system performance.

2.08 PANELBOARDS

A. General: Except as otherwise indicated, provide panelboards, enclosures and components of types, sizes and ratings indicated, which comply with manufacturer's standard materials, design and construction, in accordance with published product information; equip with number of unit panelboard devices as indicated for a complete installation. Where more than one type of component meets indicated requirements, selection is installer's option. Where types, sizes or ratings are not otherwise indicated, comply with NEC, UL and established industry standards for applications indicated. Panelboard ratings, current and voltage, fused switch or circuit breaker complement, interrupting ratings and mounting are indicated on the drawings. Where not noted, the minimum interrupting rating on the 480 volt system shall be 14 KAIC and 10 KAIC on the 120 volt system.

B. Provide dead-front safety type lighting and power panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangement shown; with anti-turn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders at top or bottom of panel to suit field conditions; equipped with copper bus bars, full-sized neutral bar, with bolt-in type molded case branch circuit breakers for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide a bare uninsulated copper grounding bar suitable for bolting to enclosure.

C. Panelboard Fronts: Provide panelboard fronts with door-in-door feature with one door over the interior and the other hinged to give access to the wiring gutter. The inner door over the interior shall have flush lock keyed to match other panels.

D. All panelboard fronts shall be equipped with interior circuit-directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Design enclosure for

surface or flush mounting, as indicated on the drawings. Provide enclosures fabricated by same manufacturer as panelboards and which fit properly with panelboards to be enclosed.

Panelboard Accessories: Provide panelboard accessories and devices, including but not necessarily limited to, circuit breakers, ground-fault protection breakers, arc fault protection breakers, H.I.D., SWD and HACR rated circuit breakers etc., as recommended by panelboard manufacturer or required by code for ratings and applications indicated.

E. Panelboards shall be of the same manufacturer as the MCC.

2.09 DISTRIBUTION TRANSFORMERS

A. Dry type transformers shall be of the same manufacturer as the MCC.

B. Three (3) phase transformers shall be 480 volt delta primary and 120/208 volt wye secondary, sized as noted with a minimum of four (4) 2-1/2% full capacity primary taps with copper windings.

C. Transformers shall be 115 degrees C. temperature rise above 40 degrees C. ambient. All insulating materials to be in accordance with NEMA ST-20 standards for 180 degree C. UL component recognized insulation system. Efficiency rating shall meet or exceed the current Department of Energy Standards.

D. Sound levels shall be guaranteed by the manufacturer not to exceed the following when tested per NEMA and ANSI Standards.

10 to 50 KVA - 45 DB
51 to 150 KVA - 50 DB

E. Mount transformers using vibration isolation.

2.10 GENERAL COMMUNICATION CABLING

A. The MCC shall employ a pre-engineered communication cabling system to interconnect units within the MCC.

B. Network cabling shall be routed through the lower horizontal wireway to isolate the network from the horizontal bussing routed through the top.

C. The full-depth vertical wireway shall serve to separate communications from power cabling to prevent noise interference on the network cable.

D. The communication cabling installation shall meet Class 2 wiring practices under the provisions of NEC Articles 725 and 800.

E. Provisions for appropriate terminators and grounding shall be provided.

F. Addition, removal, or rearrangement of units shall not interrupt the trunk line and shall not affect the cabling of other units attached to the trunk line.

G. Cable assemblies shall use 5-pole micro-style connectors with a single keyway and shall comply with SAE H1738-2 specifications.

H. Connectors shall be epoxy-coated for a 500-hour salt-spray test per MIL-STD-202.

I. Cable coupler design shall include, but shall not be limited to, a vibration-resistant ratchet to prevent loosening.

J. The system shall be constructed of molded PVC material.

2.11 ETHERNET (MODBUS TCP) COMMUNICATION CABLING

A. The Ethernet (Modbus TCP) communications network shall be configured in a star topology.

B. The cabling system shall consist of multiple, custom length Ethernet patch cables that each connect a single network device to a central Ethernet switch unit located in the MCC.

C. Ethernet switches located in the MCC shall be Connexium, Hirschmann, or approved equal.

2.12 QUALITY CONTROL

A. The entire MCC shall go through a quality inspection before shipment. This inspection shall include, but shall not be limited to, the following:

1) Physical Inspection of the following:

a. Structure.

b. Electrical conductors, including, but not limited to, the following:

1. Bussing.

2. General wiring.

3. Units.

2) Electrical Tests:

a. General electrical tests shall include, but shall not be limited to, the following:

1. Power circuit phasing.

2. Control circuit wiring.

3. Instrument transformers.

4. Meters.

5. Ground fault system.

6. Device electrical operation.

b. AC dielectric tests shall be performed on the power circuit.

3) Markings/labels include, but shall not be limited to, the following:

a. Instructional type.

b. UL/CSA.

c. Inspector's stamps.

4) Each device shall be configured and addressed to correspond with software settings.

5) A read/write test shall be performed prior to shipment on network devices, including, but not limited to, overloads, drives, and soft starters.

6) Testing shall be designed to verify system operation and shall include, but shall not be limited to, these verifications as a minimum:

a. Drawings and bill of materials.

b. I/O addressing.

c. Correct device operation by I/O address.

d. Host communications.

e. Control network interface.

7) The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

2.13 SURGE PROTECTION DEVICE

350,000 Amp Class (Service Entrance)

A. Surge suppression system shall be provided as an integral component of the MCC.

B. Standards. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41-1991 and C62.45-1987;
ANSI/IEEE C62.1 and C62.11;

Canadian Standards Association (CSA);
Federal Information Processing Standards Publication 94 (FIPS PUB 94);
National Electrical Manufacturer's Association (NEMA LS1-1992 Guideline);
National Fire Protection (NFPA 70 [NEC], 75 and 78);
Underwriters Laboratories (UL 1449 and 1283);
Underwriters Laboratories (UL 489 and 198)

C. The unit shall be UL 1449 listed and CSA approved as a transient voltage surge suppressor and UL 1283 listed as an electromagnetic interference filter.

D. High Performance Suppression System. The unit shall include an engineered, solid-state, high performance suppression system utilizing predetermined arrays of non-linear voltage dependent metal oxide varistors with similar operating characteristics.

E. Internal Connections. All internal wiring associated with the suppression filter system and subject to surge currents shall utilize low-impedance copper bus bar and/or #2 AWG copper conductor or larger. All internal connections associated with the suppression filter system and subject to surge currents shall be made with compression solderless type lugs and shall be bolted to the bus bars in order to reduce overall system impedance. No plug-in components modules, quick disconnect terminals, non-field replaceable fusing or printed circuit boards shall be used in surge current carrying paths.

F. Unit Status Indicators. The unit shall include long life, solid state, externally visible LED visual status indicators that monitor the on-line status of each phase of the unit.

G. Integral Test Point. The unit shall incorporate an integral test point allowing easy off-line diagnostic testing verifying the operational integrity of the unit's suppression filter system. Field testing shall permit proactive testing to ensure performance and long term reliability. Testing shall include performance and long term reliability. Testing shall include injection of an impulse into the off-line suppression filter system to verify the suppression performance values established at final factory testing and recorded on the diagnostic signature card. Indicator lights monitoring fuse condition or power available which inform the user of failure after the fact are not acceptable to meet the intent of this specification.

H. Remote Status Monitor Contacts. In order to monitor on-line status, the unit shall include form C dry contacts (N.O. or N.C.) to facilitate connection to a building management system. The contacts shall be normally open or normally closed and shall change state upon degradation of failure or the suppression system and/or fuse. The contacts shall also change upon phase reversal, power failure of any combination of all three phases or total power failure.

2.14 METERING DEVICES

A. Manufacturer shall provide an electronic power meter where indicated on the drawings. Three phase metering and power quality analysis shall be provided by a power quality meter provided by the MCC manufacturer.

B. Metering shall include A, V, W, Wh, Wcost, var, varh, VA, VAh, Hz, and PF in True RMS or displacement (fundamental) quantities.

C. Power analysis features shall include an event recorder, waveform capture, trace memory, harmonic spectrum display through the 63rd harmonic with total harmonic distortion and a data logger function. All analysis data shall be non-volatile.

D. Four switch inputs shall be provided which can be programmed for relay activation, counters, logic, demand sync, reset and alarms. Four output relays shall be provided which can be programmed to activate on alarms, setpoints, switch inputs, kWh pulse, trace memory triggers or communications control. These output relays shall also be able to use demand metering values of A, VAR, W and VA to control load shedding. Provide Ethernet TCP/IP interface compatible with owner's SCADA System.

E. Local user interface shall include a keypad and display for entering all setpoints and reading all measured values, and LED indicators for output relays, communication status and alarm status.

F. Instrument Transformers

1) Current transformers with shorting terminal block shall be provided. Current ratings shall be as indicated on drawings.

2) Manufacturer shall provide potential transformers with fused primary, stationary mounted, rated and configured as indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1) Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.02 INSTALLATION

A. Install MCCs in accordance with reviewed product data, final shop drawings, manufacturer’s written instructions and recommendations, and as indicated on the Drawings.

B. MCCs shall not be placed in hazardous locations. The area chosen shall be well ventilated and totally free from humidity, dust, and dirt. The temperature of the area shall be no less than 32 degrees F (0 degrees C) and no greater than 104 degrees F (40 degrees C). For indoor locations, protection shall be provided to prevent moisture entering the enclosure.

C. The MCCs shall be assembled in the factory on a smooth level surface so that sections are properly aligned. A similar smooth and level surface shall be provided for installation. An uneven foundation will cause misalignment of shipping blocks, units, and doors. The

surface under a MCC shall be of a non-combustible material unless bottom plates are installed in each vertical section.

3.03 DEMONSTRATION

A. Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.

1) Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

2) Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.

3) Review data in operation and maintenance manuals with the Owner's personnel.

4) Schedule training with the Owner, through the Architect, with at least seven day's advanced notice.

3.04 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the low voltage industrial MCCs shall be without damage at time of Substantial Completion.

END OF SECTION

SECTION 263200

STANDBY ELECTRICAL GENERATOR SYSTEM

PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 and 23 specification sections, apply to work of this section.

C. Division 26, Section 260000, Electrical General Provisions, and Section 260500, Basic Materials and Methods, apply to work of this section.

D. NFPA 30

E. Ohio Fire Code.

F. Ohio Building Code.

1.02 CONTENTS

A. Described herein are the requirements for the standby electrical generator systems.

1.03 SCOPE

A. The extent of generator system work is indicated on the drawing and by requirements of this section.

PART 2 PRODUCTS

2.01 STANDBY ELECTRICAL GENERATOR SYSTEM

A. General

1) The emergency generator system shall be a prototype tested, factory built, production tested, site tested, of the latest commercial design, together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein. The equipment supplied and installed shall meet the requirements of the national Electrical Code, U. L. and all applicable codes and regulations. All equipment shall be by a U. S. firm which manufactures the generator and controls, and assembles the standby generator sets as a matched unit so that there is one-source responsibility for warranty, parts, and service through a local representative with factory-trained service personnel.

2) Design is based on a Kohler engine/generator set. Any changes to building, ventilation fuel system, exhaust system, clearances and electrical connections

required for proper operation of an engine/generator other than base manufacturer shall be the responsibility of the contractor, without additional cost to the contract. Units manufactured by Onan, MTU or Caterpillar will be considered equal.

3) Shop drawing submittal shall include specification sheets showing all standard and optional accessories to be supplied, performance data, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator set, the transfer switch, and other remote devices included elsewhere in these specifications. Include generator sizing calculations confirming selected generator is adequate for project.

4) **Testing:** To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer shall be responsible for design prototype tests as described herein: Components of the emergency system, such as the engine/generator set, transfer switch, and accessories shall not be subjected to prototype tests since the tests are potentially damaging. Rather, similar design prototypes which will not be sold, shall be used for these tests. Prototype test programs shall include the requirements of NFPA-110 and the following:

   a. Maximum power (KW).

   b. Maximum starting (KVA) at 35% instantaneous voltage dip.

   c. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-22.40 and 16.40

   d. Governor speed regulation under steady-state and transient conditions.

   e. Voltage regulation and generator transient response.

   f. Fuel consumption at 1/4, 1/2, 3/4, and full load.

   g. Harmonic analysis, voltage wave-form deviation, and telephone influence factor.

   h. Three (3) phase line-to-line short circuit test.

   i. Alternator cooling air flow.

   j. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.

   k. Endurance testing.

5) **Warranty:** The emergency generator system and transfer switch shall be warranted by the manufacturer for one (1) year from the date of acceptance by the owner.

6) Furnish a proposal to the owner for a service and maintenance agreement for time

past the requirements of the warranty.

B. The standby electric generating sets shall include a diesel fueled liquid cooled electric plant, rated at 480/277 volt, three (3) phase, four (4) wire, 60 Hertz, kW rating as noted on plans at .8 power factor. It shall be a package unit of new and current equipment consisting of a diesel fueled engine-driven electric plant with engine mounted start-stop control system, and other mounted accessories as specified. An automatic load transfer control to provide automatic starting and stopping of the plant and switching of the load shall be included.

C. The engine shall be diesel fueled with radiator and fan for cooling, alternator, governor, and oil lubrication system, designed for automatic starting upon loss of normal building power. Engine and generator shall be mounted on common structural steel base with vibration isolation. Intake and free-turn exhaust valves shall be heat resisting alloy steel with high tungsten-chrome alloy steel exhaust valve seat inserted. Full pressure lubrication shall be supplied by a gear oil pump. The engine shall have an oil filter with replaceable element, dipstick and oil drain. Engine speed shall be governed by a electronic governor to maintain alternator frequency within one-half of one percent from no-load to full-load alternator output. The engine shall have a 12 volt, DC battery charging alternator with solid state voltage regulator. Starting shall be by a 12 volt, solenoid shift electric starter. Unit shall have fuel filters and electric shut-off valve and dry-type replaceable air cleaning element.

D. The engine instrument panel shall be permanently mounted to unit with vibration isolation. Unit shall have fused DC circuit with removable plug-in circuitry. Unit shall include the following:

1) AC meters for volts, amps and frequency.

2) Meter phase selector switch.

3) DC meters for volts, engine, water temperature, and oil pressure.

4) Running time meter.

5) Alarm horn and silencing switch per NFPA-110.

6) Lamp test switch.

7) Front-mounted voltage adjusting rheostat.

8) Panel lamps (two).

9) Cyclic cranking per NFPA-110.

10) Engine cool-down timer, five (5) minutes.

11) High-Engine-Temperature safety shutdown and lamp (red).

12) Low oil pressure safety shutdown and lamp (red).

13) Overspeed safety shutdown and lamp (red).

14) Overcrank safety shutdown and lamp (red).

15) Low coolant temperature/level safety shutdown lamp (red).

16) Run-Off/Reset-Auto switch (engine start).

17) Local/Remote two (2) wire. Start/stop control

E. The electric plant shall contain a complete engine start control which operates on closing and stop control which operates on opening contact. A cranking limiter shall be provided to open the starting circuit in approximately seventy-five (75) seconds if the plant is not started within that time. The electric plant controls shall also include a three (3) position selector switch with the following positions: RUN-STOP-REMOTE. High coolant temperature, low oil pressure and overspeed shutdown with signal light and alarm terminal shall also be provided.

F. The alternator shall be a four (4) pole revolving field type with brushless exciter and solid state voltage regulator. No commutator or commutator brushes shall be allowed. The starter shall be directly connected to the engine flywheel housing and the rotor shall be driven through a semi-flexible driving flange to ensure permanent alignment. The generator shall have a single maintenance free battery.

G. Unit Performance: Frequency regulation shall be isochronous from no load to rated load and +/- 0.5% for continuous operation. Voltage regulation shall be within plus or minus 2% of rated voltage, from no load to full load. The instantaneous voltage dip shall be less than 20% of rated voltage when full load and rated power factor is applied to the alternator. Motor starting maximum voltage dip shall be 35%. Recovery to stable operation shall occur within five (5) seconds. Stable or steady operation is defined as operation with terminal voltage remaining constant within plus or minus 1% of rated voltage. A rheostat shall provide a minimum of plus or minus 5% voltage adjustment from rated value. Temperature rise shall be within rating as defined by NEMA MG1-1.66 with Class F temperature rise and material.

On loss of normal power, the generator shall start and the electrical systems are to be on line within ten (10) seconds. The retransfer time from emergency to normal power shall be fifteen (15) minutes minimum, with an additional five (5) minutes minimum running time of the generator prior to shutdown.

H. The electric plant shall be mounted on a welded steel base which shall provide suitable mounting to any level surface. Vibration isolators shall be provided between the engine-generator and the base.

I. All accessories needed for the proper operation of the generator shall be furnished. These shall include:

1) Battery rack, battery cables, 12-volt battery(ies) capable of delivering the minimum cold-cranking amps required at zero degrees Fahrenheit per SAE Standard J-537.

Provide manufacturer's float type battery charger.

2) Gas proof, seamless, stainless steel, flexible exhaust connector(s) ending in pipe thread of SAE flange.

3) Flexible fuel line(s) rated 300°F and 100 psi ending in pipe thread.

4) Engine exhaust silencer, coated to be temperature and rust resistant, rated for critical applications. Exhaust noise shall be limited to 85 dba as measured at 10 feet in a free-field environment. Silencer shall be installed within enclosure and all piping to be protected from exposure.

5) Block heater shall be selected by the manufacturer to be of proper wattage and voltage, thermostatically controlled to maintain engine coolant at proper temperature to meet the start-up requirement of NFPA-99 or NFPA-110, based on the ambient temperature conditions of the project.

6) Steel weather-protective enclosure with removable or hinged side panels to allow inspection and maintenance shall be provided for units installed outdoors. The enclosure shall be coated with ASA gray primer and two (2a) coats of high-gloss, weatherproof, sag resistant vinylac in the manufacturer's standard color through an electrical bonding process. The specified exhaust silencer shall be vibra-mounted and installed in the enclosure. Skid end caps and rodent protection shall be installed with the housing. Provide knock-out closers on all openings in the skids to prevent rodent entry to the unit.

7) Enclosure shall be sound attenuating type. Sound pressure level performance is to be 75db(A) log average around unit from no-load to full load measured at 7 meters (23 ft.).

8) Main line circuit breaker(s) rated per plans.

9) Two (2) N.O. engine run relay contacts.

10) One (1) N.O. engine alarm/trouble contact.

11) Radiator duct flange.

J. The battery shall be lead acid type of adequate ampere hour capacity, mounted on a suitable rack as supplied by the battery manufacturer, adjacent to the generator set. Battery to be furnished by equipment manufacturer.

K. Provide an NFPA 99 remote annunciator panel which provides the following:

1) Pre-alarm - high engine temperature.

2) Pre-alarm - low oil pressure.

3) Low water temperature.

4) Low fuel.

5) High engine temperature.

6) Low oil pressure.

7) Emergency stop.

8) Overspeed.

9) Battery charger fault.

10) Low battery voltage.

11) Auxiliary fault.

12) Overcrank.

13) Line power.

14) Generator power.

15) System ready.

16) Generator switch not in auto.

17) Alarm horn.

18) Silence switch.

19) Lamp test.

L. Provide sub-base fuel tank with dual walls, leak detection and alarm. Tank shall be adequately sized for 24 hours of operation at 100% load. Tank shall be U. L. listed for above-ground use for containing flammable and combustible liquids.

1) The public shall be safeguarded from access to, or unauthorized entry to, the storage area. The genset and tank shall be enclosed in a chain link fence no less than six (6) feet in height, and there shall be as a minimum four (4) feet of clearance on all four sides of genset.

2) There shall be vehicular barrier protection, i.e., bollards, guardrail, bumper posts, located on all sides subject to vehicular damage.

3) A spill container having a capacity of not less than 5 gallons shall be provided for each fill connection.

4) Vent lines are required to be located 12 feet above ground level and outside of any enclosure.

5) The top of the foundation for the tank installation shall be six (6) inches above the expected 100-year flood plain.

6) Overfill prevention shall be provided. An alarm shall sound at 90% tank capacity when filling, and an overfill prevention device shall be capable of stopping the flow of product into the tank at 95% capacity.

7) The electrical contractor shall fill tank to 100% full after all testing has been performed. Fuel for testing requirements shall be included.

M. Automatic Transfer Switch

1) The automatic transfer switch shall be rated to withstand the rms symmetrical short circuit current available at the automatic transfer switch terminals, with the type of overcurrent protection and voltage as shown on the plans. Switch shall be 30 cycle rated switch.

2) The automatic transfer switch shall consist of a power transfer module and a control module, interconnected to provide complete automatic operation. The automatic transfer switch shall be mechanically held and electrically operated by a mechanism energized from the source to which the load is to be transferred. The switch shall be rated for continuous duty and be inherently double-throw. The switch shall be mechanically held and interlocked. The switch shall have (single)(dual) operator for transfer.

3) The control module shall be supplied with a protective cover and be mounted separately from the transfer switch for ease of maintenance. Sensing and control logic shall be microprocessor based and mounted on plug-in printed circuit boards. Printed circuit boards shall be keyed to prevent incorrect installation. Interfacing relays shall be industrial control grade, plug-in type with dust covers and locking clips.

4) Automatic operation of the switch shall not require power from any source other than the line-to-line voltage of the source to which the switch is transferring.

5) Control panel shall meet ANSI C37.90c-1974 voltage surge withstand capacity.

6) The transfer switch shall be supplied with the genset and be covered by a single source of responsibility with genset for the warranty period. Transfer switch(es) shall be rated 480 volt, three (3) pole, three (3) phase, four (4) wire, NEMA 3R, ampacity noted on drawings, with solid neutral. Switches shall be by generator manufacturer, Asco or Russell.

7) The transfer switch shall include all standard sensing, status lights, and time delays required by U.L. and NFPA. The transfer switches shall include the following

accessories:

a. Test push button to simulate a power failure on normal. Required by U.L.

b. Disconnect plug on wiring harness to disconnect switch control logic.

c. Main shaft auxiliary contact rated 10 ampere at 480V (one closed on normal and one closed on emergency).

d. Voltmeter, frequency meter and amp meter to monitor all phases of both normal and emergency.

e. Momentary lamp test switch.

f. Plant exerciser adjustable over a seven (7) or fourteen (14) day period in one (1) minute increments for exercising load or without load with selector switch and override. This exercise shall not send building into alarm, sound fire alarm, or send elevator into emergency recall.

g. **In-Phase Monitor:** Monitors normal and emergency sources and permits transfer when phase voltages are plus/minus two (2) degrees and plus/minus two (2) cycles. If the source supplying the load fails or drops below 70%, the monitor will permit immediate transfer.

h. For this project center off delay switching is acceptable to reduce transients resulting from switching with both sources available.

i. Provide transfer to normal or emergency source for the following parameters:

Voltage Loss
Phase Rotation
Single Phase Condition in any Phase

N. Unit shall be 100% load bank tested for **four (4) hours** at the site before acceptance by the owner. Factory tests are not acceptable. Tests shall include:

1) Single step load pickup.

2) Transient and steady-state governing.

3) Safety shutdown device testing.

4) Voltage regulation.

5) Complete transfer switch operation.

6) Test again under building load for one hour after all major equipment is operational. Test all variables noted above.

7) Submit all recorded test data in Operation and Maintenance Manual.

O. Submit complete shop drawings.

P. Engine Exhaust Emissions: Comply with all applicable federal, state and local government requirements at the location of the installation, as of the effective dates of regulations, and dates of manufacture and installation. Include all equipment required to comply with the regulations. In addition, in no case, shall required EPA Tier and emission levels be exceeded.

PART 3 EXECUTION

A. The equipment shall be installed as shown on the plans, in accordance with the manufacturer's recommendations and all applicable codes.

B. **Site Tests:** Installation check, start-up, load bank, and building load tests shall be performed by the manufacturer's local representative. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:

Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations under the environmental conditions, present and expected.

C. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. This shall include:

Engine heaters, battery charger, generator strip heaters, etc.

D. Start-up under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.

E. Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper systems coordination. Engine temperature, oil pressure, and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test.

F. Record all test results and submit with Operation and Maintenance Manuals.

END OF SECTION

SECTION 310000 - EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. The Work covered by this Section shall include all excavation, trenching and related work for the construction of the designated structures and pipelines, backfill and other incidental work.

B. The Work covered by this Section consists of:
1. making all necessary excavations for the construction of all Work;
2. preparing subgrade for foundations, slabs, walks, and pavements;
3. doing all pumping, fluming, and dewatering necessary to keep the trenches and other excavation free from water;
4. providing for uninterrupted flow of existing drains and sewers, and the disposal of water from any sources during the progress of the Work;
5. supporting and protecting all trench walls, structures, pipes, conduits, culverts, posts, poles, wires, fences, buildings and other public and private property adjacent to the Work;
6. removing and replacing existing sewers, culverts, pipelines and bulkheads where necessary;
7. removing after completion of the Work all sheeting and shoring or other soil support materials not necessary to support the sides of trenches;
8. removing and disposing all surplus excavated material;
9. doing all backfilling and grading, of compacting backfill to limits specified or ordered by the Engineer;
10. restoring all property damaged as a result of the Work involved in this Contract.

C. The Work includes transporting surplus excavated materials not needed for backfill at the location where the excavation is made, to other parts of the Work where filling is required, and disposal of all types of surplus material off the site.

E. The Work includes low strength mortar backfill material intended for use in backfilling as shown on the Drawings.

1.2 RELATED DOCUMENTS AND SECTIONS

A. Section 013319 – Field Test Reporting

C. Section 015000.00 - Temporary Facilities and Controls

1.3 DEFINITIONS

A. Backfill: Soil or granular materials used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, not including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding: Layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow: Satisfactory soil imported for use as fill or backfill.

D. Excavation: Removal and disposal of material encountered above subgrade or foundation elevations.
   1. Additional Excavation: Excavation below subgrade or foundation elevations as directed by Engineer.
   2. Trench: Narrow linear excavation
   3. Unauthorized Excavation: Excavation below subgrade or foundation elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
   4. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface or subsurface conditions encountered, including rock, soil materials and obstructions.

E. Embankment: A structure consisting of soil, granular material, shale, rock, or other approved material, constructed in layers to a predetermined elevation and cross-section.

F. Granular materials: Natural aggregate, such as broken or crushed rock, gravel, or sand that can be readily incorporated into an 8-inch layer, and in which at least 65% by weight of the grains or particles are retained in a No. 200 sieve.

G. Laboratory Dry Weight: The maximum laboratory dry weight shall be the weight provided by the laboratory when the sample is tested in accordance with ASTM D-698 Method A, C, or D.

H. Optimum Moisture: The water content at which the maximum density is produced in a soil by a given compaction effort (ASTM D-698).

I. Pavement Prism: Also referred to as the zone of influence. The area below a line drawn 45 degrees to the horizontal from the surface at the edge of pavement, sidewalk or curb.

J. Pipe Embedment: The material placed in a trench surrounding a pipe or conduit consisting of the foundation, bedding, haunching, and initial backfill.

K. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material one (1) cu. yd. or more in volume that when tested by an independent geotechnical testing agency, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2 inches.

L. Shale: Laminated material, formed by the consolidation in nature of soil, having a finely stratified structure. For the purpose of these specifications, the following bedrock types shall also be considered shale: mudstone, claystone, siltstone and hard clay.

M. Soil: All earth materials, organic or inorganic, which have resulted from natural processes such as weathering, decay, and chemical reaction.

N. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, pavement, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

O. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage course, or topsoil materials.

P. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Comply with all provisions of Section 013300, Shop Drawings and Submittals.

B. Product Data: For the following:
   1. Source-locations of all materials shall be identified to the Engineer.
   2. Source quality laboratory test of all fill materials as required to show compliance with material specifications.

C. Shop Drawings: Submit information for the following items:

   1. Sheeting and bracing
   2. Dewatering system and standby equipment
   3. Excavation procedures

1.5 REFERENCES

A. AASHTO M 43 Standard Specification for Size of Aggregate for Road and Bridge Construction

B. ASTM C-150 Standard Specification for Portland Cement

C. ASTM C-618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

D. ASTM D-698 Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop

E. ASTM D-1586 Standard Method for Penetration Test and Split-Barrel Sampling of Soils

F. ASTM D-2487 Standard Test Method for Classification of Soils for Engineering Purposes

G. ASTM D-2940 Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports

H. ASTM D-4253 Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

I. ASTM D-4254 Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

J. State of Ohio - Department of Transportation - Construction and Material Specifications, Item 304, Aggregate Base.

K. State of Ohio - Department of Transportation - Construction and Material Specifications, Material Detail 703.16, Suitable Materials for Embankment Construction.

L. State of Ohio - Department of Transportation - Construction and Material Specifications, Material Detail 703.02.A.2, Fine Aggregate for Portland Cement Concrete

1.6 QUALITY ASSURANCE

A. Obtain permit from EPA under National Pollutant Discharge Elimination System (NPDES) for stormwater discharge from Site.

B. Licensed Professionals Qualifications: Professional Engineer experienced in design of specified Work and licensed in State of Ohio.

1.7 PROJECT CONDITIONS

A. Existing Conditions
   1. Existing ground elevations of the site are shown by figures and/or by contours on the Drawings. The contours and elevations of the present ground are believed to be reasonably correct, but do not purport to be absolutely so, and, together with any schedule of quantities, are presented only as an approximation. The Contractor shall satisfy himself, however, by actual examination on the site of the Work, as to the existing elevations and contours, and the amount of work required.

B. Existing Utilities
   1. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
   2. Notify Engineer not less than two days in advance of proposed utility interruptions.
   3. Do not proceed with utility interruptions without Engineer's written permission.
   4. Contact utility-locator service for area where Project is located before excavating.

1.9 TESTING

A. Earthwork
   1. Special backfill material sieve analysis per ASTM C-136, one test per source.
   2. On-site trench backfill analysis per ASTM D-2487, as directed by Engineer.
   3. Pipe bedding and cover sieve analysis per ASTM C-136, one test per source.
   4. Drainage fill sieve analysis per ASTM C-136, one test per source.
   5. Soil compaction per ASTM D-698.
      a. Embankment testing shall be at least one (1) test/5,000 S.F. of each lift;
      b. Trench backfill testing shall be at least one (1) test/50 L.F. of each lift;
      c. Subgrade and/or subbase testing shall be at least one (1) test/200 L.F. of pavement or 5,000 S.F. of slabs subject to greater frequency due to soil conditions or Engineer’s direction.
   6. Backfill compaction per ASTM D-4253 and D-4254, one test per 50 L.F. of each lift.
   7. Low Strength Mortar testing per ASTM D-4832.

1.10 PROHIBITION OF EXPLOSIVES

A. The use of explosives is not permitted.

1.11 FIELD MEASUREMENTS

A. The Contract Drawings may indicate locations where certain utilities, structures or facilities might possibly interfere with the installation of new improvements. The Contractor shall dig such exploratory test pits as may be necessary to determine the exact location and elevation of the indicated subsurface structure and shall make acceptable provision for their protection, support and maintenance in operation. The Engineer shall be provided advance notification when and where excavation for test pits will take place. The Contractor shall provide the Engineer a record of field locations of all listed utilities, structures or facilities a minimum of five (5) days prior to initiating construction of the project. Locations and elevations are to be provided by a Surveyor registered in the State of Ohio.

PART 2 - PRODUCTS

2.1 GRANULAR PIPE EMBEDMENT

A. Crushed gravel or crushed limestone meeting AASHTO M 43 gradation shall be used for bedding, haunching, and initial backfill as shown on the Drawings.

2.2 SAND PIPE EMBEDMENT

A. Fine aggregate consisting of natural sand meeting the gradation requirements of ODOT Item 703.02.A.2 or shown on the Drawings. The material shall not be lumpy or frozen, and shall be free from slag, cinders, ashes, rubbish, and other deleterious or objectionable material. Sand shall not contain a total of more than 10% by weight of loam and clay.

2.3 ONSITE BACKFILL

A. Excavated soil material, capable of meeting specified compaction, and approved by the Engineer for use as backfill in designated locations.

B. Based upon subsurface investigation, the Owner does not guarantee the onsite soils in its present state consists of the proper moisture content to achieve the specified compaction without drying or adding water.

C. Unsuitable Backfill Material

1. Onsite materials that are unsuitable for backfill, unless otherwise specifically shown in the Drawings, include rock or other materials greater than six (6) inches in their largest dimension, pavement, rubbish, debris, wood, metal, plastic, frozen earth, and the following soils classified per ASTM D-2487:

Symbol	Description
OL	Organic silts and organic silty clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity

PT	Peat, muck, and other highly organic soils

2.4 SPECIAL BACKFILL MATERIAL (ODOT Item 304)

A. Special backfill material shall meet the gradation requirements of ODOT Item 304 and shall consist of crushed gravel or crushed limestone in combination with natural sand or stone. The aggregate shall meet the following gradation requirements:

Sieve	Total Percent Passing
2 inch	100
1 inch	70-100
¾ inch	50-90
No. 4	30-60
No. 30	9-33
No. 200	0-15

2.5 LOW STRENGTH MORTAR BACKFILL

A. Low Strength Mortar shall comply with ODOT Item 613.

B. Submit test data that demonstrates that the proposed mix has a strength of 50 to 100 PSI at 28 days.

C. Each load shall be tested with 3 cylinders for strength test broken at 3, 7, and 28 days until the Engineer is assured that the mix will be between 50 to 100 PSI at 28 days. Thereafter, one set of strength tests shall be taken every 50 CY.

It is intended that the sand be fine enough to stay in suspension in the mixture to the extent required for proper flow. The Engineer reserves the right to reject the sand if a flowable mixture cannot be produced.

D. Mortar Mix Proportioning

1. The initial trial mixture shall be as follows:

Quantity of Dry Materials per Cubic Yard

Cement	100 lbs.
Fly Ash	250 lbs.
Sand (SSD)*	2700 lbs.
Water	500 lbs.

* saturated-surface dry

2. These quantities of materials are expected to yield approximately 1 cubic yard of mortar of the proper consistency. Adjustments of the proportions may be made providing the total absolute volume of the materials is maintained.

2.7 ENGINEERED FILL

A. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940. The aggregate shall meet the following gradation requirements:

Sieve	Total Percent Passing

2 inch	100
1½ inch	95-100
¾ inch	70-92
3/8 inch	50-70
No. 4	35-55
No. 30	12-25
No. 200	0-8

PART 3 - EXECUTION

3.1 PROTECTION

A. Excavation; Temporary Sheeting, Shoring, and Bracing
1. All excavation shall be in accordance with the Occupation Safety and Health Administration (OSHA) regulations.
2. The Contractor shall furnish and install adequate sheeting, shoring, and bracing to maintain safe working conditions, and to protect newly built work and all adjacent neighboring structures from damage by settlement.
3. Bracing shall be arranged so as not to place a strain on portions of completed work until construction has proceeded enough to provide ample strength. Sheeting and bracing may be withdrawn and removed at the time of backfilling, but the Contractor shall be responsible for all damage to newly built work and adjacent and neighboring structures.
4. All sheeting shall be removed unless specifically authorized in writing by the Engineer to be left in place.

B. Construction Sheeting Left in Place
1. The Contractor shall furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.
2. Any construction sheeting and bracing which the Contractor has placed to facilitate his work may be ordered in writing by the Engineer to be left in place. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating an obligation on his part to issue such orders. Failure of the Engineer to order sheeting and bracing left in place shall not relieve the Contractor of his responsibility under this Contract.

C. Field Quality Control
1. Owner or Engineer may check compaction of the backfill at anytime

D. Protection of Existing Utilities
1. Uncover and determine the elevation, size and materials of existing underground utilities along the route of construction, as shown on Drawings or marked at the time of construction by the Utility Owner, at least 200 feet in advance of pipe installation.
2. Adequately support, shore up, or otherwise protect underground utilities whenever exposed in the trench. Extend supports a minimum of 12 inches into undisturbed earth each side of trench. Band or tie utility to bridging for its full length. Where binding cannot be supported by a firm foundation, provide vertical support, including any lateral bracing necessary to provide firm support.
3. Above ground (aerial) utilities, including power, telephone and cable television, shall remain in service at all times. Any anticipated disruption of service shall be with the full knowledge of the Utility Company and required advance notice to affected users. Removal of guy wires and holding of poles shall be done as required

to complete the Work, shall be as agreed upon by the Utility Company and Contractor, and shall be at the expense of the Contractor.

4. Arbitrary disruption of underground and aerial utility services will not be permitted.

E. Trench Protection

1. Provide trench protection using a trench box, wood sheeting and bracing, or such other method as determined by Contractor to maintain a stable excavation and comply with applicable Laws and Regulations.
2. For wood sheeting and bracing use sound lumber suitable for the purpose intended, and arrange so as to support the trench walls and existing structures and utilities. Cut off sheeting to be left in place not less than 18 inches below ground surface.
3. Where necessary to drive sheeting below the pipe bottom, drive sheeting to an elevation as determined by Engineer and leave such sheeting in place from a point 3 feet above the top of the buried utilities.

F. Tank Excavation

1. Prevent displacement or loose soil from falling into foundation excavation; maintain soil stability.
2. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

3.2 REPLACING, MOVING AND REPAIRING OF EXISTING UTILITIES

A. The Contractor shall:

1. replace, move, repair and maintain all utilities and all other structures encountered in the work
2. coordinate and communicate with applicable utility companies
3. repair all damage done to any of the said structures and appurtenances through his acts or neglect and shall keep them in repair during the life of this contract. The Contractor shall in all cases leave them in as good condition as they were previous to the commencement of the work and to the satisfaction of the Engineer.

3.3 DEWATERING

A. Drainage and Removal of Water

1. The Contractor shall dispose of water from the Work in a suitable manner without damage to adjacent property or structures.
2. The Contractor shall, when ordered by the Engineer, construct tight bulkheads across trench and provide pumps suitable for the removal of any water which may be encountered or which may accumulate in the trenches. Unless otherwise provided for in the Contract Documents, drainage water will not be permitted to flow through the conduit.
3. The trench shall be kept free from sewage and storm, surface, and subsurface water to at least 2 feet below the bottom of the excavation.
4. Where open water courses, ditches, or drain pipes are encountered during the progress of the Work, the Contractor shall provide protection and securing of the continuous flow in such courses or drains and shall repair any damage that may be done to them.

3.4 EXCAVATION CLASSIFICATION

A. All excavated materials are unclassified as defined in Article 1.3.

3.5 GENERAL EXCAVATION

A. All necessary excavation for buildings, structures, pavements, and site improvements shall be performed to accommodate the completion of all related Contract Work.

B. The Drawings show the horizontal and the lower limits of structures. The methods and equipment used by the Contractor when approaching the bottom limits of excavation shall be selected to provide a smooth surface and to prevent disturbing the soil below the bottom limits of excavation. All soil loosened during excavation shall be removed from the bottom of the excavation.

C. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

D. Excavation which is carried below the bottom limits of structures shall be classified as Unauthorized Excavation, unless said excavation below bottom limits of structures has been authorized by the Engineer prior to each occurrence.

3.6 TRENCH EXCAVATION

A. Excavation for trenches in which pipelines, sewers, and conduits are to be installed shall provide adequate space for workmen to space and joint pipe properly, but in every case the trench shall be kept to a minimum width. The width of trench shall not exceed the limits shown on the Drawings.

B. Excavation shall be to the depth necessary for placing of granular bedding material under the pipe as shown on the Drawings. If over-excavation occurs, the trench bottom shall be filled to grade with compacted granular bedding material.

C. Trenching operations shall not be performed beyond the distance that will be backfilled and compacted the same day.

D. In general, backfilling shall begin as soon as the conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

3.7 EXCAVATION OF UNSUITABLE MATERIALS

A. Unsuitable materials existing below the Contract bottom limits for excavation shall be removed as directed by the Engineer. Such excavation shall not exceed the vertical and lateral limits as prescribed by the Engineer.

B. In utility trenches, the voids left by removal of unsuitable excavated material shall be filled with AASHTO M 43 No. 1 and No. 2 aggregate conforming to the material requirements of Article 2.1 of this Section.

C. In excavations other than utility trenches, the voids left by removal of unsuitable excavated material shall be filled with material consisting or either: (1) Special Backfill Material; (2)

Class B concrete; or (3) Low Strength Mortar Backfill, whichever is ordered by the Engineer.

D. Removal of unsuitable excavated material and its replacement as directed will be paid on basis of Contract Conditions relative to Changes in Work unless specific unit prices have been established for excavation of unsuitable material.

3.8 DISPOSAL OF UNSUITABLE AND SURPLUS MATERIAL

A. It shall be the responsibility of the Contractor to dispose of all surplus material that cannot be used in backfill or embankments at his expense outside the limits of the project. Unsuitable excavated material, including rock or large boulders, shall be disposed of outside the limits of the project.

B. Surplus material may be wasted adjacent to or incorporated in the regular construction only when ordered in writing by the Engineer.

3.9 BACKFILL

A. Pipelines, Sewers and Conduits

1. All pipe shall have bedding extending the width of the trench with depth in conformance with the Drawings. The bedding material shall be thoroughly compacted by tamping until no further densification is possible.
2. Pipe cover material shall be used for filling above the pipe bedding along the sides of the pipe and to a height of twelve (12) inches over the top of the pipe. The pipe cover material shall be brought up evenly on both sides of the pipe to eliminate the possibility of lateral displacement of the pipe and shall be thoroughly compacted by tamping until no further densification is possible. Care shall be taken to spade the aggregate under the pipe haunch below the spring line.
3. All trenches and excavations shall be backfilled immediately after pipe is laid therein, unless otherwise directed by the Engineer.
4. After the pipe cover has been placed and compacted around the pipe as specified above, the remainder of the trench may be backfilled by machine. The backfill material shall be deposited in eight (8) inch horizontal layers, and each layer shall be thoroughly compacted to the specified density by approved methods before a succeeding layer is placed. In no case will backfilling material from a bucket be allowed to fall directly on a pipe and in all cases the bucket must be lowered so that the shock of the falling earth will not cause damage.
5. Puddling of sand bedding and pipe cover material is acceptable provided an acceptable method for removal of water is provided.

B. Structures

1. Backfilling shall not commence before concrete has attained specified strength. Do not use equipment for backfilling and compaction operations against structures that will overload the structure.
2. Backfilling around and over structures shall be carefully placed and tamped with tools of suitable weight to a point one (1) foot above the top of same. Additional backfill may be required to protect the structure from damage from heavy equipment. Backfill shall be placed in uniform layers not exceeding eight (8) inches in depth. Each layer shall be placed, then carefully and uniformly compacted to the specified density so as to eliminate the possibility of displacement of the structure.
3. After the backfill has been placed and compacted around the structure to the height specified above, the remainder may be backfilled by machine. The backfill material

shall be deposited in eight (8) inch horizontal layers, and each layer shall be thoroughly compacted to the specified density by approved methods before a succeeding layer is placed. In no case will backfilling material from a bucket be allowed to fall directly on a structure, and in all cases the bucket must be lowered so that the shock of the falling earth will not cause damage.

C. Where any new, proposed, or future pavement, driveway, parking lot, curb, curb and gutter, or walk is to be placed over a backfilled area, Special Backfill material shall be used for any portion of the trench falling within the pavement prism.

D. Where it is necessary to undercut or replace existing utility conduits and/or service lines, the excavation beneath such lines shall be backfilled the entire length with approved Granular Pipe Embedment Material compacted in place in eight (8) inch layers to the required density. The approved Granular Pipe Embedment Material shall extend outward from the spring line of the conduit a distance of two (2) feet on either side and thence downward at its natural slope.

3.10 LOW STRENGTH MORTAR BACKFILL

A. Low strength mortar backfill shall be discharged from the mixer as recommended by the supplier and approved by the Engineer.

B. Low strength mortar backfill may be placed in the trench in as few lifts as may be practical.

C. Secure conduit or pipelines before placing low strength mortar backfill to prevent conduits and pipelines from floating during backfilling.

D. For low strength mortar backfill placed against existing structures of unknown strength, backfill material shall be brought up uniformly in maximum 12 inch lifts and allowed to cure for a minimum of 24 hours or until it can carry a person's weight without leaving imprints before the next lift is placed.

E. Low strength mortar backfill shall be brought up to subgrade elevation or the pavement prism, whichever may be applicable.

3.12 SUBGRADE

A. All soil subgrade shall be prepared in accordance with this subsection.

B. Drainage
1. The surface of the subgrade shall be maintained in a smooth condition to prevent ponding of water after rains to insure the thorough drainage of the subgrade surface at all times.

C. Unsuitable Subgrade
1. Where unsuitable subgrade or subgrade not meeting the required bearing capacity is encountered in cuts, due to no fault or neglect of the Contractor, in which satisfactory stability cannot be obtained by moisture control and compaction, the unstable material shall be excavated to the depth required by the Engineer.
2. Suitable material required for the embankment to replace the undercut will be paid on basis of Contract Conditions relative to changes in Work.
3. Where soft subgrade in cuts is due to the failure of the Contractor to maintain adequate surface drainage as required in this article, or is due to any other

fault or neglect of the Contractor, the unstable condition shall be corrected as outlined above at no expense to the Owner.

D. Full Width New Pavement Construction

1. After the surface of the subgrade has been shaped to approximate cross section grade, and before any pavement, base or subbase material is placed thereon, the subgrade shall be compacted. When the rolling is completed, all surface irregularities shall be corrected and the surface of the subgrade shall be shaped as necessary to conform to the grade and cross section shown on the Drawings within the tolerance set forth in this Section and shall be so maintained until the overlying course is in place.

3.13 TOLERANCES

A. The Contractor shall check the work under this item with templates, slope boards or other devices satisfactory to the Engineer. The completed work shall conform to the Drawings within the following tolerances:

1. For subgrade, the surface shall at no place vary more than ½ inch from a ten-foot straight edge applied to the surface parallel to the centerline of the pavement, nor more than ½ inch from subgrade elevation established by construction layout stakes.

3.14 CONSTRUCTION WITH MOISTURE AND DENSITY CONTROL

A. All backfill and embankments, except rock embankments, shall be constructed using moisture and density control. All subgrade, except rock and shale in cut sections, shall be constructed using moisture and density control.

B. Backfill, embankment and subgrade material which does not contain sufficient moisture to be compacted in accordance with the requirements of Article 3.17 of this Section shall be sprinkled with water as directed by the Engineer to bring the moisture content to within the range of optimum plus or minus three (3) percent. Water shall be thoroughly incorporated into the material by means of discs or other approved equipment.

C. Backfill, embankment and subgrade material containing excess moisture shall be dried, prior to installation, to a moisture content not greater than three (3) percentage points above optimum, except that for material within the moisture content range specified herein that displays pronounced elasticity or deformation under the action of loaded construction equipment, the moisture content shall be reduced to optimum or below if necessary to secure stability. For subgrade material, these requirements for maximum moisture shall apply at the time of compaction of the subgrade and also at the time of placing pavement or subbase. Drying of wet soil shall be expedited by the use of plows, discs, or by other approved methods when so ordered by the Engineer.

3.15 PROOF ROLLING

A. Proof rolling shall be performed on areas described on the Drawings or as directed by the Engineer.

B. Proof rolling equipment shall consist of a single unit, tandem axle dump truck capable of being loaded to 30,000 pound axle load with a gross vehicle weight of 60,000 pounds. Tire pressure shall be maintained at 90 psi. Loading shall be verified by a certified weight slip.

C. Procedure

1. The designated areas of subgrade, prior to the placing of the overlying course, shall be compacted to requirement of this Section. The Contractor shall be responsible for performing a minimum of two (2) proof rollings of the subgrade, as directed by the Engineer, prior to paving. The first proof rolling shall be performed after the installation of underground improvements and rough grading has been completed. After fine grading and just prior to paving, the subgrade shall be proof rolled again. The proof roller shall operate in a systematic manner so that the number of coverages over all areas can be readily determined and recorded. Maximum spacing shall not exceed six (6) feet.
2. Moisture content of the subgrade at the time of proof rolling shall conform to the requirements of this Section.
3. The equipment shall be operated at the speed directed, but in no case shall the speed exceed five (5) miles per hour, and the normal operating speed shall not be less than two (2) miles per hour.
4. Where the operation of the proof roller shows the subgrade to be unstable or to have non-uniform stability, the Contractor shall correct the unstable areas so that the stability of the subgrade will be uniform and satisfactory. The subgrade shall then be checked for conformance to the plan lines and any irregularities of the surface caused by operation of the proof roller shall be corrected and the subgrade shall be shaped to the plan lines within the tolerances specified in this Section.
5. The proof roll is a subjective test and does not relieve the Contractor of his responsibility under the Contract to provide an acceptable subgrade.
6. If the subgrade fails due to the Contractor using it as a haul road or due to his negligence, the subgrade shall be repaired, retested, and proof rolled again at no additional cost to the Owner.

3.17 COMPACTION REQUIREMENTS

A. The bottom of excavations upon which concrete foundations or structures are to be placed shall be compacted so as to obtain 100% of maximum dry density per ASTM D-698 in the top twelve (12) inches.

B. The top twelve (12) inches of stripped original subgrade and final subgrade shall be compacted to not less than 100% of maximum dry density per ASTM D-698.

1. Subgrade under new, proposed, or future pavement shall be compacted 18 inches beyond the edge of pavement, paved shoulders or paved medians.

C. Compaction of subgrade for sidewalks (regardless of paving material) shall be 100% of maximum dry density per ASTM D-698 in the top six (6) inches.

D. Compaction of non-paved areas shall be 90% of maximum dry density per ASTM D-698.

E. Aggregate pipe embedment and aggregate backfill around structures shall be compacted to not less than 100% of maximum dry density per ASTM D-4253 and ASTM D-4254.

F. Final backfill shall be compacted to not less than 100% of maximum dry density per ASTM D-698.

G. Fill placed within the interior of structures shall be compacted to not less than 100% of maximum dry density per ASTM D-698.

H. Embankment shall be placed and compacted in layers until the density is not less than the percentage of maximum dry density indicated in the following table determined by ASTM D-698.

3.18 GRADING

A. Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading
   1. Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
      a. Lawn or unpaved areas shall be graded to plus or minus 1-inch
      b. Walks shall be graded to plus or minus 1-inch

C. Grading inside Building Lines
   1. Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

END OF SECTION 310000

SECTION 335100 - NATURAL GAS DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for natural gas distribution outside the building:

1. Piping.
2. Valves.

1.3 DEFINITIONS

A. Gas Service: Pipe from gas main or other source to gas point of delivery for building or buildings being served. Piping includes gas service piping, gas valve, service pressure regulator, meter bar or meter support, and gas meter.

B. Gas Delivery Point: Gas meter or service pressure regulator outlet, or gas service valve if gas meter is not provided.

C. Gas Distribution: Piping from service-meter assemblies (gas delivery point) to buildings.

D. PE: Polyethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Working-Pressure Ratings:

1. Piping and Valves: 100 psig minimum, unless otherwise indicated.
2. Service Regulators: 100 psig minimum, unless otherwise indicated.

B. Gas Line Pressure:

1. Coordinate and confirm with Gas Company.

1.5 SUBMITTALS

A. Product Data: For the following:

1. PE pipe and fittings.
2. Valves.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For the following natural gas distribution equipment and accessories to include in emergency, operation, and maintenance manuals.

1. Valves.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of earthquake valves and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. Comply with requirements of utility supplying natural gas and with authorities having jurisdiction for natural gas systems.

D. Comply with the International Fuel Gas Code (IFGC) for materials, installation, testing, inspection, and purging.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store PE pipes and valves protected from direct sunlight.

1.8 PROJECT CONDITIONS

A. Verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural Gas Service: Do not interrupt natural gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of gas supply according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of natural gas service.
2. Do not proceed with interruption of natural gas service without Construction Manager’s written permission.

1.9 COORDINATION

A. Coordinate natural gas distribution with other utility Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Gas Valves, 2-Inch NPS and Smaller:

    a. Flowserve.
    b. Homestead Valve, a division of Olson Tech., Inc.
    c. McDonald: A.Y. McDonald Mfg. Co.
    d. Milliken Valve Co., Inc.

2. Gas Valves, 2-1/2-Inch NPS and Larger:

    a. Flowserve.
    b. Homestead Valve, a division of Olson Tech., Inc.
    c. Milliken Valve Co., Inc.

2.2 PIPES AND FITTINGS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

B. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B; Schedule 40, black.

1. Malleable-Iron Fittings: ASME B16.3, Class 150, standard pattern, with threads complying with ASME B1.20.1.
2. Steel Fittings: ASME B16.9, wrought-steel butt-welding type; and ASME B16.11, forged steel.
3. Steel Flanges and Flanged Fittings: ASME B16.5.
4. Unions: ASME B16.39, Class 150, black malleable iron; female pattern; brass-to-iron seat; ground joint.

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket type or ASTM D 3261, butt type with dimensions matching ASTM D 2513, SDR 11, PE pipe.

D. Transition Fittings: Manufactured pipe fitting with one PE pipe end for heat-fusion connection to PE pipe and with one ASTM A 53/A 53M, Schedule 40, steel pipe end for threaded connection to steel pipe.

E. Service-Line Risers: Manufactured PE pipe fitting with PE pipe inlet for heat-fusion connection to underground PE pipe; PE pipe riser section with protective-coated, anodeless, steel casing and threaded outlet for threaded connection to aboveground steel piping.

2.3 JOINING MATERIALS

A. Components, Tapes, Gaskets, and Bolts and Nuts: Suitable for natural gas and as recommended by piping manufacturer.

2.4 VALVES

A. Shutoff Valves, General: Manual operation, suitable for natural gas service, and with 100-psig minimum working-pressure rating.

B. Gas Valves, 2-Inch NPS and Smaller: ASME B16.33, rated for 175 psig natural gas, iron body, bronze plug, straightaway pattern, square head with lockwing, tapered-plug type, tamper-resistant, with threaded ends conforming to ASME B1.20.1. Painted, suitable for exterior environment.

C. Gas Valves, 2-1/2-Inch NPS and Larger: MSS SP-78, Class 125 or Class 175 WOG, lubricated-plug type, semisteel body, wrench operated, with flanged ends. Painted, suitable for exterior environment.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off gas to premises or piping section.

B. Inspect natural gas piping according to International Fuel Gas Code to determine that natural gas utilization devices are turned off in piping section affected.

C. Comply with International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 PIPING APPLICATIONS

A. Flanges, unions, and transition and special fittings with pressure ratings same as or higher than system pressure rating may be used, unless otherwise indicated.

B. Aboveground Piping:
   1. NPS 2 and Smaller: Steel pipe, malleable-iron fittings, and threaded joints.
   2. NPS 2-1/2 and Larger: Steel pipe, butt-welding-type fittings, and welded joints. Joints for connection to service regulators, service meters, and valves with flanged connections may be flanged. Joints for connection to service regulators, service meters, and valves with threaded connections NPS 2-1/2 to NPS 4 may be threaded.

C. Underground Piping: PE pipe, PE fittings, and heat-fusion joints.

D. Underground-to-Aboveground Piping Connections: Service-line riser.

E. PE-to-Steel Piping Connections: Transition fitting.

3.4 VALVE APPLICATIONS

A. Drawings indicate types of shutoff valves to be used. If specific types are not indicated, the following requirements apply:
   1. Aboveground, NPS 2 and Smaller: Lubricated tapered plug valves.
   2. Aboveground, NPS 2-1/2 and Larger: Lubricated plug valves.

3.5 PIPING INSTALLATION

A. Install underground, natural gas distribution piping with bury depth as indicated on the plans, or 36-inches bury depth if not indicated.

B. Install underground, PE, natural gas distribution piping according to ASTM D 2774.

3.6 VALVE INSTALLATION

A. Install metal shutoff valves on aboveground, natural gas distribution piping.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect gas distribution piping to points indicated.

C. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.

D. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

E. Install aboveground, natural gas distribution piping upstream from equipment shutoff valves, electrically continuous, and bonded to grounding electrode according to NFPA 70.

F. Do not use natural gas distribution piping as grounding electrode.

3.8 LABELING AND IDENTIFYING

A. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tape over natural gas distribution piping during backfilling of trenches for piping.

B. Refer to Division 31 Section "Earthwork" for warning tapes.

3.9 PAINTING

A. Refer to Division 09 Section “Painting” for field-applied finishes.

B. Paint exposed metal piping, valves, supports, and piping specialties except units with factory-applied paint or protective coating.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas distribution according to requirements of International Fuel Gas Code and utility.

B. Repair leaks and defective valves and specialties and retest system until no leaks exist.

C. Report results in writing.

D. Verify correct pressure settings for service regulators.

END OF SECTION 335100

SECTION 400507 - HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Structural attachments.

B. Related Requirements:
1. Section 400519 "Ductile Iron Process Pipe" for execution requirements for placement of hangers and supports as specified by this Section.
2. Section 400551 "Common Requirements for Process Valves" for common product requirements for valves for placement by this Section.

1.2 COORDINATION

A. Coordinate Work of this Section with piping and equipment connections specified in other Sections and as indicated on Drawings.

1.3 SUBMITTALS

A. Product Data:

1. Pipe hangers and supports.
2. Hanger rods.
3. Structural attachments.

B. Shop Drawings:

1. Indicate system layout with location, including critical dimensions, sizes, hanger and support locations, and details of trapeze hangers, anchors, and guides.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

D. Delegated Design Submittals:

1. Shop Drawings shall be signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

E. Qualifications Statements: For manufacturer, fabricator, installer, and licensed professional.

F. Manufacturer's Approval: For installer.

1.4 QUALITY ASSURANCE

A. Perform Work according to AWS D1.1/D1.1M for welding hanger and support attachments to building structure.

B. Manufacturers Qualifications: Company specializing in manufacturing Products specified in this Section with minimum three years' experience.

C. Fabricators Qualifications: Company specializing in fabricating products specified in this Section with minimum three years' experience.

D. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years’ experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.6 WARRANTY

A. Furnish one-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. CADDY; nVent.
2. Carpenter & Paterson, Inc.
3. Empire Industries, Inc.
4. Globe Pipe Hanger Products Incorporated.
5. Haydon Corporation.
6. Hilti, Inc.

7. NIBCO INC.
8. PHD Manufacturing, Inc.
9. PHS Industries, Inc.
10. Unitron Product, Inc. / US-Strut.

B. Comply with MSS SP-58.

C. Provide means of vertical adjustment after erection.

D. Pipe Sizes 1/2 to 1-1/2 Inches (13 to 38 mm):

1. Material: Steel; ASTM A36/A36M.
2. Configuration: Split ring.
3. Swivel: Adjustable.

E. Pipe Sizes 2 Inches (50 mm) and Larger:

1. Material: Steel**;** ASTM A36/A36M.
2. Configuration: Clevis.
3. Swivel: Adjustable.

F. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

G. Wall Support for Pipe Sizes 3 Inches (76 mm) and Smaller: Cast-iron J-hook.

H. Wall Support for Pipe Sizes 4 Inches (100 mm) and Larger: Welded steel bracket.

I. Vertical Support: Riser clamp.

J. Floor Supports: Cast-iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

K. Performance and Design Criteria:

1. Pipe Hangers:

a. Design for pipe movement without disengagement of supported pipe.
b. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
c. Provide linkage to permit lateral or axial movement where anticipated.
d. If horizontal pipe movement is greater than ½ inch, or if hanger rod deflection from the vertical is greater than 4 degrees from cold to hot position of pipe, offset hanger rod and structural attachment to maintain rod vertical in hot position.

2. Heat Transmission: Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.
3. Riser Supports: Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.
4. Point Loads:

a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides.

b. Avoid point loads on plastic piping by providing extra-wide pipe saddles or galvanized-steel shields.

5. Noise Reduction: Wrap copper tubes located within buildings in a 2-inch-wide strip of rubber at each pipe support, bracket, clip, and hanger.

2.2 HANGER RODS

A. Material: Steel; ASTM A576.

B. End Connections: All thread.

C. Size: Comply with ASME B31.1

2.3 STRUCTURAL ATTACHMENTS

A. Concrete Inserts:

1. Manufacturers:

a. CADDY; nVent.
b. Carpenter & Paterson, Inc.
c. National Pipe Hanger Corporation.
d. PHS Industries, Inc.
e. Pipe Shields Inc.
f. Piping Technology & Products, Inc.
g. Rilco Manufacturing Co., Inc.
h. Unitron Product, Inc. / US-Strut.
i. Value Engineered Products, Inc.

2. Case: Malleable iron with galvanized-steel shell and expander plug.
3. Connection: Threaded, with lateral adjustment.
4. Size: To suit threaded hanger rods.

B. Mounting Brackets: Welded steel; ASTM A36/A36M.

C. Beam Clamps:

1. Manufacturers:

a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
b. B-line; Eaton, Electrical Sector.
c. CADDY; nVent.

2. Comply with MSS SP-58.
3. Material: Steel; ASTM A36/A36M.
4. Size: Suitable for load to be supported.
5. Anchoring: Locknuts and cup-point set screws.
6. Furnish reversible top or bottom flange.

D. Riser Clamps:

1. Manufacturers:

a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
b. B-line; Eaton, Electrical Sector.
c. CADDY; nVent.

2. Material: Steel; ASTM A36/A36M.

E. Offset Clamps:

1. Manufacturers:

a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
b. B-line; Eaton, Electrical Sector.
c. CADDY; nVent.

2. Configuration: Double leg, two pieces.

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.

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

3.2 INSTALLATION

A. Obtain permission from Architect/Engineer before drilling or cutting structural members.

B. Inserts:

1. Placement:

a. Concrete forms.
b. Reinforced concrete slabs and sides of reinforced concrete beams.

2. Piping 4 Inches and Larger: Provide hooked rod to concrete reinforcement section.
3. Concrete Slabs Forming Finished Ceiling: Locate inserts flush with slab surface.

C. Pipe Hangers and Supports:

1. Comply with MSS SP-58.
2. Support horizontal piping as indicated on Shop Drawings.
3. Install hangers with minimum 1/2-inch space between finished covering and adjacent Work.

4. Place hangers within 12 inches of each horizontal elbow.
5. Minimum Vertical Adjustment: 1-1/2 inches.
6. Supports:

    a. Independently of equipment.
    b. Horizontal Cast-Iron Piping: Adjacent to each hub, with maximum 5-foot spacing between hangers.
    c. Vertical Piping:

        1) Cast-Iron Piping: At each floor at hub.
        2) Other Piping: At every floor.

    d. Riser Piping: Independent of connected horizontal piping.

7. Piping in Parallel at Same Elevation: Provide multiple pipe or trapeze hangers.
8. Provide sheet-lead packing between hanger or support and piping.
9. Clamps and Brackets:

    a. Provide welded steel brackets if piping is to be run adjacent to building walls or columns.
    b. Use beam clamps if piping is to be suspended from building steel.
    c. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
    d. Use offset clamps if pipes are indicated as offset from wall surfaces.

D. Equipment Bases and Supports:

1. Housekeeping Pads:

    a. Material: Concrete, as specified in Section 033300 "Cast-in-Place Concrete."
    b. Minimum Thickness: 3-1/2 inches.
    c. Plan Area: Extend 6 inches beyond supported equipment.

2. Supports:

    a. Material: Steel members.
    b. Brace and fasten with flanges bolted to structure.
    c. Anchor Bolts and Accessories: Use templates furnished with equipment.

END OF SECTION 400507

SECTION 400519 - DUCTILE IRON PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ductile iron pipe and fittings.
2. Accessories.

B. Related Requirements:

1. Section 099635 "Chemical-Resistant Coatings” for product and execution requirements for painting specified by this Section.
2. Section 400551 "Common Requirements for Process Valves" for common product requirements for valves for placement by this Section.

1.2 COORDINATION

A. Coordinate Work of this Section with piping and equipment connections specified in other Sections and as indicated on drawings.

1.3 SUBMITTALS

A. Product Data: For ductile iron pipe and fittings.

B. Shop Drawings:

1. Indicate layout of piping systems, including equipment, critical dimensions, sizes, and materials lists.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Source Quality-Control Reports: For ductile iron pipe and fittings.

D. Field Quality-Control Reports: For ductile iron pipe and fittings.

E. Qualifications Statements: For manufacturer, installer, and licensed professional.

F. Manufacturer's Approval: For installer.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, and invert elevations.

1.5 QUALITY ASSURANCE

A. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.

B. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

C. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect piping and appurtenances by storing off ground.
3. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE AND FITTINGS

A. Piping:

1. Comply with AWWA C151.
2. Class or Pressure Rating: As indicated on piping schedule.

B. Fittings:

1. Material: AWWA C110, ductile iron.
2. Class or Pressure Rating: As indicated on piping schedule.
3. Mechanical Joints:

    a. Comply with AWWA C110 and AWWA C111.
    b. Glands: Ductile iron with asphaltic coating.
    c. Push-on Joints: Comply with AWWA C111.

4. Restrained Joints: Comply with AWWA C111.
5. Flanged Fittings: Comply with AWWA C110.

C. Cement-Mortar Lining:

1. Comply with AWWA C104.
2. Thickness: Standard.

D. Outside Coating:

1. Buried Service:

a. Type: Asphaltic.
b. Thickness: 1 mm.

2. Exposed Service: As specified in Section 099635 "Chemical-Resistant Coatings."

3. Coating Color: As specified in Section 400553 “Identification for Process Piping”.

2.2 ACCESSORIES

A. Jackets:

1. Material: Polyethylene.
2. Comply with AWWA C105.

B. Gaskets: Rubber

2.1 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Verify that field dimensions are as indicated on Drawings.

C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flange mate properly.

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

3.2 PREPARATION

A. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

B. Thoroughly clean pipe and fittings before installation.

C. Surface Preparation:

1. Clean surfaces to remove loose rust, mill scale, and other foreign substances by commercial sand blasting; SSPC SP 6.
2. Touch up shop-primed surfaces with primer as specified in Section 099635 "Chemical-Resistant Coatings."
3. Solvent-clean surfaces that are not shop primed.

3.3 INSTALLATION

A. Buried Service Piping:

1. As specified in Section 31000 “Earthwork”
2. Install pipe to elevations indicated on Drawings and ASME B31.3..
3. All elbows, tees, plugs, etc., shall be properly anchored, blocked or otherwise restrained to prevent movement of the pipe in the joints due to internal or external pressure.
4. Use minimum number of joints.
5. Flexible Couplings:

    a. Location: At connections to equipment and where indicated on Drawings.
6. Couplings and Anchors: According to manufacturer instructions.

B. Exposed Service Piping:

1. According to ASME B31.
2. Run piping straight along alignment as indicated on Drawings, with minimum number of joints.

C. Fittings:

1. According to manufacturer instructions.
2. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
3. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer instructions.
4. Provide required upstream and downstream clearances from devices as indicated on Drawings.

D. Make taps to ductile iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.

E. Install piping with sufficient slopes for venting or draining liquids and condensate to low points.

F. Dielectric Fittings: Provide between dissimilar metals.

G. Field Cuts: According to pipe manufacturer instructions.

H. Finish primed surfaces according to Section 099635 "Chemical-Resistant Coatings."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Inspection:

1. Inspect for damage to pipe lining or coating and for other defects that may be detrimental as determined by Architect/Engineer.
2. Repair damaged piping or provide new, undamaged pipe.
3. After installation, inspect for proper supports and interferences.

C. Pressure Testing:

1. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
2. Conduct hydrostatic test for minimum two hours.
3. Filling:

    a. Fill section to be tested with water slowly and expel air from piping at high points.
    b. Install corporation cocks at high points.
    c. Close air vents and corporation cocks after air is expelled.
    d. Raise pressure to specified test pressure.

4. Observe joints, fittings, and valves under test.
5. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage and retest.
6. Leakage:

    a. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
    b. Maintain pressure within plus or minus 5 psi of test pressure.
    c. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
    d. Compute maximum allowable leakage by following formula:

        1) L = SD x sqrt(P)/C.
        2) L = testing allowance in gph.
        3) S = length of pipe tested in feet.
        4) D = nominal diameter of pipe in inches.
        5) P = average test pressure during hydrostatic test in psig.
        6) C = 148,000.
        7) If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

    e. If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.

f. Correct visible leaks regardless of quantity of leakage.

3.5 CLEANING

A. Keep pipe interior clean as installation progresses.

B. After installation, clean pipe interior of soil, grit, and other debris.

END OF SECTION 400519

SECTION 400551 – COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valves.
2. Valve actuators.

B. Related Requirements:
1. Section 055000 "Metal Fabrications" for miscellaneous metalwork and fasteners specified by this Section.
2. Section 099635 "Chemical-Resistant Coatings" for fluid-applied coatings for corrosion resistance.

1.2 COORDINATION

A. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.3 SUBMITTALS

A. Product Data:

1. Valves.
2. Valve actuators.

B. Shop Drawings:

1. Indicate parts list, materials, sizes, position indicators, limit switches, control system**,** actuator mounting, wiring diagrams, control system schematics.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Valve-Labeling Schedule: Indicate valve locations and nametag text.

D. Certification of Valves Larger Than 12 Inches (305 mm): Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

E. Source Quality-Control Reports: For valves and valve actuators.

F. Field Quality-Control Reports: For valves and valve actuators.

1. Qualifications Statements: For manufacturer and licensed professional.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and actuators.

1.5 QUALITY ASSURANCE

A. Maintain clearances as indicated on Drawings.

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
3. Provide additional protection according to manufacturer instructions.

1.7 WARRANTY

A. Furnish one-year manufacturer's warranty for valves and actuators.

PART 2 - PRODUCTS

2.1 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.

B. Valve Ends: Compatible with adjacent piping system.

C. Operation:

1. Open by turning counterclockwise; close by turning clockwise.
2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

D. Valve Marking and Labeling:

1. Marking: Comply with MSS SP-25.
2. Labeling: As specified in valve schedule.
3. Provide buried valves with valve boxes, covers, and extensions as specified in Section 331416 "Site Water Utility Distribution Piping."

E. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
2. Bonnets:

   a. Clamped, screwed, or flanged to body and of same material and pressure rating as body.
   b. Furnish glands, packing nuts, or yokes as specified in valve Sections.

3. Stems and Stem Guides:

   a. Materials and Seals: As specified in valve Sections.
   b. Space stem guides 8 feet.
   c. Submerged Stem Guides: Type 304 stainless steel.

4. Nuts and Bolts: As specified in Section 055000 "Metal Fabrications."

2.2 VALVE ACTUATORS

A. Provide actuators with position indicators for shutoff valves 6 inches and larger.

B. Comply with AWWA C542.

C. Provide chain actuators for shutoff valves mounted 8 feet above floor level.

D. Provide gear and power actuators with position indicators.

E. Gear-Assisted Manual Actuators:

1. Provide totally enclosed gears.
2. Maximum Operating Force: 60 lbf.
3. Bearings: Permanently lubricated bronze.
4. Packing: Accessible for adjustment without requiring removal of actuator from valve.

F. Chain Actuator:

1. Description: Chain guides and hot dip galvanized operating chain extending to 5-1/2 feet above floor level.
2. Chain Wheels: Sprocket-rim type.
3. Furnish chain storage if chains may interfere with pedestrian traffic.

G. Valve Actuators in NEC Class I, Group D, Division 1 or 2 Hazardous Locations: UL approved.

H. Pneumatic Actuators:

1. Furnish oil lubricators**,** isolating valves, filter regulators, pressure gages, and condensate drains.
2. Provide local control to override automatic operation.

I. Electric Motor Actuators:

1. As specified in Section 260500 "Basic Material and Methods" and following:

    a. 480 V, 60 Hz, three phase.

2. Motors: As specified in Section 400593 "Common Motor Requirements for Process Equipment."
3. Control Panel:

    a. Factory mounted.
    b. NEMA 250 Type 4X.
    c. Single-point power connection and grounding lug.

4. Controls: See control narrative.
5. Disconnect Switch: Factory mounted in control panel.
6. Operation Sequences: See control narrative.
7. Gearing:

    a. Single- or double-reduction unit.
    b. Spur or helical gears and worm gearing.
    c. Lubrication: Grease or oil in sealed housing.

J. Accessories:

1. Handwheel:

    a. Furnish permanently attached handwheel for emergency manual operation.
    b. Rotation: None during powered operation.
    c. Permanently affix directional arrow and cast OPEN on handwheel to indicate appropriate direction to turn handwheel.
    d. Maximum Operating Force: 60 lbf.

2.3 FINISHES

A. Valve Lining and Coating: Comply with AWWA C550.

B. Exposed Valves: As specified in Section 099635 "Chemical-Resistant Coatings."

C. Do not coat flange faces of valves unless otherwise specified.

2.4 SOURCE QUALITY CONTROL

A. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

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.

B. Verify that piping system is ready for valve installation.

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

3.2 INSTALLATION

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Coat studs, bolts, and nuts with anti-seizing lubricant.

D. Clean field welds of slag and splatter to provide a smooth surface.

E. Install valves with stems upright or horizontal, not inverted.

F. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.

G. Install valves with clearance for installation of insulation and to allow access.

H. Provide access where valves and fittings are not accessible.

I. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.

J. Valve Applications:

1. Install butterfly valves in Aeration Tanks for air service.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Valve Field Testing:

1. Test for proper alignment.
2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
3. Architect/Engineer will witness field testing.

C. Prepare test and inspection reports.

END OF SECTION 400551

SECTION 400553 - IDENTIFICATION FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Requirements:

1. Section 099000 "Painting and Coating" for requirements for painting as specified by this Section.
2. Section 400551 "Common Requirements for Process Valves" for basic materials and methods for valves.

1.2 SUBMITTALS

A. Product Data:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Shop Drawings:

1. Indicate list of wording, symbols, letter size, and color-coding for mechanical identification and valve chart and schedule.
2. Indicate valve tag number, location, function, and valve manufacturer's name and model number.
3. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Qualifications Statement: For manufacturer.

1.3 SUSTAINABLE DESIGN SUBMITTALS

A. Product Certificates:

1. For the source and origin for salvaged and reused products.
2. For recycled material content for recycled content products.
3. For the source for regional materials and distance from Project Site.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish two containers of spray on adhesive.

B. Tools: Furnish special crimpers and other devices required for Owner to reinstall tags.

1.6 QUALITY ASSURANCE

A. Piping Color Scheme: Comply with the color table below for process piping.

CONTENTS	**PIPE PAINT COLOR**
RAW SLUDGE	GRAY
SLUDGE RECIRCULATION SUCTION	BROWN WITH YELLOW BANDS
SLUDGE DRAW OFF	BROWN WITH ORANGE BANDS
SLUDGE RECIRCULATION DISCHARGE	BROWN
DIGESTED SLUDGE	BLACK
SLUDGE GAS	RED
NATURAL GAS	RED
NONPOTABLE WATER LINE	PURPLE
POTABLE WATER	BLUE
FIRE MAIN	RED
CHLORINE	YELLOW

SULFUR DIOXIDE	YELLOW WITH RED BANDS
SEWAGE	GRAY
COMPRESSED AIR	DARK GREEN
PROCESS AIR	LIGHT GREEN
WATER LINES FOR HEATING	BLUE WITH 6-INCH RED BANDS SPACED 30 INCHES APART
FUEL OIL/DIESEL	RED
PLUMBING DRAINS AND VENTS	BLACK
FERRIC CHLORIDE	ORANGE
POLYMER	UNPAINTED PVC

B. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:

1. Craftmark Pipe Markers.
2. Kolbi Pipe Marker Co.
3. Pipemarker.com; Brimar Industries, Inc.
4. Seton Identification Products; a Brady Corporation company.

B. Laminated three-layer plastic with engraved black letters on light, contrasting background color.

2.2 TAGS

A. Plastic Tags:

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Kolbi Pipe Marker Co.
d. Marking Services, Inc.
e. R & R Identification Co.
f. Seton Identification Products; a Brady Corporation company.

2. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
3. Minimum Tag Size and Configuration: 1-1/2 inches (38 mm); square.

B. Metal Tags:

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Kolbi Pipe Marker Co.
d. Marking Services, Inc.
e. Pipemarker.com; Brimar Industries, Inc.
f. R & R Identification Co.
g. Seton Identification Products; a Brady Corporation company.

2. Stainless Steel construction; stamped letters.
3. Minimum Tag Size and Configuration: 1-1/2 inches; square with finished edges.

2.3 STENCILS

A. Manufacturers:

1. Kolbi Pipe Marker Co.
2. Marking Services, Inc.
3. Pipemarker.com; Brimar Industries, Inc.
4. R & R Identification Co.
5. Seton Identification Products; a Brady Corporation company.

B. Quality: Clean-cut symbols.

C. Letters:

1. Up to 2-Inch (51-mm) OD of Insulation or Pipe: 1/2-inch-high letters.
2. 2-1/2- to 6-Inch (64- to 150-mm) OD of Insulation or Pipe: 1-inch-high letters.
3. 6-1/2- to 12-Inch (150-mm) OD of Insulation or Pipe: 1-3/4-inch-high letters.
4. Over 12-inch OD of Insulation or Pipe: 3-inch-high-letters

D. Stencil Paint:

1. Description: Semigloss enamel.
2. As specified in Section 099000 "Painting and Coating."

2.4 PIPE MARKERS

A. Plastic Pipe Markers:

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Marking Services, Inc.
d. R & R Identification Co.
e. Seton Identification Products; a Brady Corporation company.

2. Factory-fabricated, flexible, and semi-rigid plastic.
3. Preformed to fit around pipe or pipe covering.
4. Larger sizes may be of maximum sheet size, with spring fastener.

B. Plastic Tape Pipe Markers:

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Kolbi Pipe Marker Co.
d. Marking Services, Inc.
e. Pipemarker.com; Brimar Industries, Inc.
f. Seton Identification Products; a Brady Corporation company.

2. Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

C. Plastic Underground Pipe Markers:

1. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Marking Services, Inc.
c. Pipemarker.com; Brimar Industries, Inc.
d. Rhino Marking and Protection Systems.
e. Seton Identification Products; a Brady Corporation company.

2. Brightly colored, continuously printed plastic ribbon tape.
3. Minimum Size: 6 inches wide by 4 mils thick.
4. Manufactured for direct burial service.

2.5 CEILING TACKS

A. Manufacturers:

1. Marking Services, Inc.
2. R & R Identification Co.
3. Seton Identification Products; a Brady Corporation company.

B. Material: Steel.

C. Head:

1. Color-coded.
2. Diameter: 3/4 inch.

2.6 LABELS

A. Manufacturers:

1. Brady ID.
2. Seton Identification Products; a Brady Corporation company.

B. Material: Aluminum.

C. Minimum Size: 1.9 by 0.75 inches.

D. Adhesive backed, with printed identification.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

a. Brady ID.
b. Master Lock Company, LLC.

2. Material: Anodized aluminum.
3. Furnish hasp with erasable label surface.
4. Minimum Size: 7-1/4 by 3 inches.

B. Valve Lockout Devices:

1. Manufacturers:

a. Brady ID.
b. Master Lock Company, LLC.

2. Material: Plastic.
3. Furnish device to restrict access to valve operator and to accept lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Stencil Painting: Prepare surfaces as specified in Section 099000 "Painting and Coating."

3.2 INSTALLATION

A. According to manufacturer instructions.

B. Apply stencil painting as specified in Section 099000 "Painting and Coating."

C. Install identifying devices after completion of coverings and painting.

D. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

E. Labels:

1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
2. For unfinished covering, apply paint primer before applying labels.

F. Tags:

1. Identify valves in main and branch piping with tags.
2. Install tags using corrosion-resistant chain.

G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

H. Piping:

1. Identify piping, concealed or exposed, with stenciled painting.
2. Use tags on piping 3/4-inch diameter and smaller.
3. Identify service, flow direction, and pressure.
4. Install in clear view and align with axis of piping.
5. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Ceiling Tacks:

1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
2. Locate in corner of ceiling panel closest to equipment.

END OF SECTION 400553

SECTION 400557 - ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual actuators.
2. Electric motor actuators.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous metalwork and fasteners as required by this Section.
2. Section 099635 "Chemical-Resistant Coatings" for product and execution requirements for painting specified by this Section.
3. Section 260500 "Basic Materials and Methods" for motor connections for electric actuators.
4. Section 400551 "Common Requirements for Process Valves" for common product requirements for valves for placement by this Section.
5. Section 400593 "Common Motor Requirements for Process Equipment" for motors for electric actuators.

1.2 COORDINATION

A. Coordinate Work of this Section with installation of valves and accessories.

1.3 SUBMITTALS

A. Product Data:

1. Manual actuators.
2. Pneumatic actuators.
3. Electric motor actuators.

B. Shop Drawings:

1. Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, control system schematics on assembly drawings.
2. Submit actuator Shop Drawings with valve and gate submittal.
3. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Source Quality-Control Reports: For actuators.

D. Field Quality-Control Reports: For actuators.

E. Qualifications Statements: For manufacturer and installer.

F. Manufacturer's Approval: For installer.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and types of actuators.

1.5 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.7 WARRANTY

A. Section 017000 – Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Furnish gear and power actuators with position indicators.

2.2 MANUAL ACTUATORS

A. Valves Smaller than 8 Inches (200 mm): Electrically actuated.

B. Valves 8 Inches (200 mm) to 30 Inches (760 mm): Comply with AWWA C500.

C. Valves 30 Inches (760 mm) and Larger:

1. Drive Type: Worm gear.
2. Handwheel: Minimum 12-inch diameter.
3. Bearings:
   a. Roller type; comply with ABMA 11.
   b. Minimum L10 Life: 100,000 hours.
4. Gearing: Designed for 100 percent overload.

D. Provide gear and power actuators with position indicators.

E. Gear-Assisted Manual Actuators:

1. Provide totally enclosed gears.
2. Maximum Operating Force: 60 lbf.
3. Bearings: Permanently lubricated bronze.
4. Packing: Accessible for adjustment without requiring removal of actuator from valve.

F. Chain Actuators:

1. Chain actuators for shutoff valves mounted 7 feet and greater above floor level.
2. Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above floor level.
3. Chain Wheels: Sprocket rim type.
4. Furnish chain storage if chains may interfere with pedestrian traffic.

2.3 ELECTRIC MOTOR ACTUATORS

A. Motor, reduction gearing, limit switches.

B. Comply with AWWA C542.

C. Enclosure:

1. NEMA 250 Type 4X.
2. Mounting: Attached actuator housing using flanged motor adapter.

D. Motors:

1. As specified in Section 400593 "Common Motor Requirements for Process Equipment."
2. Type:
   a. Modulating.
   b. Totally enclosed, non-ventilated, high starting torque, low starting current.
   c. Full voltage starting.
3. Electrical Characteristics:

a. Connections: As specified in Section 260500 "Basic Materials and Methods."
b. Voltage: 480 V, three phase, 60 Hz.

E. Reduction Gearing:

1. Description: Single- or double-reduction unit of spur or helical gears and worm-gearing.
2. Lubrication: Grease or oil.
3. Bearings:

a. Ball type; comply with ABMA 9.
b. Minimum L10 Life: 100,000 hours.

F. Limit Switches:

1. Type: Heavy duty, open contact.
2. Actuation: Rotor cam.

2.4 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

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.

B. Verify that field dimensions are as indicated on Drawings.

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

3.2 INSTALLATION

A. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.

B. Extend chain actuators to 5-1/2 feet above floor level.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. After installation, inspect for proper supports and interferences.

C. Repair damaged coatings with material equal to original coating as specified in Section 099635 "Chemical-Resistant Coatings."

D. Prepare test and inspection reports.

END OF SECTION 400557

SECTION 400562 - PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Eccentric plug valves.

B. Related Requirements:

1. Section 400551 "Common Requirements for Process Valves" for basic materials and methods related to valves commonly used for process systems.

PART 2 - PRODUCTS

2.1 ECCENTRIC PLUG VALVES

A. Manufacturers:

1. Clow Valve Company; a subsidiary of McWane, Inc.
2. DeZURIK.
3. Henry Pratt Company; a Mueller brand.
4. Kennedy Valve Company; a division of McWane, Inc.
5. Val-Matic Valve & Manufacturing Corp.

B. Description:

1. As specified in Section 400551 "Common Requirements for Process Valves."
2. Type:
    a. Non-lubricated.
    b. Eccentric.
3. Minimum Working Pressure: 150 PSI.
4. Ports:
    a. Configuration: Round.
    b. Minimum Port Area: 80 percent of nominal pipe area for valves 20” and smaller.
5. Stem Bearings: Self-lubricating.
6. Stem Seals:
    a. Type: V-ring.
    b. Material: Neoprene.
7. Packing and Gland: Accessible and externally adjustable.
8. End Connections:

a. Flanged: Comply with ASME B16.5.

C. Operation:

1. As specified in Section 400551 "Common Requirements for Process Valves."
2. Greater Than 3 Inches (75 mm): Wormgear manual operators with handwheel.

D. Materials:

1. Body:

a. Cast iron, AWWA C517
b. Lining: Elastomer, as recommended by valve manufacturer for service conditions.

2. Plug:

a. Cast iron, AWWA C517.
b. Lining: Resilient coating, as recommended by valve manufacturer for service conditions.

3. Seats: Nickel.
4. Stem: Type 316 stainless steel.
5. Stem Bearings: Stainless steel.
6. Seals: PTFE.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 400551 "Common Requirements for Process Valves."

2.2 SOURCE QUALITY CONTROL

A. As specified in Section 400551 "Common Requirements for Process Valves."

B. Testing: Test gate valves according to AWWA C509.

PART 3 - EXECUTION

3.1 INSTALLATION

A. According to AWWA C517.

B. Horizontal Piping: Stem horizontal.

C. Vertical Piping: Plug at top when closed.

D. Plugs: On top when open and on pressure side when closed.

END OF SECTION 400562

SECTION 400565.23 - SWING CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Swing check valves.

B. Related Requirements:

1. Section 099635 "Chemical-Resistant Coatings" for coating and touchup of shop-primed surfaces with primer.
2. Section 400551 "Common Requirements for Process Valves" for basic materials and methods related to valves commonly used for process systems.

1.2 COORDINATION

A. Coordinate Work of this Section with piping and equipment connections as specified in other Sections.

1.3 SUBMITTALS

A. Product Data: Swing check valves.

B. Source Quality-Control Reports: For swing check valves.

C. Field Quality-Control Reports: For swing check valves.

D. Qualifications Statement: For manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, and invert elevations.

1.5 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

B. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect valves and appurtenances by storing off ground.
3. Provide additional protection according to manufacturer instructions.

1.7 WARRANTY

A. Furnish one-year manufacturer's warranty for swing check valves.

PART 2 - PRODUCTS

2.1 SWING CHECK VALVES

A. Manufacturers.
1. American Darling
2. Clow
3. Empire-GA
4. Mueller
5. U.S. Pipe

B. Description:

1. Type: Swing, resilient seated, with outside lever and adjustable weight.
2. Size: 3 inches and larger.
3. Comply with AWWA C508.
4. Minimum Working Pressure: 150 PSI.
5. Flow Area: Full open, equal to connecting nominal pipe diameter.
6. Check Valves 6 Inches (150 mm) and Larger: Furnish with adjustable air cushion chambers.
7. Mounting: Horizontal or vertical.
8. End Connections: Flanged, ASME B16.42.

9. Body and Cover: Ductile iron, ASTM A536.
10. Disc: Ductile iron, ASTM A536.
11. Seat: Field replaceable, bronze, ASTM B62
12. Chamber and Plunger: Bronze, ASTM B62.
13. Hinge Pin and Key: Stainless steel.
14. Packing and O-Ring: Buna-N.
15. Rubber Components: Buna-N.

16. Connecting Hardware: Type 304 stainless steel.

C. Finishes: As specified in Section 400551 "Common Requirements for Process Valves."

2.2 SOURCE QUALITY CONTROL

A. Testing:

1. Hydrostatically test check valves at twice rated pressure according to AWWA C508.
2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field dimensions are as indicated Drawings.

B. Inspect existing flanges for nonstandard bolt-hole configurations or design, and verify that new valve and flange mate properly.

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

3.2 PREPARATION

A. Thoroughly clean valves before installation.

B. Surface Preparation:

1. Touch up shop-primed surfaces with primer as specified in Section 099635 "Chemical-Resistant Coatings."
2. Solvent-clean surfaces that are not shop primed.
3. Clean surfaces to remove loose rust, mill scale, and other foreign substances by commercial sand blasting; SSPC SP 6.
4. Prime surfaces as specified in Section 099635 "Chemical-Resistant Coatings."

3.3 INSTALLATION

A. According to AWWA C508 and manufacturer instructions.

B. Dielectric Fittings: Provide between dissimilar metals.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Inspection:

1. Inspect for damage to valve lining or coating and for other defects that may be detrimental as determined by Architect/Engineer.
2. Repair damaged valve or provide new, undamaged valve.
3. After installation, inspect for proper supports and interferences.

C. Pressure Testing: As indicated in piping schedule.

D. Prepare test and inspection reports.

3.5 CLEANING

A. Keep valve interior clean as installation progresses.

B. After installation, clean valve interior of soil, grit, loose mortar, and other debris.

END OF SECTION 400565.23

SECTION 400593 - COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors furnished with equipment.

B. Related Requirements:

1. Section 260500 "Basic Materials and Methods."

1.2 SUBMITTALS

A. Product Data:

1. Submit manufacturer information for each motor furnished loose.
2. Indicate nameplate data, compliance with specified standards, electrical ratings and characteristics, physical dimensions, weights, mechanical performance data, and support points.

B. Qualifications Statements: For manufacturer and testing agency.

1.3 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years’ experience.

B. Testing Agency Qualifications: Company in testing products specified in this Section with minimum three years’ experience.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.
2. For extended outdoor storage, remove motors from equipment and store separately.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.5 WARRANTY

A. Furnish one-year manufacturer's warranty for motors furnished loose.

PART 2 - PRODUCTS

2.1 MOTORS FURNISHED WITH EQUIPMENT

A. Motors 3/4 hp (560 W) and Larger: Three phase.

B. Motors Smaller Than 3/4 hp (560 W): Single phase, except motors less than ¼ hp may be equipment manufacturer's standard.

C. Three-Phase Motors:

1. Energy-efficient squirrel-cage induction motor with windings to accomplish starting methods and indicated number of speeds.
2. Comply with NEMA MG 1, Design B.
3. Characteristics:

    a. 460 V, three phase, 60 Hz.

4. Service Factor: 1.15.
5. Enclosure: Meet conditions of installation.
6. Design for continuous operation in 104-degree F environment, with temperature rise according to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
7. Insulation System: NEMA Class F.
8. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
9. Thermistor System (Motor Frame Sizes 254T and Larger): Three Positive Temperature Coefficient (PTC) thermistors embedded in motor windings and epoxy-encapsulated solid-state control relay with wiring to terminal box.
10. Bearings:

    a. Grease-lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication.
    b. Comply with ABMA 9.
    c. L-10 Life: 200,000 hours.
    d. Stamp bearing sizes on motor nameplate.

11. Sound Power Levels: Comply with NEMA MG 1.

D. Single-Phase Motors:

1. Permanent split-capacitor type.
2. Characteristics:

    a. 115/230 V, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials.

2.2 SOURCE QUALITY CONTROL

A. Testing: Test motors according to NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.1 PREPARATION

A. Disconnect and remove abandoned motors.

B. Clean and repair existing motors to remain or those to be reinstalled.

3.2 INSTALLATION OF MOTORS

A. Existing Installations:

1. Maintain access to existing motors and other installations remaining active and requiring access.
2. Modify installation or provide access panel.

B. Install motors securely on firm foundation.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Inspect and test according to NETA ATS, except Section 4.

C. Perform inspections and tests as listed in NETA ATS, Section 7.15.

D. Prepare test and inspection reports.

END OF SECTION 400593

SECTION 407000 – FILED MOUNTED INSTRUMENTATION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dissolved Oxygen Probes

2. MLSS Optical Sensors.

B. Related Requirements:

1. Section 260500 “Basic Materials and Methods” for control power wiring requirements.

1.2 REFERENCES

A. ANSI/NFPA 70 National Electrical Code

B. Instrument Society of America

C. Underwriters Laboratories (UL): Applicable listings

1.3 SUBMITTALS

A. Section 013300 – Submittal Procedures: Requirements for submittals

B. Shop Drawings:
1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

C. Manufacturers Certificate: Certify that products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01700 – Execution and Closeout Requirements: Requirements for closeout procedures.

1.5 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquids.

B. Conform to requirements of ANSI/NFPA 70.

C. Furnish products listed and classified by Underwriters Laboratories as suitable for purposes specified as shown.

1.6 QUALIFICATIONS

A. Manufacturer Company: Company specializing in manufacturing products specified in this Section with five years' experience.

1.7 WARRANTY

A. Section 017000 – Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install the instrumentation and appurtenances required for this project.

B. Electronic instruments shall be solid state and the manufacturer's latest design. Equipment shall use a 4-20 mA DC standard process signal unless otherwise specified. Signals from measuring systems and analyzers with millivolt outputs shall be immediately raised and converted to 4-20 mA DC signals for transmission.

C. All field instruments shall be of the same manufacturer and general model type.

2.2 DISSOLVED OXYGEN PROBE

A. Manufacturers:

1. Hach.
2. YSI, Inc.
3. Danfos.
4. Approved equivalent.

B. Probe Specifications:

1. Measuring Range: Unlimited from 0.00 to 20.00 ppm / 0.00 to 20.00 mg/L / 0-200% saturation.
2. Resolution: 0.01 ppm / 0.01 mg/L / 0.01% saturation.
3. Repeatability: 0.05 ppm.
4. Accuracy: <1 ppm:± 0.1 ppm;>1 ppm: ± 0.2 ppm
5. Sensitivity: ± 0.05% of span.
6. Response Time: to 90% <30 seconds; to 95%: <90 seconds.

7. Interferences: *No interference from the following;* H_2S, pH, K^{+1}, Na^{+1}, Mg^{+2}, Ca^{+2}, NH_4^{+1}, AI^{+3}, Pb^{+2}, Cd^{+2}, Zn^{+2}, Cr(tot,) Fe^{+2}, Fe^{+3}, Mn^{+2}, Cu^{+2}, Mi^{+2}, Co^{+2}, CN^{-1}, NO_3^{-1}, SO_4^{-2}, S^{-2}, PO_4^{+3}, CI^{-1}, Anion Active Tensides, Crude Oils, CI_2^{-1}
8. Sensor Cable: Provide with integral cable with a quick disconnect type plug, length as required. Maximum distance from analyzer to sensor of 300 m.
9. Probe Material: Foamed Noryl and 316 SS.
10. Sensor Material: Polybutyl Methacrylate.
11. Probe Warranty: 3 years MINIMUM.
12. Sensor Warranty: 1 year MINIMUM.

C. Controller Specifications:

1. DO: 0.00 – 20.00 PPM/0.00 – 20.00 mg/L/0-999.9% saturation.
2. Accuracy: ± 0.1% of span.
3. Repeatability: ± 0.05% of span.
4. Temperature Drift: ± 0.02% of span per °C.
5. Zero and Span
6. Response Time: 60 seconds to 90% of value on step change.
7. Relay Types/Outputs Resistive: Three SPDT (Form C), 5A @ 114/230 Vac, 5A @ 30 Vdc.
8. Alarms: Settings for low alarm point, low alarm point deadband, high alarm point, high alarm point deadband, off delay, on delay.
9. Analog Outputs: Two isolated 0/4-20 mA, 0.004 mA resolution, up to 600 ohm load.

2.3 MLSS OPTICAL SENSOR

A. S461/S Suspended Solids Sensor by Chemitee or Hach equivalent."

B. Measuring principle Light Absorption in accordance with Lambert Beer Wavelength 880 nm pulsed light method.

C. Measuring ranges: 0-30 g/L, Normal Sludge Accuracy: ±2% f.s.

D. Operating Temperature: 0-60°C Max.

E. Operating Pressure: 5 bar.

F. Material: SS, Epoxy Windows.

G. Dimension: mm 207x42 (lxØ)

H. Mechanical protection IP68.

I. Complete with 10m waterproof cable

2.4 OPERATION

A. Control power wiring: As specified in Section 260500 “Basic Materials and Methods”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 – Execution and Closeout Requirements: Requirements for installation examination.

3.2 INSTALLATION

A. According to manufacturer instructions.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIEDL QUALITY CONTROL

A. Section 01400 – Quality Requirements: Requirements for inspecting and testing.

B. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer’s representative.

C. Furnish installation certificate from equipment manufacturer’s representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01700 – Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner’s personnel.

3.5 ATTACHMENTS

A. Instrument Schedule

1. Dissolved Oxygen Probe
   a. QTY: 2
   b. Type: On-Line Analyzer – Luminescence Optical Sensor
   c. Media: Wastewater

d. Minimum Operating Range: 0-20 mg/L
e. Power 120V
f. Submerged: Yes
g. Explosion Proof: No
h. Output: 4-20 mA.
i. Furnished by: Manufacturer.

2. MLSS Optical Sensor
   a. QTY: 2
   b. Type: On-Line Analyzer – Optical Sensor
   c. Media: Wastewater
   d. Minimum Operating Range: 0-30 g/L
   e. Submerged: Yes
   f. Explosion Proof: No
   g. Output: 4-20 mA.
   h. Furnished by: Manufacturer.

END OF SECTION 407000

PART 1 - SECTION 432110 - PROGRESSING CAVITY PUMPS GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. References

1. AISI American Iron and Steel Institute
2. ASTM American Society for Testing and Materials
3. IEEE Institute of Electrical and Electronic Engineers
4. NEMA National Electrical Manufacturers Association
5. SSPC Steel Structures Painting Council
6. NFPA 70 National Electric Code (NEC)

1.2 SUMMARY

A. This section includes the furnishings and installation of positive displacement, progressing cavity pumps and all pertinent accessories, complete and in place, ready for service as shown on the Drawings and described in this section. This includes:

1. Two (2) Sludge Dewatering Feed Pumps, equipped with VFDs.

B. The pump shall include all drives, VFDs as applicable, drive shafts, couplings, piggy-bag arrangement with belts and belt guards for the Sludge Transfer pumps and in-line motor arrangement for Dewatering Feed Pumps, drive bases, pump bases, anchor bolts, and other appurtenances as specified or required for a complete installation.

C. All pumps shall be of the same manufacturer. Equipment Schedule is provided at the end of this section.

D. The pumping units shall be of the self-priming, positive displacement, progressing cavity type.

E. Furnish all labor, material, equipment, products, incidentals, and testing required and necessary to provide a complete and operational system. Install where noted on the drawings and as specified within these specifications.

F. The unit shall include all manufacture's motors, starters/electrical work necessary connecting conduit, wiring controls, control panels within requirements of Division 26. Motor starters shall be provided under Division 26 by the Electrical Contractor.

G. Coordinate all work with this equipment and any other associated equipment, installed and specified under other sections of these specifications.

H. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

I. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.

1.3 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

B. Provide equipment that is a standard product of the manufacturer.

C. The pumps, gear reducers, and motors shall be a product of the manufacturers' regularly engaged in the manufacturing of equipment having similar service and equal size for a minimum of ten (10) years and a minimum 20 installations at equivalent applications. Supplier shall provide a list of names and dates of installations for verification by the engineer or Owner's Representative.

D. Factory test each pump using water with a factory certified motor, the same size as that specified. Tests shall consist of checking each pump at its rated speed, head, capacity, efficiency, and brake horsepower; and at such other conditions of head and capacity to properly establish the performance curve. Submit copies of the performance curves to the Contractor for Engineer review prior to releasing the pumps to the Contractor. The standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.

E. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.

1.4 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.

B. Product Data: Submit the manufacturer's technical data and installation instructions including certified pump curves with efficiency, capacity, head, speed, brake horsepower required and operating point required for each pump.

C. Shop Drawings: Submit the manufacturer's technical data and installation instructions including certified pump curves with efficiency, capacity, head, speed, brake horsepower required and operating point required for each pump.

1. Complete description in sufficient detail to permit an item-by-item comparison with the Specification. Complete description in sufficient detail to permit an item-by-item comparison with the Specification,
2. Dimensions and required clearances,
3. Pump with motor weights
4. Performance data including pump curves showing overall pump efficiencies, low rate, head, break horsepower, motor horsepower, speed and shat-off head.
5. Materials of construction
6. Layout drawings for all equipment showing installation details and anchor bolt

layout.

7. Wiring diagrams for all electrical equipment.
8. Deviations from Contract Documents.
9. Manufacturer's installation and testing instruction.
10. Manufacturer's standard guarantee.
11. Certification from the pump supplier that site conditions have been examined.

D. Maintenance and Operating Instructions, including the following additional information:

1. Recommendations for short and long term storage.
2. Explanation of operating safety considerations.
3. Detailed installation instructions, with clear step-by-step points on the correct mechanical and electrical installation procedures.
4. Repair parts and maintenance materials.
5. Troubleshooting data.
6. Repair data.
7. Manufacturer's warranty.

1.5 DELIVERY, STORAGE AND HANDLING

A. All equipment shall be delivered in the largest pieces practical for field assembly by the Contractor. Individual pieces shall be permanently tagged with welded erection marks or stainless steel tags cross referenced with information on the manufacturer's erection and assembly drawings.

B. Packing, Shipping, Handling and Unloading.

1. Comply with Section 016600, Product Handling and Protection.

C. Acceptance at Site.

1. Inspect all equipment and materials against reviewed Shop Drawings at time of delivery.
2. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.

D. Storage and Protection

1. Carefully prepare for storage and label all equipment and materials after they have been inspected.
2. Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions.

1.6 SEQUENCING

A. Do not install equipment until design strength of all cast-in-place concrete supporting elements has been attained and all supporting steel has been adequately bolted, braced, and welded.

B. Comply with Section 011100 Summary of Work.

1.7 WARRANTY

A. The pump manufacturer shall guarantee the complete pumping assemblies for a period of 12 months after acceptance or 18 months after shipment, whichever occurs first. The warranty as specified here shall cover all defective parts, material, and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Moyno Pumps.
2. Netzsch Pumps.
3. Or Engineer Approved equal.

B. Contractor choosing an alternative shall refer to the Bid Form. Any proposed alternative must provide all of the qualities described within this specification along with the bid.

2.2 PUMP CONSTRUCTION

A. General:

1. The pumps shall be heavy duty, positive displacement, single stage, progressing cavity type. The pumps shall be cradle mounted to allow the normally vertical suction port to be rotated to any angle perpendicular to the centerline to facilitate piping connections.
2. Full service in place (FSIP) design shall be provided, if available, to allow the replacement of the rotor and stator without having to disconnect the pump from the suction or discharge piping.

B. Pump Suction and Discharge Casing

1. The pump casing shall be designed for the type of service specified and shall be of sufficient strength, weight, and metal thickness to ensure long life, accurate alignment, and reliable operation.
2. The suction and discharge connections shall be ANSI/B16.1 flanges sized for the pump specified. The discharge flange shall have a vent/gauge connection that can be rotated in 90 increments. The discharge support feet shall be separate from the discharge flange.
3. Two (2) square hand-hole side plates on each side of the pump, 180° apart, large enough to permit easy inspection of the drive shaft joint and mechanical seal and servicing of pump.
4. The casing shall have multiple 3/4-inch FNPT connections (minimum 4) for vents, drains, and gauges. The connections shall be at the highest and lowest point of the housing regardless of suction orientation.
5. There shall be a top inspection cover integral to the design to allow for inspection of rotor joint and clean out of the suction body.

C. Stator

1. Stators shall be of double helix design and chemically bonded to the inside of a carbon steel tube. Stators formed from a single piece carbon steel casing are also acceptable. Additional hardware to seal around the stator shall not be accepted. Split stators or stators with sealing lines are not acceptable as the can potentially leak.
2. The Shore A durometer of the BUNA stator shall be 71+4.
3. The stator shall be machined with grooves to accept a 720° retaining ring. The stator affixed to the suction casing by the use of four (4) tie-bar bolts for easy removal replacements are also acceptable.
4. The stator shall be fastened to the suction housing and discharge flange with removable clamp rings to facilitate stator removal. The stator affixed to the suction casing by the use of four (4) tie-bar bolts for easy removal replacements are also acceptable.

D. Rotor:

1. The rotor shall be precision machined from tool steel with a chromium content of 11-13.5% hardened to a Rockwell C hardness of C57-60 and then covered with heavy layers of hard chrome plating.
2. The removal of the rotor shall not require any disconnection of the suction or discharge piping. Pump shall be full service in place, if available. Deviations or special adaptors are not allowed.

E. Joints

1. Gear joints shall be of the grease lubricated crowned gear type, totally enclosed and protected by a wire reinforced elastomeric seal. Oil filled gear joints with double seals are also acceptable.
2. Mechanical components of the gear joints shall be designed to operate for 10,000 hours at the manufacturer's published maximum speeds and pressures.
3. Universal type of joints: The rotor shall be connected to the drive shaft by means of a connecting rod with high strength, shock resistant universal gear joints. Pin joints are <u>not</u> acceptable.
4. The sealed gear type universal joints shall be lubricated by oil or grease.

F. Drive Train

1. The rotor shall be drive by means of a heavy-duty drive train. The rotor shall be joined to the drive shaft by means of a connecting rod with gear joints.

G. Shaft Seal

1. Mechanical seals shall have a type 316 stainless steel springs with knife edged Silicon carbide rotating face, Silicon carbide stationary face, and Viton bellows. Mechanical seals that have exposed spring designs are not acceptable for risk of allowing solids to be trapped in the springs. Flat rotating face designs are not acceptable for risk of putting more stress on the seal faces at pump start-up and the increased risk of overheating.
2. The mechanical seal shall be inside mounted, located inside the pump suction housing with ample open area around the seal and not in a dead-end enclosed housing where solids could accumulate.

3. The shaft seal shall not be more than 2 inches perpendicular away from the suction port to ensure proper seal flushing and cooling around the seal faces. Seals sitting inside a stuffing box shall not be accepted.

H. Pump Drive Shaft

1. The drive shaft shall be of the solid drive shaft design in order to avoid clogging and/or trapping of solids, which could either interrupt the movement of the connecting rod or disturb the seal of the rear gear joint. Maximum shaft deflection under normal operating conditions shall not exceed 0.002-inch.

2. The universal joint head shall be removable from the drive shaft to allow access to the stuffing box or mechanical seal without disturbing the drive end of the pump.

I. Motor mounted in a piggy-bag arrangement with belts and guards (Sludge Transfer Pump):

1. Motor shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut-off to zero head, unless otherwise specifically permitted in this Section.

2. Motor Enclosure Type: TEFC

3. Motors shall be suitable for use on adjustable frequency drives.

J. Belt Drive:

1. Belt drives shall be either V-belt or cogged timing belt. V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards – Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 5 to 1. Sufficient clearance shall be provided for access to the stuffing box. Each belt drive shall include a sliding base or other suitable means of tension adjustment. Belt drives shall be the piggy-back type.

K. Gear Motor (Dewatering Feed Pump):

1. Manufacturer: NORD or equal.

2. Gear motors or gear reducers shall be designed in accordance with AGMA 6019-E (Class II).

3. Unless otherwise noted, gear motors shall:
   a. Be Energy efficient.
   b. Have TEFC enclosure.
   c. Be heavy and inverter duty rated, suitable for 460-volt, 3 phase, 60 Hz power supply.
   d. Have Class F insulation.
   e. Be integral to the gear reducer.
   f. Be suitable for a 5:1 constant torque turndown ratio
   g. Conform to the provisions of National Electric Code.

4. The gear reducer shall be in-line with a 1.4 service factor. The gear case is to be single piece SAE 30 gray cast iron with internal reinforcements for strength rigidity.

5. The nominal input power rating of each gear or speed reducer shall be at least equal to the nameplate power rating of the drive motor. Drive units shall be designed for 24-hour continuous service.

6. The gearbox drive shaft shall be solid mounted in two ball or tapered roller bearings oil lubricated. Gearbox shall have the ability to be removed without requiring any pump disassembly.

7. The gear box or gearmotor shall be in compliant with the Anti-Friction Bearing Manufacturer's Association Minimum B-10 life expectancy of the bearings and be in excess of 100,000 hours at the maximum operating conditions of this Specification.

8. The thermal power rating of each unit shall equal or exceed the nameplate power rating of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F.

9. Each gear reducer shall be a totally enclosed unit with oil lubrication and antifriction bearings throughout.

10. Furnish a flexible, forged steel coupling of an approved type for connecting the pump and motor.
    a. Coupling shall be of the proper size to transmit the power required to drive the pump under all conditions of operation.
    b. Coupling shall be suitably lubricated and designed for long periods of continuous operation.
    c. Coupling design shall take care of inaccuracies of alignment and permit axial adjustment.
    d. Coupling construction shall be such that shaft of a unit may be removed without disturbing adjustment of the other.
    e. Provide and install an approved steel guard over the coupling.

2.3 ACCESSORIES

A. Pump dry-run protection

1. The pump shall have a thermal probe attached to the stator to monitor stator temperature.

2. The probe shall be connected to a control that would trigger a switch to activate an alarm and/or to shut the pump down to prevent dry run (not ruin the stator). The pump safety control instruments shall be provided by the pump manufacturer and installed in the Control Panel by the Control Integrator.

B. Over Pressure Protection: Each pump unit shall be supplied with a silicone-filled isolation ring with a dual mounted gauge and single point pressure switch. The pressure ranges for the switch and gauge shall be selected specifically for each specified service. The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans and be constructed with a carbon steel body and fittings with a Buna sleeve.

1. A discharge pressure gauge and pressure switch shall be furnished by the pump manufacturer for each pump. The pressure shall read in pounds per square inch. The range of each pressure transmitter shall be 0-200 psig.

2. The pressure switch and gauge shall be protected by a radial gauge isolator capable of covering the full pressure range. Flat diaphragm isolators are not acceptable.

3. The switch shall be SPDT, NEMA 4.

C. Suction side pressure gauges:

1. Pump suction flanges shall be tapped for gauge connection.

2. Gauge connection shall be 3/4-inch diameter.

3. Each connection shall include a shutoff needle valve and necessary length of pipe to allow the mounting of a pressure gauge. The open end of the gauge connection shall be plugged to prevent the accumulation of debris.

4. Each pump shall be supplied with liquid filled pressure gauge(s) with snubber and diaphragm seal. Liquid shall be glycerin-water mixture. Suction gauge shall be adequately sized to indicate suction conditions. The gauges shall be properly installed on the pump suction and discharge lines.

5. On suction side, the gauges shall operate over a range of 20 inches of mercury vacuum to 10 psig pressure.

6. Manufacturer: Gauges shall be a product of H.O. Trerice, Ashcroft, Wika or equal.

D. The Contractor shall provide expansion joints for pump suction and discharge lines. Flexible Expansion Pump Connectors: Expansion joints shall be a rubber spool type of a single, open wide arch design. Joint construction shall consist of a Butyl tube and cover, reinforced with a suitable woven fabric. Joints shall be designed to meet the design pressures and temperature for the system. Expansion joints ends shall be flanges drilled to 150 lbs class standards, and be full rubber faced and integral to the body. Flange backing rings of cast iron with a built-in support sleeve shall be provided. Expansion joints shall be Flexicraft Industries, Flextra 150 Model, or equal.

E. Data Plates: Attach stainless steel data plates to the pump, showing the manufacturer's name, pump size and type, serial number, capacity and head rating, and other pertinent data. Attach a special data plate to the pump frame listing identification of the frame and bearing numbers.

F. Hardware: All machine bolts, nuts and cap screws shall be hex head. Hardware or parts requiring special tools or wrenches shall not be used.

2.4 CONTROLS

A. The Electrical Contractor shall provide the Ethernet IP connection to Screw Press Control panel for the Dewatering Feed Pumps.

B. Dewatering Feed Pumps will be controlled by VFD's to be provided by the electrical contractor. Reference specification section 262419.

C. Each pump shall be provided with easily identifiable terminal points to facilitate the exchange of the central control functions between the pumps and the process control system as indicated on the Contract Drawings

D. Sludge Dewatering Feed Pumps

1. Local Control Panel shall be equipped with Hand/Off/Auto selector switch to be provided by Electrical Contractor.

2. Interlocks: Pump #1 or 2 and the Screw Press.

3. When selector switch is set to automatic mode of operation "AUTO" at the Dewatering Feed Pump and Screw Press, the dewatering system runs together, and operation is controlled from the Screw Press HMI Screen. The flowmeter controller located in the Sludge Dewatering Building on the Dewatering Feed Pump force main to the Screw Press, it shall control the VFDs on the feed pump.

   Note, there are only manual valves installed on the pump suction and discharge piping. The flow path shall be set by opening corresponding valves on the suction and discharge piping prior starting dewatering operation.

4. The "Hand" mode of operation is manly for the equipment maintenance, it initiates the Pump run only from the Local Control Panel.

5. Alarms
   a. If Pump stops running, it triggers an Alarm and shut down the Screw Press.
   b. If Screw Press stops running, it shall stop the Pump operation.
   c. Pump Alarms
      1) Pump running dry.
      2) Over pressure.
      3) Motor overload.
      4) If Pump stops running it shall annunciate an Alarm and stop Screw Press.

2.5 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts to be provided for each set of pumps supplied:

1. One (1) complete mechanical seal
2. One (1) one rotor
3. One (1) stator
4. One (1) connecting rod assembly.
5. One (1) joint kit
6. One (1) set V-belts, where applicable.
7. One (1) complete set of any special tools required to dismantle pump.

2.6 SURFACE PREPARATION AND PAINING

A. Shop Finishing

1. Protect all exposed ferrous metals with a minimum of one coat of shop primer. Apply an additional coat of two-part epoxy to motors, pumps, gear boxes, and other similar equipment.
2. All surfaces must be dry, clean, and free of rust, scale, oil and grease. Clean steel surfaces by pickling or blasting to a minimum of SSPC-SP6.
3. Surface preparation, application and minimum DFT millage to be as per the paint manufactures published recommendation.
4. Painting shall be in accordance with the manufacturer standards.

B. Field Painting

1. All rust, scale, dirt or other foreign matter shall be removed by solvent cleaning, wire brushing, short blasting or other standard commercial cleaning procedure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment and accessories in accordance with reviewed Shop Drawings and manufacturer's instructions, as specified herein and shown on Contract Drawings.

B. Furnish and set stainless steel anchor bolts with nuts and washers in accordance with the manufacturer's recommendations.

C. All electrical equipment, conduit and wiring not indicated on the Drawings, but necessary to provide a complete operating system shall be provided at no additional cost to the Owner.

D. Electrical Wiring: The external conduit and wiring required for power supply and control to electrical equipment supplied in this Section shall be furnished and installed in Division - 16, Electrical.

E. Motor size: Any deviation in motor size must be approved by the Engineer. Any electrical equipment or wiring that must change to accommodate a different size motor will be at no additional cost to the Owner.

F. The grade and amount of oil and grease shall be in accordance with the manufacturer's recommendations.

G. Initial lubrication required for startup and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

A. The manufacturer shall furnish the services of a qualified representative for a period of not less than one day to inspect and adjust the equipment furnished in this section. This qualified representative shall also conduct such tests as necessary to demonstrate satisfactory operation and to instruct the Owner's personnel in the care and operation of the equipment.

B. The service representative of the Manufacture shall be present at the site for two (2) work-days, to furnish the startup services and training of the Owner’s personnel covering the operation, mechanical maintenance and electrical requirements. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.

C. For the purposes of this section, a work-day is defined as an eight hour period at the Site, excluding travel time.

3.3 TESTING

A. After completion of installation, the pumps shall be completely tested to demonstrate compliance with operating requirements as specified.

3.4 MAINTENANCE

A. Comply with the requirements of Section 017823

B. Repair Parts and Maintenance Material:

1. Supply tools and a repair parts kit for the pump furnished as recommended by the manufacturer.

3.5 FULL SERVICE IN PLACE

A. Manufacturer shall provide pumps with the full service in place (FSIP) design, if applicable, which allows to replace the rotor and stator without having to disconnect the pump from the suction or discharge piping.

B. Full service in place (FSIP) design shall be provided to allow the replacement of the rotor and stator without having to disconnect the pump from the suction or discharge piping.

3.6 PUMP SCHEDULE

A. SLUDGE DEWATERING FEED PUMPS

1.	Location	-	Sludge Transport / Electrical Building
2.	Service	-	Sludge feed from the Sludge Wet Well to Dewatering Equipment
3.	Fluid service	-	Aerobically Digested waste activated sludge.
4.	Percent of Solids	-	2% to 6%
5.	Quantity	-	2
6.	Number of stages	-	1
7.	Design flow capacity	-	70 gpm
8.	Design flow pump head	-	26.32 ft
9.	Maximum pump speed	-	XX RPM
10.	Suction Lift	-	22 ft
11.	Duty	-	Constant
12.	Minimum motor size	-	X Hp
13.	Motor Speed	-	1750 RPM
14.	Drive	-	VFD
15.	Ambient environment	-	Indoors
16.	Fluid temperature	-	Ambient
17.	Type of suction port	-	Flanged
18.	Suction and Discharge:	-	3" 125 # FF ANSI per ASME 16.5B

END OF SECTION 432110

SECTION 432359 - SCREW PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes screw centrifugal pumps.

B. Related Requirements:

1. Section 260500 "Basic Materials and Methods" for conduit and electrical power to pumps.
2. Section 262419 "Motor Control Centers" for execution and product requirements for equipment specified by this Section.
3. Section 400593 "Common Motor Requirements for Process Equipment" for electric motors and accessories normally supplied as part of equipment assemblies.

1.2 COORDINATION

A. Coordinate installation and startup of Work of this Section with plant operations.

1.3 SUBMITTALS

A. Product Data: Screw centrifugal pumps.

B. Shop Drawings:

1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
2. Include manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.
3. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For screw pumps.

1.5 WARRANTY

A. Furnish one-year manufacturer's warranty for pumps and accessories.

PART 2 - PRODUCTS

2.1 SCREW CENTRIFUGAL PUMPS

A. Manufacturers:

1. Hayward Gordon.
2. WEMCO-Hidrostal; Weir Group PLC.

B. Vertical, screw centrifugal pump, with V-belt drive electric motor.

C. Performance and Design Criteria, RAS:

1. Design Flow Rate: 1.2 mgd.
2. Design Flow Total Dynamic Head: 4.72 ft.

D. Performance and Design Criteria, WAS:

1. Design Flow Rate: 250 gpm.
2. Design Flow Total Dynamic Head: 16 ft.

E. Casing: Cast iron; comply with ASTM A48/A48M, Class 30.

1. Construction: Heavy duty, with removable and replaceable suction cone and backplate.
2. End Connections: Flanged; Comply with ASME B16.1, Class 125.

F. Impeller: Screw centrifugal, fully open.

1. Material: Cast iron with minimum hardness of 450 Brinell; comply with ASTM A532/A532M.
2. Statically and dynamically balanced after assembly.
3. Attachment: Secured to shaft by key.

G. Suction Liner: High chrome cast iron with minimum hardness of 450 Brinell; comply with ASTM A532/532M, Class 111, Type A1.

1. Configuration: Externally adjustable.

H. Shaft: Steel; comply with ASTM A29/A29M.

1. Sleeve: Stainless steel, ASTM A743/A743M.

a. Configuration: Removable.

I. Bearings: Roller.

1. Application: Radial and thrust.
2. Minimum L-10 Life: 100,000 hours at continuous maximum load and speed, according to ABMA 11.

J. Seals: Single-cartridge type, balanced mechanical.

K. Lubrication: Oil or grease.

L. Fabrication:

1. Pump and Drive Mating Surfaces: Machine finished.
2. Base:

a. Material: Heavy-duty cast-iron or fabricated structural steel.
b. Furnish drip rim and drain connection.

M. Operation:

1. Electrical Characteristics: As specified in Section 260500 "Basic Materials and Methods", Section 262419 "Motor Control Centers”

2. Motors: As specified in Section 400593 "Common Motor Requirements for Process Equipment."

3. Control Panel: As specified in Section 406700 "Control System Equipment Panels and Racks."

4. Controls: As noted in Control Narrative.

5. Disconnect Switch: Factory mounted in control panel.

PART 3 - EXECUTION

3.1 INSTALLATION OF SCREW PUMPS

A. Install pumps where indicated on Drawings and according to manufacturer instructions.

B. Provide and connect piping, power and control conduit, and wiring to make system operational and ready for startup.

C. Flush piping with clean water.

3.2 FIELD QUALITY CONTROL

A. Preoperational Check: Before operating system or components, perform following:

1. Check pump and motor alignment.
2. Check for proper motor rotation.
3. Check pump and drive units for proper lubrication.

B. Startup and Performance Testing:

1. Operate pump on clear water at design point for continuous period of two hours, under supervision of manufacturer's representative and in presence of Architect/Engineer.

C. Verify pump performance by performing time-drawdown test or time-fill test.

D. Check pump and motor for high bearing temperature and excessive vibration according to manufacturer instructions. Check for motor overload by taking ampere readings.

E. Equipment Acceptance:

1. Adjust, repair, modify, or replace system components that fail to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3.3 ATTACHEMENTS

A. Pump Schedule

1. RAS Pumps

a. Number Required: 2
b. Pumped Liquid: RAS
c. Design Capacity, each: 855 gpm.
d. TDH: 4.72 ft.
e. Impeller Diameter: 11 in
f. Minimum Motor Horsepower: 5 HP
g. VFD: Yes
h. Motor Speed: 900 RPM.
i. Power Requirements: 460 volt, 3 phase, 60 Hz
j. Model: Hayward Gordon XCS8-C or Engineered approved Equivalent.
k. Discharge Size: 10 in”
l. Suction Size: 10 in”

2. WAS Pumps

a. Number Required: 2
b. Pumped Liquid: WAS
c. Design Capacity, each: 250 gpm.
d. TDH: 16 ft.
e. Impeller Diameter: 9 in
f. Minimum Motor Horsepower: 3 HP
g. VFD: Yes
h. Motor Speed: 1140 RPM
i. Power Requirements: 460 volt, 3 phase, 60 Hz
j. Model: Hayward Gordon XCS4A or Engineer approved equivalent
k. Discharge Size: 4 in”
l. Suction Size: 4 in”

END OF SECTION 432359

SECTION 432513 - SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and all Specification Sections, apply to work of this section.

B. References:

1. HIC Hydraulic Institute Test Code
2. ASTM A48 Specification for Gray Iron Castings
3. ASTM A108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
4. ASTM A276 Specification for Stainless Steel Bars and Shapes
5. ASTM A36 Specification for Carbon Structural Steel
6. ASTM B62 Specification for Composition Bronze or Ounce Metal Castings
7. ASTM A743 Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application / ASTM A744
8. ANSI American National Standards Institute
9. AWWA American Water Works Association
10. FM Factory Mutual
11. IEEE Institute of Electrical & Electronic Engineers
12. NEC National Electrical Code
13. NEMA National Electrical Manufacturers Association
14. UL Underwriters' Laboratories Incorporated
15. Ohio BC International Building Code

1.2 DESCRIPTION OF WORK

A. Contractor shall remove existing submersible grinder pump in Pump Station “B”, located north of the Sludge Holding Tanks 1-4, including discharge pipe, pipe supports, disconnecting elbow, guide rails and replace it with the new submersible filtrate pump as shown on the Drawings.

B. This specification includes furnishing and installation of a new non-clog submersible, pump in the existing wet well for pumping filtrate drain from the Sludge Dewatering Building and supernatant from the existing Sludge Holding Tanks 1-4.

C. The Contractor shall provide and install the following: submersible pump, discharge piping, disconnecting elbow, new guide rails and supports, ultrasonic level sensor, backup floats, lifting chain, motor, local control panel, VFD and power supply, HH-LL alarm floats, control panel for a complete operating system as shown on the drawings and as specified herein.

1.3 QUALITY ASSURANCE

A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of

the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.

B. Manufacturers with 20 or more years of experience who have furnished at least 20 similar lift stations that have been in regular operation not less than 5 years will be considered. Evidence of experience and operational data may be required from the manufacturer to determine the suitability and efficiency of the equipment offered.

C. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

D. Provide equipment that is a standard product of the manufacturer.

E. To assure compatibility, all equipment items furnished under this specification shall be furnished by a single manufacturer who shall be responsible for the adequacy of design.

F. Each completed and assembled pump/motor unit shall undergo the following factory tests at the manufacturer's plant prior to shipment. The Manufacturer shall provide on demand a copy of his quality control plan for these tests and an ISO 9001 factory certificate:

1. Minimum 3-point hydraulic performance test.
2. No-Leak seal integrity test.
3. Electrical integrity test.

G. Under this Contract, the Contractor shall be responsible for the purchase, storage, and installation of all equipment required providing a complete operating facility. The Drawings and Specifications are intended to illustrate and define the equipment installation; however, the Contractor shall properly install, adjust, and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Specifications.

1.4 SHOP DRAWINGS AND SUBMITTALS

A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.

B. Product Data: Submit the manufacturer's technical data and installation instructions including certified pump curves with efficiency, capacity, head, speed, brake horsepower required, and operating point required for each pump. The Contractor shall submit, as a minimum, the following information:

1. Manufacturer: pump and motor
2. Pump: weight
3. Casing: material
4. Motor jacket: type of material (if applicable)
5. Casing bolts and nuts: material
6. Impeller: material, design, coating
7. Wear ring: number, location, material
8. Shaft: material, diameter, length

9. Mechanical Seals: type, upper and lower seal material, spring material, O-ring material, other material of construction.
10. Motor: type, NEC Article 500 rating, insulation class, service factor, continuous duty ambient temperature, starts per hour
11. Thermal switches: number, temperature setting
12. Float switch: type, material
13. Coatings: primer type, finish type, number of coats, total dry film thickness, suitability for media being pumped
14. Guide system: type, size, material
15. Pressure gauges
16. Minimum submergence and NPSH required at all design points.
17. Spare parts: number and type
18. Motor controls including enclosure, circuit protection, disconnects, starters, transformers, phase monitor, switches, relays and contacts, lights, meters, timers, alternators, strip heater, alarms, and fuses. On shop drawings, indicate equipment location, rough-in and anchor placement dimensions and tolerances, clearances required and elevation. Also submit, with drawing data, the appropriate characteristic head/capacity curve for the pumps and motors to be provided. Submit all wiring diagrams.

C. Shop Drawings: All shop drawings shall clearly identify the specific equipment and material being supplied, the quantity being supplied, and all accessories, dimensions, weights, descriptions, mounting and connection details, and any other information necessary to determine compliance with the plans and specifications. The Contractor shall Submit, as minimum, the following information:

1. Dimensions of pump; discharge and guide rails.
2. Plan view of pump indicating clearances required for hatch openings.
3. Pump layout, spacing requirements.
4. Motor data, including starting kVA, starting torque, full load current, full load torque efficiency curves, and power factor curves (computer model printouts not acceptable).
5. Where required, verification that the variable speed drive is capable of delivering the required torque and power over the entire speed range of the pump.
6. Control panel, wiring diagrams for all electrical work.
7. Deviations from Contract Document.

D. Manufacturer's Certificates, including certified test curves with the design points clearly marked (computer model printouts are not acceptable) shall be submitted and approved by the Engineer prior to the pump(s) shipment. Performance curves shall be submitted for each pump to be supplied to both the Engineer and the Owner.

1. Each pump shall be shop tested for capacity, head, speed, power and efficiency in accordance with Standards of the Hydraulic Institute.
2. Tests shall consist of checking each pump at its rated speed, head, capacity, efficiency, and brake horsepower; and at such other conditions of head and capacity to properly establish the performance curve.
3. The required shaft power (P2) in the guaranteed duty point shall be less than rated pump motor horsepower (HP).

4. The pump hydrostatic and performance testing shall be submitted 30 days prior to delivery.

E. O&M Manuals: Prior to or with the delivery of equipment, the Manufacturer shall provide electronic copy of an Operation and Maintenance Manual for Engineers review. O&M Manuals shall contain copies of the approved shop drawings, equipment storage, installation, startup, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The O&M Manuals shall be in compliance with the General Requirements.

F. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent work.

G. Installation Report: The equipment manufacturer shall also submit a written report stating the equipment:

1. Is properly installed.
2. Is in accurate alignment.
3. Is properly lubricated.
4. Has been tested and operated satisfactorily.

H. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review for all pump equipment. Warranty shall be against mechanical failure due to materials and workmanship or abrasive wear under the original specified operating conditions.

1.5 WARRANTY

A. All equipment furnished shall be warranted per Section 013325. The pump manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship.

B. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of startup, or eighteen (18) months from the date of delivery, unless noted otherwise within the specifications. The warranty shall be in printed form and previously published as the manufacturer's standard warranty for all similar units manufactured, latest revision. Upon warranty occurrence, the manufacturer's authorized service center shall remove the pump, repair, reinstall and provide start up on the repaired pump. A detailed failure analysis shall be submitted to the Owner for their records summarizing corrective action taken.

C. The manufacturer shall guarantee clog-free operation for a period of 24 months from the date of start-up of the pumps by the local authorized factory representative. A certificate shall be provided to the Owner on the day of start up with the local contact information and effective date.

D. The pumps shall be provided with prorated 60 months (5 years) warranty against defects in materials and or workmanship.

E. Any defects found within the warranty period shall be replaced if damaged or defective in the normal use of the equipment at no cost to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 016600, Product Handling and Protection.

B. Handling, delivery, and storage of the equipment shall be in accordance with the Manufacturer's recommendations. No extra cost shall be charged the Owner for the handling, delivery, or storage of the equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturers

1. Flygt
2. KSB
3. Or approved equal.

B. Equipment Schedule is provided at the end of this section.

2.2 PUMP CONSTRUCTION

A. General:

1. Submersible, closed-coupled wastewater pumps.
2. Pumps shall include, but not be limited to all drives, pump bases, pumps, connection discharge, level sensors, minimum 2-inch 316 stainless steel bracket guide rails, 3/16 inch - 316 stainless steel chain, anchor bolts, submersible cable, electrical control panels and other appurtenances as specified or required for a complete installation.
3. The pumping units shall come complete with sliding brackets, motors, guide bars, stainless steel pull chain, power cables and all other necessary appurtenances.
4. Pumps and level control primary instruments shall be easily removable for routine service without the need for personnel to enter the wet well. This shall be accomplished by utilizing a sliding guide bracket attached to the pump and adequately braced; a stainless steel lifting cable provided for each pump; and a specially formed discharge flange that automatically and firmly connect and disconnect with the discharge pipe without bolts, nuts, fasteners, or extreme force.
5. The pumping units shall come complete with, motors, power cables and all other necessary appurtenances to provide a complete operating system.

B. Material of Construction:

1. Pump housing: ASTM A-48, Class 35B
2. Impeller and Insert ring: A 532 ALLOY III A (25% Chrome)
3. Stator housing: ASTM A-48, Class 35B
4. Shaft: ASTM A479 S43100-T
5. Shaft seal: Pump side: - Corrosion resistant Tungsten carbide WCCR

6. Shaft seal Motor side: - Carbon (Csb) -Aluminum oxide (AL2O3)

C. Submersible Motors

1. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. It shall be permanently submersible according to standards IEC 60034 and protection class IP 68.
2. Motor shall not overload for the entire pump curve performance range.
3. The motor shall be capable of no less than 15 evenly spaced starts per hour and be able to operate throughout the entire pump performance curve from shut-off through run-out.
4. The stator windings shall be insulated with moisture resistant Class H insulation rated for 356°F.

D. Mechanical Requirements

1. Bearings and Lubrication
   a. The pump shaft shall rotate on two bearings with a nominal L10 lifetime of 50,000 hours. The upper bearing shall be a single deep groove ball bearing.
   b. The lower bearing shall be a two-row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

2. Shaft Seal: Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring system.
   a. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counterclockwise direction of rotation without damage or loss of seal function.

3. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. Seal lubricant shall be non-hazardous.
   a. Moisture Protection System
      1) One (1) moisture sensing probes are to be provided that extend into the oil chamber located between the outer and inner seal and used t detect the presence of moisture should the outer seal fail, if applicable.
      2) The moisture protection system shall also be designed to detect water in the motor chamber and provide a warning signal prior to water levels reaching the bearing or wound stator assemblies.

4. Guide Bars
   a. It shall be possible to lift and lower the pumps on parallel guide bars and connect them to wet well mounted discharge connection. There shall be no need for personal to enter the wet well when removing or reinstalling the pumps.
   b. Pump and guide rail assemblies shall comply with the requirements for NEC Article 500 Class 1, Div. 1, Groups C and D, hazardous location, explosion-proof service or as listed in the Pump Schedule.

c. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two parallel guide bars extending from the top of the station to the wet well mounted discharge connection. The material of the guide bars shall Stainless steel AISI 316. The guide bars shall be fastened at the top of the station with a guide bar holder made of Stainless steel AISI 316.

5. Discharge Connection
   a. The sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable.
   b. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump/motor unit shall bear on the sump floor directly or on a sump floor mounted stand.
   c. The contractor shall supply and install a discharge connection made of cast iron ASTM A-48, Class 35B.
   d. The outlet flange of the discharge connection shall be drilled according to ANSI B16.1-89.
   e. There shall be no need for personnel to enter the wet-well.

6. Cap/Cable Assembly
   a. The motor shall be equipped with 30 feet of screened cable suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA. The outer jacket of the cable shall be oil resistant chlorinated polyethylene or synthetic rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
   b. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomeric compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.
   c. The motor shall be protected by 3 thermal switches embedded in the stator set to open at 260°F and one leakage sensor floating type located in the stator chamber. The sensor and the switches shall be connected to the control panel which shall stop the motor and send an alarm when the sensors are activated.
   d. The cable entry shall consist of dual cylindrical elastomer sleeves, flanked by washers, all having a close tolerance fit against the cable and the cable entry. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

7. Electrical Requirements
   a. All motors covered by this specification shall conform to the latest applicable requirements of NEMA, IEEE, ANSI and NEC standards.
   b. Motors shall be designed for continuous submerged duty in water and sewage, and minimum 15-minute duty continuous in air under full load operating conditions.
   c. 3-Phase motors shall be rated 460 Volts.
   d. Motor construction shall be designed to withstand 200-psi water pressure at all seal locations.

e. All motors shall be rated as Class H, 1.15 service factor, Class 1, Groups C & D.
f. All motors shall be U.L. (Underwriters Laboratories) or FM approved, and name plated accordingly.
g. The ability to provide any/all replacement parts, engineering design support, complete dynamometer testing, and U/L rerate capability shall be provided domestically.

2.3 ELECTRICAL CONTROLS

A. The Contractor shall furnish all labor, equipment and materials to install pump controls as shown on the Drawings, for operation on a 480 volt, 3 phase, 60 Hertz, 3 wire system.

B. The submersible cable of the pump shall be connected to the cable from the Control panel in a floor or wall mounted cable connection box to ease the installation and disassembling of the pumps and keep the submersible cables as short as possible.

1. The cable connection box shall be submersible NEMA 6P (IP 67) to secure that no water can enter the motor via the cables even when the complete area is flooded.

C. The pumps shall be fed and controlled from the local control panel, provided with control circuit transformers with disconnects and overload protection in NEMA 4X stainless steel enclosure.

D. Local control stations shall be provided by the pump supplier as specified herein, per Specifications Divisions 26 and 40 and Contract Drawings.

E. The local control panel shall include: a combination circuit breaker/overload unit providing overload protection, short circuit protection, manual reset; across-the-line magnetic contactor or VFD as shown on the Drawings; hand/off/automatic pump operation selector switch; necessary auxiliary isolated contacts for computer/SCADA system interface; pump running pilot lights; running time meters; motor monitoring relays as required to interface with the sensors/detectors mounted at the motor.

F. The following control components shall be provided:

1. Alarm indication of max. 20 alarms
2. Level indicator, continuously
3. Current display with target / actual value
4. Operating hour display and start counter
5. Level control start and stop
6. Random starting range
7. Run out time with automatic adjustment to the operating conditions.
8. Dry run protection for starting and run out.
9. Operation time 0-60 min, adjustable
10. Delayed start after power failure
11. Protection circuit according to ATEX 95 directive,
12. Diagnostic Tool
13. Data loss protection in case of power failure
14. Hand-off button
15. Keypad and display

16. LED lamps for mains voltage, operation / fault / pump blocked, Motor contactor, 3-pole, with auxiliary contact, for the direct start, made-changeable
17. Phase sequence indicator
18. Phase failure monitoring (3 phase),
19. Potential free signals that can be used together with different Monitoring and control systems.

2.4 ACCESSORIES

A. All accessories shall be provided as shown on the Drawings and specified herein.

B. Ultrasonic Level Sensor:

1. CSA approved according to Class I Zone 0, Gr. IIC and Div.1 Gr A, B, C&D
2. Material of casing: Polypropylene.
3. Degree of protection: NEMA 6.
4. They shall be applicable for liquids with a density of 0.95 – 1.10 g/cm3. The Level control shall include 40 feet submersible cable.
5. Equipped with 4-20 mA signal.
6. Contractor shall provide readout and cabling to Control Panel per Division 26.
7. Manufacturer: Flowserve, Rosemount Instruments Inc., Kobold Instruments Inc., IFM Efector, or approved equal.

C. Provide a float-based level system to serve as a back-up control at High-Level Alarm and Low-Level Alarm to initiate pump “Stop”, as shown on the drawings.

1. Float switches shall be mercury switches hermetically sealed within the float suspended with 2-conductor immersion-rated control cable with cast iron weight affixed to cable above the float. Switch contacts shall be used in pilot-control circuits and be rated 12 amps at 115- or 230-volt AC.
2. Float switches shall be attached to a weighted stainless steel chain which will be fastened to a stainless steel eye bolt accessible from the top of the wet well without entering the wet well for removal.

D. For each pump the contractor shall supply and install a chain/cable holder made with 4 hooks of Stainless steel AISI 316.

E. Each pump shall be fitted with 35 feet of stainless steel lifting chain. The working load of the lifting system shall be 50% greater than the pump unit weight.

F. Contractor shall furnish stainless steel anchor bolts with nuts and washers, as recommended by pump manufacturer.

G. All machine bolts, nuts and cap screws shall be of the hex head type. Hardware or parts requiring special tools or wrenches shall not be used.

2.5 SHOP PAINTING

A. All surfaces shall be thoroughly cleaned of dirt, grease, oil, rust, scale, or other injurious substances. All metal surfaces shall be sandblasted in accordance with SSPC-SP10, Near-White Blast Cleaning.

B. All metal surfaces which shall be partially or wholly submerged shall receive a shop coat with two-pack Oxirane Ester paint, Duasolid 50. The total layer thickness should be at least 120 microns. Zink dust primer shall not be used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with Contract Drawings and manufacturer's shop drawings, instructions, and recommendations.

B. The manufacturer shall provide installation assistance and certification as required for proper installation prior to start-up.

3.2 INITIAL LUBRICATION

A. Initial lubrication required for startup and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.3 INSPECTION, STARTUP, AND TESTING

A. The manufacturer shall furnish the services of a qualified representative for a period of not one (1) work-day to inspect, make final adjustments, supervise initial startup of each pump.

B. This qualified representative shall also conduct tests as necessary to demonstrate satisfactory operation and to instruct the Owner's personnel in the care and operation of the equipment.

C. The representative shall complete a start-up report for the Owner before final acceptance of the pumps.

D. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.

E. For the purposes of this section, a work-day is defined as an eight hour period at the Site, excluding travel time.

3.4 PUMP TEST

A. Unless otherwise noted, certified performance data based upon tests of each actual pump proposed to be furnished shall be submitted to the Engineer for acceptance. Tests shall be performed in accordance with the Test Code of the Hydraulic Institute Standards and shall demonstrate compliance with the operating conditions specified.

3.5 MOTOR TEST

A. Tests shall be performed in accordance with the American Standard Test Code.

B. Short commercial test: For motors of less than 25 Hp, a certified report of the short commercial test of each actual motor proposed to be furnished shall be submitted to the Engineer for acceptance.

C. Complete Test: For motors of 25 Hp and greater, certified motor efficiency curve at 100, 75, and 50 percent of full load based upon a complete test of a motor of identical design specifications to the motor proposed to be furnished shall be submitted.

3.6 OPERATION AND MAINTENANE MANUALS

A. Operation and maintenance (O&M) manuals shall be provided prior to or with the delivery of the equipment. The O & M manuals shall include instructions on storage, installation, start-up, and operation and maintenance, together with a complete parts list and a recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

3.7 PUMP SCHEDULE

A. Filtrate Pump Station

Type of Pump	Submersible
Pump Rating	Unclassified
Number of pumps installed	1
Pumped Liquid	Filtrate/Supernatant/Drain
Design Capacity (each)	90 gpm
TDH	44 ft
Max. Motor Size	5 HP
Min. Efficiency at Pump Design Capacity	62 %
Max Motor Speed	1800 rpm, VFD
Power Requirements	460 V, 3 ph, 60 Hz
Discharge Size	3”

END OF SECTION 432513

SSSECTION 461211 – SCREW SHAFTLESS CONVEYOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary conditions, Division-1 Specifications sections, and all Specification Sections apply to work of this section.

B. The following equipment and related work are specified and furnished under other items:

1. Section 030000 – Concrete Work
2. Section 055800 – Metal Fabrications
3. Division 26 – Electrical
4. Section 467331 – Sludge Dewatering, Section

1.2 SUMMARY

A. The Contractor shall provide two (2) shaftless screw conveyor for the conveyance of dewatered sludge to sludge drying bed as shown on the plans. The unit will receive dewatered sludge, conveying it to sludge drying bed without spillage or carryback of material. The length of the sections of the conveyor, and the angle of the inclined section, is shown in Schedule 461211 – A. The exact final dimensions to be determined by the Contractor to suit the dewatering equipment and the conveyor system to be used, as well as the plant layout.

B. Screw Conveyors with shafts and intermediate hanger bearings will not be acceptable for this project.

C. Furnish equipment complete with all supports for the horizontal and incline conveyors; all mechanical equipment required for proper operation, including complete drive units; control panel, all steel and other metal construction specified herein; and all additional materials or fabrication as required by the supplier's design.

D. The contractor is responsible for coordination of all mechanical & electrical equipment, and structural interconnecting or otherwise interfacing with the conveyor and any site measurements required for a detailed conveyor submittal.

1.3 PERFORMANCE REQUIREMENTS

A. The shaftless screw conveyor shall meet the performance and design requirements as listed in Schedule 461211 – A. Conveyor selection design standards to be based on the operational experience of the manufacturer with shaftless screw conveyors.

B. Conveyor rotational speeds shall not be greater than herein specified unless availability of the reducer ratio requires slight adjustment (±3 rpm) or if shown by the conveyor manufacturer calculations to be required to meet design load. Deviations from specified speed cannot be utilized to reduce the conveyor trough and spiral size. Faster speeds are utilized to prevent the fluidization or apparent thinning when conveying dewatered sludge.

1.4 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.

B. Product Data:

1. Submit Manufacturer's literature, warranty technical data and installation instruction complete with accessories, catalog cuts, drawings, specifications, fabrication details and parts identification for all work of this Section.
2. Torque calculations for the gear reducer and reducer motor.
3. Horsepower calculation for the drive motors.
4. Manufacturer's certification, signed by a corporate officer, informing that the proposed equipment fully complies with requirements of this specification.
5. Motor characteristics and performance information.
6. Gear reducer data including service factor, efficiency and materials.
7. Parts list including a list of recommended spare parts.

C. Shop Drawings:

1. Manufacturer's installation drawings. Dimension drawings depicting all mechanical and electrical equipment dimensions and required clearances.
2. General arrangement drawings for the proposed equipment.
3. Submit support locations and loads to Engineer with shop drawing for review.
4. Submit proposed hanger support locations referenced from the steel columns of the Cake Loading Building and dead and live loads at each point.
5. Cut sheets for electric motors and auxiliary items.
6. Complete schematic diagrams for electrical control panels.

D. Maintenance and Operating Instructions: Maintenance and Operation manuals shall completely describe operation of the shaftless screw conveyor, start-up, optimization and maintenance operations for the equipment to be furnished under this section.

1. Recommendations for short- and long-term storage.
2. Detailed installation instructions, with clear step-by-step points on the correct mechanical and electrical installation procedures.
3. Explanation of operating safety considerations
4. Trouble shooting instructions.
5. Electrical diagram.
6. Manufacturer's warranty.
7. Repair parts and maintenance material.

1.5 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with Manufacturer's instructions and recommendations for work.

B. The shaftless screw conveyor shall be manufactured of the best quality material and workmanship.

C. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and the satisfactory operation of the system.

D. Provide evidence of at least fifteen (15) years demonstrable experience in the design and manufacture of shaftless conveyor systems. The Supplier shall have at least twenty-five (25) full-

scale shaftless conveyor systems operating successfully for at least five (5) years in North America at municipal wastewater treatment plants.

E. Any shaftless screw conveyor proposed as an "or equal" design will be subject to the Consulting Engineer's approval. If such approval is granted, the Contractor and conveyor Manufacturer will nonetheless be responsible for the resolution of any technical problems arising from the use of the "or equal" design.

1.6 WARRANTY

A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after the equipment was first placed into operation at the jobsite or eighteen (18) months after the equipment was first delivered to site, whichever date occurs first. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

B. The shaftless screw liner and spiral shall be warranted for a period of three years from factory start-up against wear.

C. Liner: For a wear indicator (two colors) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30% of the conveyor length during the first three years of service. If these wear indications occur the conveyor supplier shall provide new formed and banded liner to replace all the liner in the conveyor that has excessive wear.

1. Screw: Excessive wear on the screw shall be indicated by loss of more than 50% of the height of the main outer screw section over 30% of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw to replace the screw in the conveyor that has excessive wear.

1.7 JOB CONDITIONS

A. To be delivered in assembled match-marked sections ready for final installation, without the need for field welding. Knocked-down kits of parts will not be acceptable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The system shall be of the shaftless screw conveyors:

1. Spirac USA, Inc., Newnan, Georgia
2. Keystone Conveyor Corporation
3. MLM Conveying Systems, Inc.
4. Esmil Corporation.
5. Or approved equal.

2.2 MATERIALS

A. Materials used in the fabrication of the equipment under this section shall conform to the Schedule 11312-A:

1. Chutes, Troughs, End Plates: AISI 304 stainless steel Covers, Hoppers & Supports

2.	Spiral Flighting:	Special Chrome-Alloy Steel w/minimum 225 Brinell Hardness
3.	Wear Liner:	UHMW Polyethylene, Duraflo® SPX™
4.	Hardware:	AISI 304 stainless steel

2.3 FABRICATION

A. The shaftless screw conveyor equipment shall include the following:

1. Troughs, Liners & Covers
2. Spiral Flighting
3. Chutes
4. End Shaft
5. Electric Motor & Gear Reducer
6. Mounting and Support Structure
7. Electrical Control Panel
8. Safety Accessories
9. Spare Parts

B. All welds to be continuous unless otherwise specified. Facing surfaces of field-welded components shall be beveled and match marked.

C. Sharp corners of all cut and sheared edges shall be made smooth by edge grinding.

2.4 POWER SUPPLY

A. All electrical equipment shall conform to applicable standard of the National Electrical Manufactures Association (NEMA) and the National Electrical Code (NEC). Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

B. Power supply to the equipment shall be 460 volts, 60 Hz, 3 ph.

C. Power supply for electrical controls shall be 24V DC or 120 volts, 60 Hz, single phase.

2.5 DRIVE UNITS

A. Each spiral conveyor shall be driven by a constant-speed gear reducer motor drive unit mounted to a bellhousing adapter flange mounted to the end plate of the conveyor.

B. The adapter flange shall allow the leakage of any material from the conveyor trough to atmosphere rather than into the gear reducer/ motor drive unit. Direct coupling of the gear reducer/motor drive unit to the end flange of the conveyor will not be acceptable.

C. The drive unit shall be rigidly supported so there is no visible "wobble" movement under any operating condition. In the event of a prolonged power failure or emergency system shutdown the drive system shall be designed, at a minimum, to start the conveyor from a dead stop with the trough filled at 2 times the design load for loads designed up to 67% fill rate and 1.5 times for loads designed exceeding 67% fill rate.

D. All motors shall be of energy efficient design meeting or exceeding NEMA MG1- table 12-10 and EP Act guidelines. The motors shall be 460-volt, 60 Hz, 3 phase conforming to the General Equipment

specifications, except as modified herein. Each motor shall be 40°C ambient rated, 3300 feet (1000m) altitude or lower operation, with a maximum temperature rise of 80 degree C by resistance at 1.0 service factor (95 degree C rise at 1.15 s.f.). The motors have Class B insulation with Design B speed/torque characteristics in accordance with NEMA MG1-12.35 and 12.38, and be C face type, with NEMA frame sizes.

E. Motors shall have a 1.15 service factor and a TEFC enclosure.

F. Gear Reducers

1. All gears shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have an AFBMA B-10 life of 30,000 hours.

2. The reducer will be air-cooled unit with no auxiliary cooling requirement. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

2.6 LOCAL CONTROL PANEL

A. All local electrical controls shall be furnished by the manufacturer of the conveyor system and conform to the provisions, National Electric Code.

B. All enclosures shall be NEMA 4X stainless steel or composite material as per Section 407000 with latches (no screws). All hardware on the enclosures, hinges, pins, clamps, nuts, bolts, washers, etc., shall be stainless steel. Enclosure doors shall be hinged with print pocket.

C. Local Control Panel shall be equipped with:

1. Hand-Off/Reset-Auto (HOA) selector switch
2. Emergency acknowledgement button; emergency indicator and sound horn.

D. Motion Failure Alarm Unit: An external conveyor mounted motion failure alarm; (alternately known as "zero speed" or "under-speed" switch) to detect spiral or drive shaft failure shall be utilized in this design. SITRANS WM100 with a NEMA 4 enclosure.

E. Emergency Shutdown: Each conveyor shall be furnished with an emergency trip cord and safety switch. The cord shall run the full length of each conveyor. The trip switch shall immediately stop all conveyors when the switch is actuated. The switch shall be RS type by Conveyor Components Corporation or approved equal. Provide hook stick for emergency trip cord operation for the conveyors 03-06.

F. Components:

1. Local Control Panel shall be NEMA 4X stainless steel.
2. Enclosure shall house the control devices, relays and terminal blocks.
3. Pilot devices shall be mounted on the enclosure front panel.
4. Conveyor drive motors will be controlled bythe VFD to be provided by the equipment supplier.
5. Two contacts shall be provided one for a RUN signal and one for FAIL signal. The contacts shall be rated at 2-AMPS, 120VAC, and resistive load.
6. Interlocks for control by the Screw Press Control panel shall be hardwired to the associated screw conveyor control panel.

2.7 SURFACE PREPARATION

A. All iron and mild steel surfaces to be painted shall be dry abrasive blasted in accordance with SSPC-SP6, and in accordance with the painting Section 09801. Surfaces shall be painted or hot dip galvanized within 24 hours to prevent rusting and surface discoloration.

B. All carbon steel frame and support members shall be prepared with a commercial sandblast (SSPC-SP6) and be finished with a two-part epoxy paint system.

C. Stainless steel shall be cleaned with mild abrasive wheels and/or nonferrous blast media to remove heavy scale and welding carbon and/or pickled and passivated with stainless steel cleaner then rinsed.

D. After surface preparation, ferrous metal surfaces, if any, except for the spiral flighting shall receive a minimum of one (1) coat of epoxy primer. Provide a total minimum dry film thickness of 3 mils prior to shipment to jobsite. Primer shall be compatible with the paint system specified for the equipment under "Painting" section of these specifications. Finish coats shall be applied at the jobsite by the General Contractor, per Specification 09801 requirements.

1. The spiral shall be furnished with one coat of shop primer only.
2. Electric motors, gear reducers, electrical control panels, and other purchased sub-components shall be furnished with the manufacturer's standard finish.
3. Stainless steel surfaces do not require painting.

2.8 SPIRAL

A. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.

B. Spiral flights shall be cold-formed high strength chrome alloy steel with a minimum hardness of 225 Brinell. The spiral flights shall be designed with adequate stability to prevent distortion and jumping in the trough. A second, inner spiral, concentric with the outside spiral shall also be provided. The torsional rating of the auger flighting shall exceed the torque rating of the drive motor at 150% of its nameplate horsepower. The "spring effect" of the spiral shall not exceed + 1.0 mm per 100 mm of length at maximum load conditions. The minimum outer spiral thickness shall be 0.75" for spiral diameters up to 9" and 1" for spirals diameters exceeding 9".

C. The spiral flighting shall be formed in sections from one continuous flat bar and shall be concentric to within $\pm$2mm. Sectional flighting formed from plate shall not be permitted.

D. Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled in the field and shall be made in accordance with the supplier's requirements. The spiral flights shall be coupled to the end shaft by a flanged, bolted connection.

E. Sectional flighting made from flat plates will not be acceptable.

F. Field welds at the jobsite by the Contractor for installation may be necessary when any overall conveyor length presents shipping or handling constraints.

2.9 SPIRAL MOUNTING

A. A gland packing ring consisting of two Teflon fiber packing rings shall seal the drive shaft at its penetration through the end plate, along with a greased labyrinth sealing system.

B. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating flange and shall be bolted to the spiral connection plate. Additionally, a grease lubricated labyrinth seal shall be shaft mounted internally in the conveyor between the back plate and spiral coupling connection.

2.10 HORIZONTAL AND INCLINED TROUGHS

A. Troughs shall be U-shaped and similar to the dimensional standards of CEMA 350 and enclosure classification IIE.

1. A flanged drain outlet shall be provided with each conveyor to facilitate cleaning if required by contract drawings. The drain outlet shall be piped to a drain as shown on the drawings, with adequate cleaning facilities. Drain flushing connections are to be provided if and where specified by the contract drawings. The Contractor shall furnish all labor and materials to connect the conveyor flush water and/or drains with the plant water and drain system.
2. Each trough shall be equipped with inlet and/or discharge openings as shown on the contract drawings. If required, each inlet and discharge opening shall be flanged suitable for interconnection to other devices. Any interconnecting devices such as chutes and hoppers shall be fabricated from the same grade of material as the troughs and with a gauge thickness to suit the application requirements.

B. Bolted covers shall be furnished for any portion of each trough that is not covered by the filling chute. Covers shall be manufactured in maximum five (5) foot length section to allow for easy access and ease of liner replacement. To prevent unsafe access to the conveyors, quick opening covers will not be allowed unless they are equipped with cover sensor to prevent access during operation. Each conveyor shall be fixed with the appropriate warning labels to call for lock out – tag out of the electrical system before the covers are removed. If required, inspection hatches or sample ports with finger guards will be supplied as indicated on the contract drawings.

C. In order to avoid excessive wear and increased maintenance the conveyors shall be designed without the use of steel hold down bars. Proprietary hold-down guide liners mounted under the lids will be accepted that do not interfere with the flow of conveyed product.

D. The conveyor system Manufacturer shall design Conveyor and supports to be self-supporting at the span to supports interior of the Sludge Processing Building and Sludge Loadout Building. The beams or truss-like structure supporting the conveyor at the span between the buildings and shall be designed and mounted to the conveyor to maximize clearance beneath the conveyor and shall not prevent conveyor access for inspection or liner replacement.

E. The horizontal distributional conveyor shall be provided with bi-directional and e two discharge shoots on opposite ends of the conveyor as shown on the drawings.

2.11 WEAR LINERS

A. Liner - The inside trough surfaces of the conveyors shall be lined with a layer of ultra-high molecular weight polyethylene UHMW-PE. The wear liner shall be SPIRAC Duraflo SPX or Xylethon by Durawear. The liner shall be a single piece, formed and bonded with two (2) layers of the same material, each

of a different color, to provide a visible indication when the liner is nearing the end of its useful life. Liners with a second layer of different material are not acceptable. The liner shall be supplied in maximum 3.3 foot long sections to provide ease of replacement. The liner shall be held in place with stainless steel clips; no fasteners will be allowed. Liner thickness shall be at a minimum 3/8" for vertical conveyors; 1/2" thick for spirals up to 14" diameter, and 5/8" thick for larger spirals. Liners less than the specified minimum thickness and molecular weight shall not be acceptable.

B. The liner material shall have the following physical properties, as a minimum:

Property	Value/Unit	Testing Method
Density	61.2 lbs/ft^3	DIN53479
Molecular Weight	9.2x10^6 g/mol	Margolies
Ball Indentation Hardness	5,946 lbs/in^2	DIN53456
Shore Hardness D	64	DIN53505
Crystalline Melting Range	278^o F	-
Dynamic Coefficient of friction	0.1-0.12 ratio of tension/load	Plastic to steel

2.12 CONVEYOR SUPPORTS

A. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the contract drawings and as required by the supplier's design of 304 stainless steel structural angle, minimum 0.25" thick. The supports shall be shop fabricated from stainless steel shapes and plates and shall be assembled and fitted to the conveyor prior to its delivery to the jobsite. Supports and conveyor segments shall be match marked and shipped to the jobsite for assembly and installation by the Contractor. The manufacturer shall allow for 1 inch of grout beneath each support foot pad for the Contractor to compensate for uneven floor elevation. At a minimum, each conveyor shall be provided with supports at the inlet and discharge end, with intermediate supports as required.

B. All shop welding shall conform to the latest standards of the American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports.

C. All hanging supports furnished by the conveyor manufacturer shall be one (1) foot longer than required for field fit by the Contractor, who shall supply connections approved by the Engineer. The Contractor shall be responsible for all fasteners both for hanging and floor anchors.

2.13 HOPPERS, DISCHARGE CHUTES AND GATES

A. Furnish inlet and discharge hoppers of the same gauge and construction material as the conveyor troughs, at locations as shown on the drawings. Flanges shall be a minimum 5 mm thick.

1. A 10-gauge galvanized steel chute shall be located at the discharge end of the conveyor to direct the flow of material from the conveyor to the desired destination. The chute shall be designed so as to prevent the build-up of material on its interior surfaces.

2.14 SPARE PARTS

A. Furnish the following spare parts (if applicable to scope of supply) as a minimum:

1. One (1) Packing gland set, for each conveyor supplied.

B. All spare parts shall be boxed in substantial wooden crates for storage.

2.15 LUBRICANTS

A. Furnish lubricants of the type and quantity as recommended by the conveyor manufacturer for (start-up) operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The conveyor shall be delivered by the Manufacturer in fully assembled and complete with hardware and instructions, with exception to the spiral splices. Assembly shall consist only of joining the sections anchoring the supports, installing the bolt, and electrical hookup.

B. Install equipment in accordance with reviewed Shop Drawings, and manufacturer's instructions, as specified herein and shown on Contract Drawings.

C. Initial lubrication required for start-up and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

A. The conveyor system supplier shall furnish the services at site of a factory-trained representative for a period of two (2) days in no more than one (1) trip to the jobsite. Service shall be provided as necessary after the Contractor has installed the equipment. These services shall be furnished for the purposes of:

1. The equipment manufacturer’s inspection of the equipment following installation by others, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner’s personnel in the operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.
2. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
3. For the purposes of this section, a work-day is defined as an eight hour period at the Site, excluding travel time.

B. After inspection of the installed equipment the Supplier shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

3.3 DEMONSTRATION AND INSTRUCTIONS

A. Provide the services of a qualified factory-trained manufacturer’s representative to conduct training covering operation, mechanical maintenance and electrical requirements.

3.4 SHAFTLESS SCREW CONVEYOR SCHEDULE

SCHEDULE 461211 – A

Location	Sludge Dewatering Building

Type	Horizontal	Incline	Horizontal, Bi-directional
Trough length	As shown on the Drawings	As shown on the Drawings	As shown on the Drawings
Inlet QTY	1	1	1
Outlet Qty	1	1	2
Trough Material &Thickness	304 SS,10 ga	304 SS,10 ga	304 SS,10 ga
Lid Material &Thickness	304 SS,12 ga	304 SS,12 ga	304 SS,12 ga
Lid Type / Length	Bolted / 5ft max	Bolted / 5ft max	Bolted / 5ft max
Liner Type	UHMW-PE	UHMW-PE	UHMW-PE
Liner Thickness	3/8 in	3/8 in	3/8 in
Conveyor Length	As shown on the Drawings	As shown on the Drawings	As shown on the Drawings
Angle of Inclination	-	max 35°, as show on the Drawings	As shown on the Drawings'-
Conveyed Material	14-20% dry solids		
Vol. Flowrate (ft^3/hr) (lbs/hr)	113 7100±	113 7100±	113 7100±
Fill Factor	50	50	50
Spiral Type	AB	AB	AB
Spiral Material	HTMAS	HTMAS	HTMAS
RPM	To Be Provided	To Be Provided	To Be Provide
Drive Type	Helical Gear	Helical Gear	Helical Gear
Max. Motor hp	3	3	3
Power Supply	460V / 3ph / 60 Hz	460V / 3ph / 60 Hz	460V / 3ph / 60 Hz
Transport Direction	Push	Push	Reversible

END OF SECTION 461211

SECTION 463333 – POLYMER BLENDING AND FEED EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. The following equipment and related work are specified and furnished under other items:
1. Section 030000 – Concrete
2. Section 055800 – Metal Fabrications
3. Division 26 – Electrical
4. Section 467331 – Sludge Dewatering

1.2 SUMMARY

A. This section includes furnishing, installing, and placing into successful operation one (1) complete polymer blending system with progressive cavity pump, motors and controls, including all integral piping, valves, fitting, pipe supports, special equipment and appurtenances in accordance with this specification, including all incidental work necessary to make it complete, satisfactory and ready for operation.

B. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution.

C. Polymer blending system shall operate in conjunction with sludge dewatering equipment as specified in Section 467331– Multi-Disc Screw Press. All equipment shall be delivered as part of the complete dewatering skid mounted system.

1.3 SYSTEM DESCRIPTION

A. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution ranging from 0.1 to 2% concentration based on neat emulsion polymer with active contents of 30-50%.

B. Design Requirements for the Polymer Feed System:
1. Polymer shall be drawn from a tote located next to polymer feed system, as shown on the Drawings.
2. Polymer Type: Emulsion.
3. Polymer Activity (percent active): 30 to 50.
4. Solution Concentration Range: 0.1% to 2% based on neat polymer.
5. Solution Concentration Design Point: 0.5% based on neat polymer.

Neat Polymer Flow Range gph	Dilution Water Range gph
0.5–10	120–1200

C. Performance Requirements: Polymer Feed System shall be capable of supplying between 0.5 and 10 gallons per hour liquid emulsion polymer, with the entire flow passing through the preparation unit. Following preparation and mixing, the polymer solution leaving the mixer shall be ready to feed the dewatering volute press unit.

1.4 SUBMITTALS

A. Product Data: Provide unit capacities, projected effluent values, loading parameters, design parameters, oxygen requirements, dimensions, etc.

B. Shop Drawings:
1. Submit detailed specifications and shop drawings with both shaded isometric and orthogonal views of the proposed system, including dimensions and weights.
2. Submit wiring, control schematics, and control logic diagrams for all electrical and control components furnished.
3. Factory testing documentation.

C. Provide detailed Operations and Maintenance Manuals including storage, installation start- up and operating instructions. Provide safety precautions and warnings of all hazards operating equipment.

1.5 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with Manufacturer's instructions and recommendations for work.

B. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and the satisfactory operation of the system.

C. Provide evidence of at least fifteen (15) years demonstrable experience in the design and manufacture of polymer blending systems. The Supplier shall have at least twenty-five (25) polymer feed systems operating successfully for at least five (5) years in North America at municipal wastewater treatment plants that were designed and furnished under the Supplier’s own name.

D. Prior shipment the system shall be inspected for quality of construction verifying all fasteners and fittings are tight, all wires are secure and connections whisker-free.

E. The complete system shall be fully factory tested prior to shipment. Testing shall include setting and verification of all instrumentation and sensors per the design requirements of the application; pressure testing all plumbing systems for a minimum of one hour at 100 psi. If leaks are found they shall be fixed and a new test shall be conducted for one hour at 100 psi until the plumbing system is verified to be leak free: verification of system design flow rates, and complete function simulation of operation.

1.6 DELIVERY AND STORAGE

A. The equipment shall be shipped in a new, high quality completely enclosed weatherproof wooden create.

B. The crate shall include a shock sensor to warn of equipment mishandling during shipment.

1.7 WARRANTY

A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after the equipment was first placed into operation at the jobsite or eighteen (18) months after the equipment was first delivered to site, whichever date occurs first. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

B. The mixing chamber shall be warranted for the life of the system against plugging for any reason.

1.8 SPARE PARTS

A. Provide the following Spare Parts:
   1. One (1) progressive cavity pump stator
   2. One (1) progressive cavity pump shaft seal

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. VeloDyne – Velocity Dynamics of Louisville, CO
   2. Or approved equal

B. This listed equipment is part of the Base Bid and shall be considered as establishing the type, function, appearance, and quality required as defined in the General Conditions

C. The drawings and specifications were prepared based on Velodyne. CONTRACTOR shall include in the Bid and shall be responsible for the cost of any changes, including engineering changes, to accommodate the other Base Bid equipment including but not limited to structural, mechanical, and electrical work.

D. CONTRACTOR may provide Alternative Bids for equipment from other manufacturers by writing their name into the blank(s) provided on the Bid form. CONTRACTOR shall comply with all provisions regarding substitute items and shall include in the Bid and be responsible for the cost of any changes to accommodate substitute equipment including, but not limited to, structural, mechanical, and electrical work. CONTRACTOR shall also pay costs of engineering services for review of substitutes and for revisions of drawings and/or specifications by ENGINEER to accommodate substitutes.

2.2 EQUIPMENT PERFORMANCE

A. The polymer-blending system shall be a complete package that automatically dilutes, activates and feeds liquid polymer and water. Blenders shall instantaneously invert neat polymer into solution, producing a thoroughly diluted and completed activated homogenous blend, free of "fish-eyes" and unblended polymer.

B. The polymer blending and feed equipment shall be provided to meet the following performance and design requirements:
   1. Polymer Type: Liquid emulsion (30-75 percent active)

2. Neat Polymer Feed Rate: 0.5 to 10 gph
3. Diluted Polymer Concentration: 0.1-1% of Total Active
4. Dilution Water Flow Range: 120-1200 gph at 50 psi minimum.

2.3 MULTIZONE MIXING CHAMBER

A. To provide control and versatility to optimize the performance of the wide range of polymers available and to optimize system reliability, a multi-stage hydro-mechanical polymer blending technology shall be provided with both a non-mechanical and mechanical mixing stage:

1. Non-Mechanical Stage: To optimize reliability, the device shall be capable of activating and blending polymer based on plant water pressure alone of 30 psi or greater. Polymer shall be injected directly into a water jet by means of an injection quill positioned such that the non-mechanical mixing energy is no way diminished prior to polymer and water contact. The non-mechanical zone shall be designed such that the velocity of the mixing energy-producing water jet is maintained or increases as flow decreases. Polymer activation efficiency shall be consistent over the dilution water range.
2. Hydro-Mechanical Mixing Stage: To provide optimal polymer performance under all operating conditions and to provide total control over mixing energy, in addition to the non-mechanical mixing stage the device shall be capable of producing its mixing energy independent of plant water pressure though a variable intensity, controllable stainless steel hydro-mechanical mixer. The mixing impeller shall be fully controllable and capable of inducing ultra-high, non-damaging recirculation through the impeller. The polymer mixing impeller shall be designed to produce both axial and radial flow to optimize mixing effectiveness and to effectively induce high, non-damaging mixing energy over the systems full flow range.

3. To prevent polymer build-up, the mixing chamber shall maintain high velocity in the entire chamber – at no time shall there be low velocity within any portion of the mixing chamber.

B. Both mechanical and non-mechanical mixing zones shall be clear polycarbonate to view the mixing action and blending effectiveness. Acrylic chambers prone to becoming brittle over time and cracking, or opaque pipe shall not be acceptable.

C. The mixing chamber shall have a maximum rated pressure of 100 psi. Provide a 316 stainless steel, adjustable-range pressure relief valve on mixing chamber set at 75 psi.

D. Impeller shall be driven by a 0.5-hp, 90-volt DC, 5.0 FLA, washdown-duty, TENV motor. Impeller speed shall be minimum 1,750 rpm. Motor shall be direct coupled to impeller shaft. The speed of the mixer shall be controlled by an SCR speed controller mounted in the polymer feed motor control panel. Motors mounted under the mixing chamber where seal failure or leaks can damage the motor shall not be acceptable.

E. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flush. A drain port behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. All bearings shall be external from the mixing chamber.

F. Neat Polymer Check Valve: Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. Minimum area to valve seat shall be 3/16 inch. The valve body shall be constructed of Teflon with Viton seals, and the ball shall be stainless steel. The valve shall be readily

accessible for cleaning and shall be easily disassembled. Conventional check valves and/or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.

G. Dilution Water Control
   1. If Manufacturer requires two-stream dilution control, dilution water shall be split into two streams. Primary water flow shall supply the mixing chamber. Secondary water flow shall be used to post dilute the activated polymer stream.
   2. Flow indicators and flow control valves shall be provided for the dilution water stream:
      a. The dilution water flow rate shall be monitored by a Rotameter flow meter having the range of 120-1200 gph. Unions of flanges shall be provided on the flow meter to allow easy removal for cleaning.
   3. Provide a factory installed and pre-wired 120 VAC electric solenoid valve for on/off control of dilution water flow. Solenoid valve body shall be 316L SS.
   4. A differential pressure type low water differential pressure alarm with 120-volt rated contacts shall be provided. The switch shall be adjustable between 9 and 60 psig. Static working pressure, shall be at least 150 psi. The pressure switch shall be as manufactured by Ashcroft, or equal.
   5. Dilution water and solution output connections shall be 316 stainless steel unions connected to chassis.

2.4 DILUTION WATER INLET MANIFOLD

A. The dilution water inlet assembly shall include an inlet fitting, a factory installed and pre- wired 120 VAC, NEMA 4X dilution water solenoid valve, Rotameter-type flow meter, stainless steel liquid-filled dilution water inlet pressure gauge, and 316L stainless steel water control valves. Plastic control valves shall not be acceptable. Manufacturer shall provide valves in accordance with Division 40.

2.5 NEAT POLYMER METERING PUMP (PROGRESSING CAVITY)

A. The system shall have one (1) neat polymer metering pump integrally mounted on the system's skid.
   1. The neat polymer metering pump shall be progressing cavity-type pump, constructed of 316 stainless steel rotor and fluoroelastomer stator. The sft seal shall be a lip seal type riding on a ceramic sleeve.
   2. The pump shall have a minimum continuous output range of 0.5 to 10 gph.
   3. The pump shall contain a minimum of four stages to minimize slip.
   4. The pump shall be mounted to the skid frame with a 304 stainless steel bracket that positions the pump suction no more than 18 inches off the base to maintain ideal pump suction conditions.
   5. A 120VAC SCR variable speed controller with 90-vold DC, 5.0 FLA, 1/2 HP close-coupled, washdown-duty, TENV motor. Maximum pump shaft speed shall be 545 rpm. The speed of the pump shall be controlled by a SCR speed controller mounted in the polymer feed motor control panel.

B. Provide a calibration cylinder with one full port PVC ball valves having Viton O-rings. The column shall be calibrated for a one-minute draw-down at maximum pump rate and read in GPH and milliliters. The calibration column shall be rigidly mounted to the systems frame with a minimum of two heavy duty brackets. Mounting the calibration to the neat polymer inlet piping shall not be acceptable. Provide a breather plug in the top of the calibration column designed to allow

adequate displacement of air during calibration while preventing water or other foreign material from entering the calibration column.

C. Provide a thermal type loss of polymer flow sensor.

D. Pump shall be Moyno Industrial Products, a Division of Robbins & Meyers, Inc., Seepex, or equal.

E. Pump shall allow for manual adjustment of the pumping capacity.

F. Provide a factory installed and pre-wired high-pressure switch on the discharge of the pump. Pressure switch shall be Square D Type GAW, or equal. High pressure setting shall be set by manufacturer. The high discharge pressure switch shall shut down the pump in the event of high discharge pressure (On and Remote modes). Manual reset shall be required to restart the pump.

G. Spare Parts:
   1. The following spare parts shall be supplied for the progressive cavity pump:
      a. One (1) Stator
      b. One (1) Rotor
   2. These parts shall be identified, prepared, and packed for long-term storage.

2.6 SOLUTION DISCHARGE ASSEMBLY

A. Provide a 2-1/2-inch stainless steel liquid filled pressure gauge to monitor system discharge pressure.

B. Provide a PVC ball-type check valve to prevent backflow. Valve shall be sized for total solution flow of the system.

2.7 FRAME/SKID

A. The system's frame shall be of rugged 304 stainless steel construction. All pipe supports shall be stainless steel. Piping and valves shall be mounted with rigid pipe clamps.

B. All components of each dilution/feed assembly, including pump, drive, control devices and instruments, and local control panel shall be factory pre-plumbed and pre-wired.

2.8 CONTROL PANEL

A. All equipment and controls specified to be furnished with the equipment shall comply with the requirements of Division 26.

B. Provide a NEMA 4X, FRP control panel factory mounted to the polymer system skid and pre-wired to all skid motors and controls. The control panel shall have all logic controllers, SCR motor controllers, digital displays, potentiometers, switches, lights, relays, and other control devices as required for a functioning system.

C. Polymer system control panel shall have the following devices on the front of the control panel enclosure:
   1. System On-Off/Reset-Remote selector switch.
   2. Manual mixer speed control potentiometer.
   3. Manual polymer metering pump speed potentiometer (ten turn).

4. Polymer metering pump flow display (signal based on pump speed).
5. Green power on indicating light.
6. Red "low water differential pressure" alarm indicating light.
7. Red "low polymer flow" alarm indicating light.
8. Red "high polymer discharge pressure" indicating light.

D. Polymer system control panel shall receive the following inputs from the Dewatering Press Motor Control Panel (MCP):
1. Polymer system start/stop command (discrete dry contact).
2. Polymer metering pump pacing speed signal (analog 4-20mA).

E. Polymer system control panel shall provide the following outputs to the Volute Press Motor Control Panel (MCP):
1. Polymer system running (discrete dry contract).
2. Polymer system "in remote" (discrete dry contact).
3. Polymer system common alarm (discrete dry contact) active when any system alarm is active.
4. Polymer system high discharge pressure alarm (discrete dry contact).
5. Polymer metering pump speed feedback (analog, 4-20mA).

F. Control panel shall accept 120-volt AC, single-phase, 20-amp hardwired branch circuit power. Provide a main control panel circuit breaker disconnect and a dedicated circuit breaker for each motor.

G. All conduit and wiring from the polymer system control panel to the associated polymer system devices shall be factory-prewired or provided by Section 46 33 33–Polymer Feed Equipment Supplier.

H. Electrical devices, terminal blocks, selector switches, indicating lights, etc. for this equipment are specified under Section 40 70 00–Controls and Instrumentation Equipment of these specifications.

2.9 PIPING AND VALVES

A. All piping and valves shall conform to Division 40. Piping and fittings shall be Schedule 80 PVC. Solenoid valves shall be 316 or 316L stainless steel.

B. CONTRACTOR shall provide strainer and all unions, piping, fittings, and appurtenances to connect to emulsion polymer tote, as shown on the Drawings, including 2-inch NPT connection, isolation ball valves, 1-inch quick-disconnect adapter, vent connection, and 20 feet of 1-inch clear, braided, PVC tubing.

2.10 SPARE PARTS

A. CONTRACTOR shall provide, along with the shop drawings, a list of the manufacturer's recommended spare parts for the specified equipment. The list shall include a description of each spare part, current pricing, and expected delivery time for each part. No spare parts shall be provided by CONTRACTOR/manufacturer as part of this Contract.

B. Manufacturer to supply following spare parts:
1. One (1) stator for the neat polymer progressive cavity pump
2. One (1) rotor for the neat polymer progressive cavity pump

C. These parts shall be identified, prepared, and packed for long-term storage.

2.11 FINISHES

A. It is the intent of these specifications that equipment, support and accessories be furnished factory shop-primed and finish-painted. Equipment and appurtenances shall be prepared in accordance with commercial grade SSPC specifications No. 6. Priming and finish painting shall be as recommended by manufacturer and shall be suitable for a corrosive atmosphere. Touchup paint shall be provided by manufacturer.

2.12 ANCHOR BOLTS

A. Provide all anchor bolts required for equipment furnished. Anchor bolts shall be 316 stainless steel and shall be of ample strength for intended service. Provide anchor bolts in accordance with Division 5.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to requirements specified in Division 01 for equipment installation, quality control, testing, supervision, start-up, and operator training.

B. The complete system shall be fully factory tested prior to shipment. Testing shall include setting and verification of all instrumentation and sensors; pressure testing all skid-mounted plumbing systems as specified in Division 40. If leaks are found, they shall be fixed and a new test shall be conducted until the plumbing system is verified to be leak free. The system shall undergo factory verification of system design flow rates and complete functional of operation. Documentation of each test shall be maintained and provided to ENGINEER as a part of shop drawing review.

C. Refer to Section 467331–Volute Dewatering Press for startup and performance testing requirements of the dewatering process, including performance of Polymer Blending and Feed Equipment.

END OF SECTION 463333

SECTION 464321 - CIRCULAR CLARIFIER EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access bridge and walkway.
2. Clarifier drive mechanism.
3. Rake arms and solids collectors.
4. Effluent trough and weir assembly.
5. Weirs and baffles.
6. Influent feedwell.

B. Related Requirements:

1. Section 260500 – Basic Materials and Methods: Execution requirements for electrical connections to equipment specified by this Section.
2. Section 400593 - Common Motor Requirements for Process Equipment: Execution requirements for motors specified in this Section.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.3 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Gear Manufacturers Association:

1. AGMA 6001 - Design and Selection of Components for Enclosed Gear Drives.
2. AGMA 6013 - Standard for Industrial Enclosed Gear Drives.
3. AGMA 6034 - Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
4. AGMA 6113 - Standard for Industrial Enclosed Gear Drives (Metric Edition).

C. American Society of Mechanical Engineers:

1. ASME B17.1 - Keys and Keyseats.
2. ASME B17.2 - Woodruff Keys and Keyseats.
3. ASME B29.100 - Double-Pitch Roller Chains, Attachments, and Sprockets.

D. ASTM International:
   1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

1.4 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's Product Data for system materials and component equipment, including electrical characteristics.

C. Shop Drawings:

   1. Indicate system materials and component equipment.
   2. Submit wiring and control diagrams, installation and anchoring requirements, fasteners, and other details.

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

   1. Certify that installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of **factory** tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

I. Qualifications Statement:

   1. Submit qualifications for manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed clarifiers and components.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish three sets of manufacturer's recommended spare parts.

C. Tools: Furnish special wrenches and other devices required for Owner to maintain and calibrate equipment.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on-Site and inspect for damage.

C. Store materials according to manufacturer's instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for circular clarifier equipment and accessories.

PART 2 - PRODUCTS

2.1 CIRCULAR CLARIFIER EQUIPMENT

A. Manufacturers:

1. Clearstream Environmental, Inc.
2. Eimco.
3. Envirex; Siemens Water Technologies.
4. WesTech Engineering.

B. Substitutions: As specified in Section 016000 - Product Requirements.

C. Description: Drive mechanism rotates sludge collector assembly, which moves settled primary sludge to collection hopper or collects settled secondary biosolids for recirculation.

D. Performance and Design Criteria:

1. Clarifier Mechanism:

a. Continuous use under design load.
b. No operating mechanisms below or in contact with liquid surface.

2. Scraper Arms Rotational Speed: Constant, 12 fpm.
3. Access Bridge Live Load: 50 psf, with deflection limited to 1/360 of span.
4. Turntable Bearing Assembly: Arrange components for easy replacement.

E. Sludge Collector Assembly: Spiral Blade

1. Scraper Arms: Structural steel.
2. Scraper Blades:

a. Material: Steel plate.
b. Minimum Thickness: 1/4 inch.
c. Provide squeegees, bolted to underside of scraper arms with 2 inches vertical adjustment.

3. Squeegees:

a. Material: Stainless steel.
b. Minimum Thickness: 1/8 inch.

4. Center Drive Drum:

a. Material: Structural steel.

5. Center Shaft:

a. Material: Steel pipe, according to ASTM A53 (A53M), Schedule 40.

F. Drive Assembly:

1. Description: Motor, speed reduction and turntable gearing, turntable bearing assembly, and drive assembly bearings.
2. Motor: As specified in Section 400593 - Common Motor Requirements for Process Equipment.
3. Speed Reduction and Turntable Gearing:

    a. Comply with AGMA Standards.
    b. Primary and Secondary Speed Reducers: Parallel Helical and Planetary gearing.
    c. Turntable: Pinion-and-spur-gear reduction unit.
    d. Gears: Cast alloy steel.
    e. Shaft Material: Steel.
    f. Gear Shafts and Bolting: Comply with AGMA 6001.
    g. Housings:

        1) Fully enclosed.
        2) Material: Steel.
        3) Provide dust and oil seals.

4. Turntable Bearing Assembly:

    a. Base: Steel.
    b. Turntable: Cast integrally with spur gear.

5. Drive Assembly Bearings:

    a. Type: Ball; comply with ABMA 9.

6. Lubrication:

    a. Type: Grease.
    b. Grease Fittings: Where not readily accessible, provide extension to accessible location.

7. Key-Mounted Connections: Comply with ASME B17.1 or ASME B17.2.

G. Walkway and Operating Platform:

1. Material: Grating.
2. Minimum Walkway Width: 36 inches.
3. Double Railing:

    a. Material: Galvanized steel, 1-1/2-inch diameter.
    b. Minimum Height: 42 inches, on both sides of walkway and around outside of operating platform.

H. Influent Feedwell:

1. Material: Steel.
2. Minimum Thickness: 3/16”.
3. Set the top and bottom of the feedwell to be 6 inches above maximum water level and 5 feet below maximum water level.

4. Provide unobstructed ports in the feedwell to allow scum to escape.

I. Effluent Trough: Precast outboard launders.

J. Effluent Weir Plates:

1. Material: FRP.
2. Minimum Vertical Adjustment: 3 inches.

K. Operation:

1. Electrical Characteristics: As specified in Section 260500 – Basic Materials and Methods and following:

a. 1/2 hp.
b. Voltage: 480 V, three phase, 60 Hz.

2. Control Panel:

a. Factory mounted.
b. NEMA 4X.
c. Single-point power connection and grounding lug.

3. Controls:

a. Overload Protection: Indicate load on the mechanism continuously, annunciate an alarm if impending excessive load, and stop mechanism if excessive load reached.
b. Alarm: Audible horn or bell, relay, reset button, test circuit, and ON-OFF switch. Provide auxiliary contacts in alarm circuit.

4. Disconnect Switch: Factory-mounted in control panel.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that clarifier basin is installed and ready to receive circular clarifier equipment.

3.2 INSTALLATION

A. Install circular clarifier equipment according to manufacturer's instructions.

B. Weir Plates: Mount weir plates against double bead of the sealant.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Dry Startup: Run equipment without liquid in basins and inspect for:

1. Alignment of sprockets, chain, flights, and wearing surfaces.
2. Binding and excessive heat buildup in drive units.

C. Wet Startup: Run equipment with wastewater in basins and verify proper operation.

D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

E. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

F. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 ADJUSTING

A. Section 017000 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Check control module functions and adjust as necessary.

3.5 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 464321

SECTION 466656 - OPEN-CHANNEL LOW-PRESSURE/HIGH-INTENSITY ULTRAVIOLET TREATMENT EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Open-channel, low-pressure, high-intensity UV treatment equipment and accessories.

B. Related Requirements:

1. Section 260500 - Wiring Connections: Execution and product requirements for connecting equipment specified by this Section.

1.2 REFERENCE STANDARDS

A. American National Standards Institute:

1. ANSI C82.4 - American National Standard for Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).

B. Federal Communications Commission (FCC):

1. 47 CFR 15 - Radio Frequency Devices.

C. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with Work of other Sections.

C. Maintain flow of wastewater and its disinfection until proposed system is tested, approved, and fully operational.

1.4 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's information, including average UV intensity within each reactor, UV density, head loss caused by each bank of lamp modules, lamp module cross-sectional area, aspect ratio of lamp bank.

C. Shop Drawings:

1. Indicate size and configuration of assembly, mountings, weights, and accessory connections.
2. Indicate system materials and component equipment.
3. Electrical schematics and layouts.
4. Hydraulic calculations demonstrating compliance with the required hydraulic characteristics.
5. Lifetime disinfection performance guarantee.

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

E. Test and Evaluation Reports: Submit installation certificate from equipment manufacturer's representative, as described in PART 3.

F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

G. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Manufacturer Reports:

1. Certify that equipment has been installed according to manufacturer instructions.
2. Indicate activities on Site, adverse findings, and recommendations.

1.6 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of installed UV treatment equipment and accessories.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:
1. Low-Pressure, High-Intensity UV Lamps: 2.
2. Quartz Lamp Sleeves and Seals: 1.

3. Lamp Driver: 1.
4. Operators Kit including UV-resistant face shield, gloves, and cleaning solution: 1.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. The equipment will be free of defects in material and workmanship, including damaged during shipping of 12 months from date of start-up or 18 months after shipment, whichever comes first.

B. UV Lamps will be warranted for a minimum of 15,000 hours when operated in automatic mode, prorated after 9,000 hours. On/off cycles are limited to an average of (4) per day accumulated over the guaranteed life of the lamp.

C. Lamp Drivers will be warranted for 10 years, prorated after 1 year.

D. UV Intensity Sensors will be warranted for 5 years, prorated after 1 year.

PART 2 - PRODUCTS

2.1 OPEN-CHANNEL, LOW-PRESSURE, HIGH-INTENSITY ULTRAVIOLET TREATMENT EQUIPMENT

A. Manufacturers:
1. Trojan Technologies.
2. Calgon Carbon Corporation.
3. Ozonia North America LLC

B. Description:

1. Outdoor, open-channel, gravity-flow, staggered inclined orientated UV disinfection system, consisting of following:

a. UV lamp module with support rack and bracket.
b. Instrumentation, controls, and power distribution.
c. UV monitoring system.
d. Elapsed time meter.
e. Lamp cleaning system.

C. Lamps:

1. Type:

a. High intensity low pressure amalgam.

2. Filament: Clamped design to withstand shock and vibration.
3. Module:

a. Description: Lamps placed in individual fused quartz sleeves and sealed and supported in NEMA 6P (IP67) stainless-steel frames.
b. Wiring: Teflon insulated stranded wire.
c. Base: Type 316 Stainless Steel frame and wall.
d. Ballast Enclosure: NEMA 4X (IP66).
e. Plugs: Accessible from the top of the bank to facilitate lamp removal without moving the UV banks or any other component. Plug shall be rated Type 6P.
f. Each bank will contain two (2) light locks at the top to prevent short circuiting over the top of the lamps.
g. Furnish mechanical lifting device for individual lamp modules weighing over 55 lb.

4. Sleeves:

a. Description: Open at one end only and domed at the other end.
b. Material: Fused quartz.
c. Seal: Stainless-steel nut and O-ring seal.
d. Configuration: Prevent lamp sleeve from touching steel component.

5. Ballast/Drivers:

a. Each driver will power two (2) UV lamps.
b. Minimum Power Factor: 99 percent and less than 5% total harmonic distortion current at the maximum power level.
c. Design: Modular, for quick disconnect and replacement.
d. Shall be UL, CE, and RoHS compliant.
e. The communication protocol shall be Modbus implemented on an RS485 electrical interface.

6. Cleaning System

a. Automatic in-situ cleaning system using both chemical and mechanical methods, capable of cleaning lamps during disinfection and without removing lamps from unit.
b. Automatically wipe lamp sleeve surface while dowsing lamp sleeve surface with acidic solution.
c. The wiper shall be parked out of the effluent when not in use.
d. Cleaning solution replacement can be performed while the UV Bank and lamps are in place and operational in the channel.
e. Wipers shall travel the full length of the UV lamp arc.
f. UV intensity sensors shall be cleaned using cleaning methods as the lamp sleeves.

D. Performance and Design Criteria:

1. Flow Rate:

a. Peak: 10.3 MGD.
b. Average: 3 MGD.

2. Head Loss at Peak Flow Rate: 1.0 inches.
3. TSS Concentration: 20 mg/L.
4. Wastewater Temperature Range: 33 to 85 degrees F.
5. Five-Day BOD: 20 mg/L.
6. Lamps:

a. Type: Low pressure, high intensity.
b. Useful Arc Tube Life: 15,000 hours.
c. UV Transmittance at 254 nm: 60 percent.
d. Maximum Power Input per Lamp: 1000 W.

7. Maximum Ozone Production: Zero.
8. Inactivation:

a. E. Coli:

1) Thirty-Day Daily Sample Mean: 126 MPN per 100 mL.

E. Materials:

1. Metal Components in Contact with Wastewater: Type 316 stainless steel.
2. Components Exposed to UV Light: Type 316 stainless steel , quartz.

F. Operation:

1. Electrical Characteristics:

a. All applicable electrical components will be UL-listed.
b. Each UV lamp within a bank will be powered from a PDC.
c. UV manufacturer to supply all cabling between lamps and drivers.
d. Electrical supply to each PDC will be 480/277 V 60 HZ, 3 Phase, 4 Wire + Ground, 53.3 kVA, 65 Amps.
e. Electrical supply to the Hydraulic System Center will be 480V 60Hz, 3 Phase, 3 Wire + Ground, 2.5 kVA.
f. Electrical supply to the low water level sensor box will be 120V, 1 Phase, 2 Wire + Ground.
g. Electrical supply to the System Control Center will be 120V 60 Hz, 1 Phase, 2 Wire + Ground, 1.8 kVA, 15 Amps.

2. Power Distribution Center (PDC):

a. The configuration of Power Distribution Centers shall be lamps per pdc.
b. PDC enclosure material shall be 304 Stainless Steel – Type 4X (IP66).
c. All internal components shall be sealed from the environment.
d. All Power Distribution Centers to be UL approved or equivalent.
e. An internal heater will be provided in the PDC to prevent condensation when the external temperature drops below the dew point.
f. Each PDC shall be able to electrically isolate each bank of lamp drivers and safely replace a lamp driver without de-energizing any other operating banks.

3. Hydraulic System Center

a. The Hydraulic System Center (HSC) houses the components required to operate the automatic cleaning system and bank Automatic Raising Mechanism (ARM).
b. HSC enclosure material will be 304 Stainless Steel (Type 4X, IP66).
c. The HSC will contain hydraulic power unit complete with pump, fluid reservoir, manifolds, valves and filter.

4. Controls:

a. Description: Automatic flow- and water-quality-paced PLC control system energizes and de-energizes lamps to maintain required UV dosage and adjusts UV intensity in proportion to wastewater flow rate.
b. The System Control Center shall include a sunshade. The operator interface screen will be designed for a rugged outdoor environment capable of operating at ambient temperature between -30C and +70 C with a high brightness display (minimum 1000 Nit). HMI screen shall be certified for outdoor use.
c. OIS: Menu driven with automatic fault messages when alarm conditions are annunciated.
d. Signals: 4 to 20 mA dc.
e. Furnish programming to perform operations.
f. Lamp Status Indicators: ON-OFF.
g. The 100 most recent alarms will be recorded.

h. Elapsed time of each bank will be recorded and displayed on the displayed screen when prompted.

5. Low Water Level Sensor:

a. Ensure lamps extinguish automatically is the water level in the channel drops below an acceptable level. .

6. UV Intensity Detection System:

a. The sensors will measure only the germicidal portion of light emitted by the lamps.
b. The UV sensor shall be factory-calibrated to US National Institute for Standards and Technology (NIST).
c. The sensor shall be accessible without shutting down the system, lifting a bank/module or removing lamps.
d. Provide UV intensity data for dose monitoring and control functions.
e. Reference sensor readings can be taken without interrupting disinfection and without removing UV lamps, banks/modules or sleeves.

7. Switches: Furnish one HAND-OFF-AUTO switch for each UV bank.
8. Alarms:

a. LOW UV INTENSITY WARNING.
b. LOW UV INTENSITY.
c. Individual LAMP FAILURE.
d. Multiple LAMPS FAILURE.
e. MODULE FAILURE.

9. Disconnect Switch: Factory mounted in control panel.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

3.2 INSTALLATION

A. According to manufacturer instructions.

3.3 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Inspection and Functional Testing:

1. Operate UV system for minimum seven consecutive days with plant wastewater.
2. Test and Inspect:

    a. Proper installation and alignment of UV support racks and frames.
    b. Watertightness.
    c. Electrical wiring and connections.
    d. Instrumentation, alarms, and indicators.
    e. ON-OFF and HAND-OFF-AUTO switches and ground fault circuit interrupters.
    f. Lamp removal system.
    g. Lamp cleaning system.

C. Performance Testing:

1. After installed UV equipment has been inspected and functional test has been completed, begin performance testing.
2. Collect samples at or near peak flow rate.
3. Analyze samples for following parameters:

    a. E. Coli, MPN per 100 mL, immediately upstream of UV treatment equipment.
    b. E. Coli, MPN per 100 mL, immediately downstream of UV treatment equipment.
    c. TSS, immediately upstream of UV treatment equipment.
    d. Percent UV transmittance (UVT) at 254 nm, immediately upstream of UV treatment equipment.

4. Test for 14 continuous days and collect and analyze samples three times in each 24-hour period. Contractor shall be responsible for associated lab costs.
5. If sample results do not meet specified performance, retest for minimum two additional consecutive days or until acceptable bacteriological results have been obtained.

D. Manufacturer Services:

1. Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than how many days needed on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.

E. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

F. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 466656

SECTION 467627 – MULTI DISC SCREW PRESS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Related Section:

1. Section 030000 – Concrete Work
2. Section 055800 – Metal Fabrications
3. Division 26 – Electrical
4. Section 461211 – Shaftless Conveyor
5. Section 463333 – Polymer System

C. This section contains references to the following documents:

1. American National Standards Institute (ANSI)
2. American Society of Testing and Materials (ASTM)
3. American Iron and Steel Institute (AISI)
4. American Welding Society (AWS)
5. American Institute of Steel Construction (AISC)
6. American Bearing Manufacturers Association (ABMA)
7. American Gear Manufacturers Association (AGMA)
8. National Electrical Manufacturers Association (NEMA)
9. Underwriters Laboratory (UL).
10. National Electrical Code (NEC)

1.2 DESCRIPTION OF WORK

A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as specified and required to furnish and install a Multi Disc Screw Press sludge dewatering system and any associated equipment required to construct a system capable of dewatering feed sludge and producing a dry and solid cake.

B. This section shall include furnishing Multi Disc Screw Dewatering Press equipped with three (3) dewatering drums, together with associated sludge conditioning tank, control panel, polymer system, flowmeter, dewatered cake conveyors, and access platform as specified in the Contract Documents and as required to meet the specified performance requirements and to provide a full and properly functioning sludge dewatering system.

C. Review installation procedures under other Sections and coordinate the installation of items that may need to be installed with the Screw Press.

D. All equipment furnished under this section shall be the responsibility of a single Manufacturer to fabricate or procure, integrate, factory test, and deliver to the project site. It shall be the responsibility of the Manufacturer to coordinate all details and components required for a properly functioning system.

E. All welding shall conform with the American Welding Society Structural Welding Code.

F. All construction shall allow easy access and visual inspection of all internal components.

G. All electrical work, motors and drives shall comply with all relevant NEMA standards.

1.3 SYSTEM DESCRIPTION

A. The sludge dewatering system shall consist of the Dewatering Screw press sized to dewater aerobically digested sludge with the following parameters:

1.	Type of Influent Solids:	Anaerobically Digested Waste Activated Sludge and Primary Solids
2.	Influent Dry Solids Concentration:	3%
3.	Hydraulic Capacity:	67 gpm
4.	Solids Loading Capacity:	1000 lbs/ hr

B. The Dewatering Screw Press shall be a complete, prefabricated sludge dewatering system, as described herein and shown on the Drawings, consisting of the following:

1. Flocculation and dosing chamber used for flocculation/mixing of the polymer and influent sludge. This tank shall be equipped with a sludge inlet, drainage outlet, polymer (flocculant) inlet, an electric agitator and mixer. The feed tubes connecting mixing tank with dewatering drums.
2. Three (3) dewatering drums run by gearmotors equipped with individual rinsing water system with nozzles. Each dewatering drum shall have individual fixing elements and can be removed separately while other screws are in operation.
3. The filtrate collection tray shall be provided with flanges for filtrate removal. Side walls of the filtrate collection tray are an integral part of the frame-base.
4. A self-contained electrical and control panels including: control panel for the dewatering screw press and panel(s) for ancillary equipment such as feed pumps and solids conveyor.

C. The dewatering system shall integrate all appurtenances necessary for a complete, functional dewatering system operation, including but not limited to the following:
   a. Liquid Polymer Blending System
   b. Sludge Feed Pumps
   c. Dewatering Conveyors
   d. Flowmeter
   e. Screw press structural support

1.4 PERFORMANCE TESTING

A. Performance testing must demonstrate that performance of the dewatering equipment can simultaneously achieve:

1. Sludge processing capacity of 1000 dry pounds per hour, 330 dry pounds per hour per dewatering drum, and be capable of dewatering liquid 100% anaerobically digested primary and waste activated sludge with solids concentration ranging 3-5 percent to a cake with average solids concentration above 17-18 percent. This design loading must be achieved at or below the maximum drum rotation speed specified below.
2. Minimum solids capture rate shall be 98% at the rated capacity of the Multi-Disc Screw Press.
3. Stated average performance criteria shall be obtained with a maximum cationic emulsion polymer, with active polymer concentration ≥ 39%, dosage of 2-3 gallons per dry ton of solids (16-24 lbs of polymer/dry ton).

4. Flushing water shall be used only for rinsing of outer area of the dewatering drum, but not for cleaning of filtration gapes.

1.5 QUALITY ASSURANCE

A. All equipment and components shall be furnished as complete standard type assemblies in accordance with the standards of the industry.

B. All equipment furnished under this section shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the specified equipment.

C. To ensure unity of responsibility, the Screw Press, supporting frames, polymer mixing and feeding blend unit, conveyors, and control systems shall be furnished and coordinated by a single supplier. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire dewatering system package.

D. The Supplier shall have at least ten (10) full-scale systems utilizing the exact technology at the same scale size proposed for this project operating successfully for at least three (3) years in North America at municipal wastewater treatment plants that were furnished under the manufacturer's own name.

E. Prior to shipment, the Dewatering Screw Press and control panel shall be factory tested at the place of assembly. Factory test each pre-assembled, pre-wired, Multi-Disc Dewatering Screw Press and its associated control panel to be supplied to the job site. Prior to shipment, verify through a one-hour continuous operating test that the Multi-Disc Dewatering Screw Press and associated equipment operate smoothly, noiselessly, vibration free, and without overheating of any bearing or motor.

F. The owner/engineer shall, at their option, be permitted to witness the factory quality control test at the manufacturer's facility. The manufacturer shall give the owner/engineer a minimum of one (1) weeks' notice prior to testing.

G. The equipment furnished shall be fabricated, assembled, installed, and placed in proper operation condition in full conformity with approved drawings, specifications, engineering data, and/or recommendations furnished by the equipment manufacturer. The equipment manufacturer shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.

H. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work. All equipment shall perform as specified and accessories shall be provided as required for satisfactory operation.

1.6 SUBMITTALS

A. Submit manufacturer's technical data and application instructions per Section 013323.

B. Product Data: Submit manufacturer's technical data and application instructions.

C. Shop Drawings: The Contractor shall submit complete shop drawings of all equipment furnished for this project as covered by these specifications. All shop drawings shall clearly identify the specific equipment and material being supplied, the quantity being supplied, and all accessories, dimensions, descriptions, dimensional/orientation layout drawings, mounting and connection details, electrical control diagrams, wiring schematics and any other information required of the

Engineer/Owner to determine compliance with the plans and specifications. The submittal as a minimum shall include the above data drawings and other related materials. The shop drawings shall be reviewed by the Contractor for completeness and compliance with the project and so acknowledge prior to the review by the Engineer.

D. Shop Drawings: Submit for review the following:

1. Dimensional drawings depicting all mechanical and electrical equipment dimensions and required overhead clearances.
2. Equipment layout, principal dimensions with related verifications required for installation including anchorage location.
3. Details on connectors for solids discharge chutes.
4. Equipment weight
5. Electrical control drawings
6. Drive motor data
7. A list of recommended Spare Parts including any Special Tools required for routine maintenance of the equipment.
8. Certified copies of performance shop test data and reports shall be supplied for approval before shipment from the factory.

E. Operation and Maintenance (O& M) manuals shall describe the theory of dewatering system, start-up, optimization and maintenance operations for the equipment furnished and installed under this Section. The final O & M manuals shall be provided in digital format after equipment start-up in the close-out submittal process. The O & M manuals shall meet the requirements of Sections 01060 and 01097, including the following additional information:

1. As-Build Drawings of the Multi Disc Screw Press
2. Electrical diagrams
3. Controls and Accessories
4. Explanation of operating safety considerations
5. Repair Parts and maintenance materials
6. Troubleshooting data
7. Repair data

F. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review. The date of the warranty begins after commissioning and operational demonstration and will be determined in the field by the Owner's Engineer.

1.7 WARRANTY

A. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of startup, not to exceed eighteen (18) months from the date of delivery, unless noted otherwise within the specifications.

B. Any defects found within the warranty period shall be replaced if damaged or defective in the normal use of the equipment at no cost to the Owner.

1.8 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 016600, Product Handling and Protection.

B. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

C. Handling, delivery, and storage of the equipment shall be in accordance with the Manufacturer's recommendations. No extra cost shall be charged the Owner for the handling, delivery, or storage of the equipment.

D. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.

E. Acceptance at Site:

1. Inspect all equipment and materials against reviewed Shop Drawings at time of delivery.
2. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.
3. The Contractor shall notify the Manufacturer on any damages to equipment within 5 days to effect proper remedial action. Failure to notify the Manufacturer of damage to equipment prior to unloading shall void all warranties pertaining to subject equipment.

F. Storage and Protection: Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions. Carefully prepare for storage and label all equipment and materials after they have been inspected.

1.9 SEQUENCING

A. Comply with Section 011100, Summary of Work.

B. The Contractor shall take special note that the City of Conneaut WWTP must remain in operation at all times unless outages are approved by the Owner.

1.10 SPARE PARTS

A. Furnish the following spare parts:

1. Spray wash system solenoid valve.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer

1. Esmil Group, Multi-Disc Screw Press
2. Process Wastewater Technologies, Volute Dewatering Press, PWTech.
3. Or Engineer approved equal.

B. The sludge dewatering process, electrical, controls and structural design has been based around Esmil Group, Multi-Disc Screw Press. Other named or approved equals may differ with respect to the structure, electrical power, or controls.

2.2 EQUIPMENT DESCRIPTION

A. General

1. The Screw Press shall be designed to adequately condition and dewater the sludge such that a dewatered sludge cake is produced that easily discharges from the dewatering drum, without binding or plugging.
2. System shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope.
3. The system shall operate without the need for operator attention other than periodic inspection and chemical replenishment.
4. Manufacturer shall provide a Flowmeter to control influent sludge flow to the screw press, installed as shown on the Drawing. The Flowmeter shall be the electro-magnetic type, by Endress Promag W400, or equal. The flowmeter shall have 4-inch flanges, ANSI 150 lbs, and NEMA 4X enclosure.

B. The Dewatering Screw Press shall be a complete prefabricated system as described herein and shown on the Drawings, consisting of the following:

1. Flocculation and dosing Chamber:
   a. Installed on the separated frame.
   b. Tank shall be equipped with adjustable thread coupling located inside the chamber.
   c. Sludge conditioning system consisting of flocculation chamber with a mixer (agitator) with electric drive-motor which allows efficient mixing of polymer solution with initial sludge. Mixer is equipped with two adjustable blades to perform proper flocculation process.
   d. Flocculation and dosing chamber frame is equipped on both sides with eyelets for transportation and holes for anchoring to the concrete base.
   e. The flocculation and dosing chamber shall be equipped with a junction box to enable the connection to the main screw press control panel.
2. Three (3) dewatering drums with drive-motors including individual rinsing water system with nozzles. Each dewatering drum shall have individual fixing elements and can be removed separately while other screws are in operation.
   a. The dewatering drum consists of a variable flight pitch screw located within a support frame of alternating fixed and moving discs. Fixed discs are equipped with spacers that hold the fixed discs apart and provide a gap for moving discs between them.
   b. The feed tubes connecting mixing tank with dewatering drums.
   c. A spring-loaded dam plate at the end of the drum sets the gap from where the cake exits, providing the back pressure that forces final sludge dewatering.
3. Machine frame structure for the dewatering drums includes filtrate collection tray and outlet flanges. Frame is equipped on both sides with eyelets for transportation and holes for anchoring to the concrete base.
4. The flocculated sludge is fed into the dewatering drum by self-flowing through feeding tubes. Filtrate seeps between the moving and fixed drum disks and drains out into the filtrate tray below the dewatering drum. Next the filtrate is discharged from the drums through a filtrate discharge pipe and returned to the plant.
5. As the sludge moves through the drum, the water is removed through the gaps between the movable and fixed disks. In the thickening zone, water is removed from sludge by the gravity and pressure of the screw flights. In the dewatering area, sludge is compressed due to the reduction of the space between the screw flights and conical shape of the shaft.
6. The final compression of sludge occurs at the end of the dewatering area by an adjustable dam plate mounted on the outlet end of the screw. Through a gap between the plate and the drum end, the dewatered sludge is squeezed out of the drum to a container.

7. A self-contained electrical and control panel including control and monitoring of ancillary equipment such as main equipment: sludge feed pump, polymer preparation and feed equipment, and dewatered sludge cake removal equipment.

2.3 MATERIALS OF CONSTRUCTION

A. All materials utilized in the construction of the sludge dewatering equipment shall be entirely suitable in every respect for the service required. All metals in contact with polyelectrolyte or sludge, and all other metal components other than those specified below in Table 1 shall be stainless steel, type 304 or 316.

B. No carbon steel shall be used for any part of the screw press.

C. The following table indicates the materials and coatings that shall be provided for The Screw Press and related components unless specified otherwise herein:

1. Flocculation and dosing chamber and Support Frame: Type AISI 304 Stainless steel
2. Rinsing Water Spray Pipes: Type AISI 304 Stainless steel, plastic
3. Technological pipes: Type AISI 304 Stainless steel, plastic
4. Dewatering Drums: Type AISI 304 Stainless steel
5. Dewatering Drum Screw: Type AISI 304 Stainless steel with FREA-metal blade edge
6. Gear Motors: Cast Iron
7. Gear Motor Coating: Acrylic paint
8. Spray Nozzles: Plastic
9. Dewatering drums covers: AISI 316L, Polycarbonate
10. Electrical Enclosure: Carbon Steel with acrylic paint or AISI 304 Stainless Steel
11. Electrical Wiring Housing: Non-metallic flexible liquid-tight conduit and fittings
12. Valve, Wetted Sections: Stainless Steel or Brass, EPDM Seating

2.4 STRUCTURAL COMPONENTS

A. The dewatering screw press manufacture shall provide and design the supports for the dewatering screw press. The dewatering screw press manufacture shall submit calculations and plans, sealed by a PE licensed in the State of Ohio, for the dewatering screw press supports. Submittal shall include anchorage requirements (anchor size, embedment, projection, etc.) to the building. Support anchorage shall not induce a moment at the anchorage connection.

B. The structural support frame shall be fabricated of type 304 stainless steel. It shall be a rigid structure, adequately braced to withstand intended loads without excessive vibration or deflection.

C. The framework shall be of welded and/or bolted construction. The structure shall be designed for installation on a prepared concrete foundation and secured with anchor bolts.

2.5 DEWATERING DRUMS

A. The dewatering drums shall be constructed of ASTM type 304 Stainless Steel. All circular components shall be laser cut to ensure maximum evenness of wear and operating life. The dewatering drum consists of a screw shaft rotating with a variable speed in the cylindrical body. The body consists of a support structure and series of alternating fixed and movable disks with gaps between them. The width of the gap decreases towards the discharge zone, from 0.02” in the thickening area up to 0.011” in the dewatering area and up to 0.0059” at the end of the drum. Nominal drum size shall be 18-inch.

B. The dewatering drums must have a minimum internal volume of 45 cubic feet. The maximum operational speed of the dewatering drums must not exceed 2.5 RPM at the design loading.

C. Screw flights side shall be protected by welded hard metal strips “Frea-Metal” with thickness of not less than 0.05 inches. Vickers hardness of the metal strips shall be not less than 600 Hv or Brinell Hardens of 534 HB.

D. Screws shaft shall have conical form with diameter increasing from initial sludge inlet zone to cake discharge zone for increasing DS content in the dewatered sludge.

E. Assembly shall be undertaken in such a way that all fixed discs shall be concentric and parallel. Fixed and movable discs thickness shall not be less than 0.12 in. All fixed discs shall be supported by a common support frame and be equally spaced apart for each section of the dewatering drum. Spacers must be fixed into fixed discs by thread connection. Any separate spacers are not allowed. Fixed and movable discs shall be made of AISI 304 Stainless Steel, using of plastic discs is not allowed. Movable discs shall be changeable with life period of not less than 15,000 operation hours.

F. The dewatering drum shall be installed in horizontal position with two mounting points to unit’s frame – at the initial sludge inlet zone and at the cake discharge zone. Intermediate fixation points along the drum are not allowed.

G. Each Dewatering Drum shall be equipped with individual spray bar. Each spray bar shall consist of a spray pipe fitted with spray nozzles, located above the dewatering drum. The spray pipe and spray nozzle assembly shall be readily removable. Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another on the dewatering drum surface. The sprays shall operate periodically and shall partly remove solids built up externally on the drum such that over time no significant buildup of solids occurs on the drum. Each spray bar must be equipped by solenoid valve.

1. Nominal rinsing water consumption: 29 gpm
2. Nominal rinsing water pressure: 30-60 psi
3. Typical total consumption: 87 gph

H. Each Dewatering Drum shall have a drive motor:

1. The Dewatering Drum drive motor shall be a one-piece gear-motor.
2. Gear-motors shall be hollow shaft design, designed to drive the dewatering drum screws with no additional couplings or joints. Motors shall be filled with grease on assembly and sealed for life. Screw rotational speed shall be obtained through a reduction gear. Input power to the dewatering drum drive shall be supplied through an A.C. variable frequency drive unit.
3. Drive Motor Data:
    a. Maximum Horsepower: 3 Hp
    b. Power Requirements: 460 VAC, 3-phase, 60 Hz
    c. No load motor speed: 1765 RPM, VFD
    d. Gear Reduction: 435.50:1
    e. Output shaft speed: 4.1 RPM @ 60Hz
    f. Insulation Class: NEMA 4
    g. Enclosure: TEFC
    h. Enclosure material: Die Cast Iron

2.6 FLOCCULATION CHAMBER

A. The Screw Press shall have a mixing system which consists of flocculation chamber equipped by agitator with drive motor. Chamber sizing and design shall ensure adequate residence times and mixing conditions to ensure complete flocculation and satisfactory dewatering performance. Chamber design shall minimize the possibility of any short circuiting of flow.

B. Design and manufacture of the chamber shall ensure no leakage of fluids under normal working conditions.

C. The flocculation chamber shall be manufactured in type AISI 304 Stainless Steel.

D. The flocculation chamber shall be equipped with maximum level sensor and pressure sensor.

E. Each Agitator shall have a drive motor:

1. The flocculation chamber drive motor shall be a one-piece gear-motor.
2. Gear-motors shall be hollow shaft design, designed to drive the agitator with no additional couplings or joints. Motors shall be filled with grease on assembly and sealed for life. Screw rotational speed shall be obtained through a hypoid reduction gear. Input power to the agitator drive shall be supplied through an A.C. variable frequency drive unit.
3. Flocculation chamber drive motor data:
    a. Maximum Horsepower: 3 Hp
    b. Power Requirements: 460 VAC, 3-phase, 60 Hz
    c. No load motor speed: 1765 RPM, VFD
    d. Gear Reduction: 93.5:1
    e. Output shaft speed: 19 RPM @ 60Hz
    f. Insulation Class: NEMA 4
    g. Enclosure: TEFC
    h. Enclosure material: Die Cast Iron

2.7 CONTROLS

A. The Screw Press shall have an integrated electrical control system that shall allow for safe, simple, and automated operation of the unit. The electrical control system shall have statuses for unit in operation, and unit alarms to an external PLC (plant SCADA system). External SCADA system connection shall be over Ethernet and allow to monitor status and alarms for all system components available at local control system as minimum.

B. Control Panel Features:

1. Control Panel shall be UL listed.
2. Enclosures: Control panel enclosures shall be free-standing, wall mounted, and it shall be located in the Electrical Room. The Control Panel is fabricated of AISI 304 Stainless Steel and shall be suitable for NEMA 4X service. Enclosure shall be a maximum of 12-inch deep.
3. The control panel shall accept a 480volt, 60 hertz, 3-phase AC power input.
4. Variable frequency drives (VFD) shall be provided for the dewatering drums drive motor, and mixer in flocculation chamber.
5. Short circuit and overcurrent protection for system components shall be accomplished utilizing fuses. Individual thermal overload protection shall be provided for each motor.
6. Control Panel shall be capable of receiving and processing all input signals and output signals to & from the equipment specified in this Section:

7. Table 2 includes but is not limited to a summary of additional I/O points to be directly monitored or controlled by the Multi-Disc Screw Press.
8. Control System:

Signal Description	Signal Type	I/O Type
Sludge Pump - Start/Stop Command	Control	N/O Output
External Sludge Pump – Run Status	Status	DI
Sludge Pump - Fault	Status	DI
Sludge Pump - VFD Speed Control	Control	AO
Sludge Pump – Dry Run – Stator Over Temp		
Conveyor 1 - Start/Stop Command	Control	N/O Output
Conveyor 1 - Run Status	Status	DI
Conveyor 1 - Fault Alarm	Alarm	DI
Conveyor 2 - Start/Stop Command	Control	N/O Output
Conveyor 2 - Run Status	Status	DI
Conveyor 2 - Fault Alarm	Alarm	DI
Polymer System - Start/Stop Command	Control	N/O Output
Polymer System Concentrate Pump – Run Status	Status	DI
Polymer System – Remote Status	Status	DI
Polymer System Water Low Flow – Fault Alarm	Alarm	DI
Polymer System – Speed Control	Control	AO
Multi Disc Screw Press System General Alarm to Plant SCADA System	Alarm	Ethernet
Flow Meter	Control	AI

C. External Enclosure Features:

1. The external door of the control panel shall have the following switches and indicators:
   a. Main Isolating Switch (Circuit Breaker).
   b. An emergency stop button which shall be a mushroom head style pushbutton that when depressed shall immediately de-energize all moving equipment in the system.
2. Within a windowed enclosure mounted on the panel door:
   a. HMI Touch Screen.
      1) The HMI for the system shall be a WEINTEK with minimum 9,7-inch LCD screen and fully compatible with the PLC. The unit shall provide a graphics interface and utilize menu driven screens to allow dewatering system control, status monitoring, and alarm handling; and provide both fully automatic control and override manual control features.
      2) The HMI shall provide access to all status and control functions for operations personnel with password access to limit change options dependent on authority.
      3) The HMI shall also provide access to diagnostic information, e.g. I/O status, and all PID and control functions for the commissioning engineer to allow changes to be made with appropriate password without the need for a programming terminal.
   b. An H-O-A system switch to switch the system from HAND (Manual) to OFF to AUTO modes.

1) In Hand mode the HMI shall include manual (local) control of all motors controlled by the Press Control System.

c. Power on Light (green).

d. An Operating Light for when the unit is in operation (green).

3. Provide a general Alarm Light and Horn- a flashing (red) light located on the top of the panel.

2.8 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. The Screw Press shall be provided with an Allen Bradley PLC, installed, wired, and programmed to perform the listed functions. The PLC shall be a standard unit with no specialist hardware or firmware modifications. Full application software will be generated by the Screw Press manufacturer to operate the dewatering system using the PLC manufacturer's proprietary software package.

1. Operational Control:
   a. Control of all components of the dewatering system including the ability to set times, operation and operating speeds or capacities for the sludge dewatering press feed pump, discharge sludge cake conveyors, dewatering drums, mixers, polymer blending and feed system and wash-down sprays.

2. System Tuning:
   a. PLC shall allow suitably qualified operators to adjust operating parameters such as delay timers for fault alarms and system calibration constants.

3. Monitoring Operation:
   a. PLC shall allow the operator to inspect the operation of all the components including indicators such as output speed or capacity, elapsed operating times, and any faults present.
   b. Operator shall be able to view approximated readouts of all operational speeds and flowrates relevant to the operation of the system.

4. Manual Operation of Components:
   a. Operator shall be able to operate manually each item of equipment from the PLC/HMI interface for inspection and maintenance reasons.

5. Time Clocks:
   a. Operator shall be able to set the unit to operate at specific time or on specific days with no operators present.

6. The PLC shall include an Ethernet port for communications and for import and export of all dewatering system equipment data from/to the plant SCADA system.

7. The PLC shall be capable of monitoring, recording, and outputting all input and output status parameters noted herein to the HMI and the plant SCADA system.

B. The PLC shall be capable of monitoring, recording, and outputting all alarm conditions to the plant SCADA system.

2.9 ELECTRICAL HARDWARE

A. Power wiring shall be 460VAC, type SIS insulation stranded copper and shall be sized for the required load, 12AWG minimum.

B. Control wiring shall be 24VDC, type SIS insulation stranded copper and shall be sized for the required load, 18AWG minimum.

C. Main three-pole switch disconnectors GA series Lovato Electric. Circuit breakers shall be iC60N C series Schneider Electric or equal.

D. Motor starters shall be full voltage, non-reversing, IEC style across-the-line units. Coils shall be 24VDC. Schneider Electric type or equivalent.

E. Selector switches shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10A continuous service. Selector switches shall be Harmony XB4 series Schneider Electric or equal.

F. Pilot lights shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Units shall be 24VDC full voltage incandescent type. Pilot lights shall be Harmony XB7 series Schneider Electric or equal.

G. Terminal blocks shall be high density, solderless box lug style, with 600-volt rating. Terminal blocks shall be Wago, Wieland type or equal.

H. Control relays shall be general purpose type with a 6A contact rating, miniature square base and internal on status pilot light. Relays shall be Schneider Electric Type RXM4 Series or equal.

I. Programmable Logic Controller (PLC) shall be Allen Bradley.

J. Variable Frequency Drives (VFD) shall be UL listed and shall be manufactured by Allen Bradley.

2.10 FUNCTIONAL DESCRIPTION

A. The control panel shall undertake the following operations:

1. Auto-Manual Operation: The Screw Press system shall be able to be set to either Auto, Manual or Off on the control panel.
    a. When set to manual, all items must be switched on and off at the control panel by the switches on the HMI unit.
    b. When set to off, no items shall work whether switched on or off either at the control panel or anywhere else.
    c. When set to auto, all items of equipment shall be turned on into work as per the following descriptions:
        1) Under this mode of operation, the screw press will run constantly and will shut itself down in the event of any malfunctions detected by the control system. The screw press should always be run in automatic mode.
        2) Turn automatic mode on by switching the three-position selector switch H-O-A to automatic position and pressing automatic mode button on the touch panel
        3) A mixer drive in flocculation chamber switches on when turning automatic mode on. Influent sludge feed pump and polymer feeder switch on after the predetermined delay time counting from the moment of turning automatic mode on.
        4) The screws' drives are switched on when the preset sludge level in the flocculation chamber is reached.
        5) Also, after screws' drives are switched on and subsequently operated in the automatic mode, rinsing valves will be activated periodically, according to the predefined stop and start intervals. If there is more than one valve, only one valve opens at a time to reduce instantaneous water requirement.

B. The control panel shall provide signals to allow for all input and output parameters and alarms to be taken directly from the Screw Press control panel to the plant SCADA system. Provide a list of addresses for all parameters and alarms. The Plant SCADA system will not monitor the system parameters as a part of this scope but shall provide the capability for future use.

PART 3 - EXECUTION

3.1 DELIVERY

A. All equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

3.2 INSTALLATION

A. Equipment shall be installed in accordance with the Manufacturer's recommendations to provide a complete installation.

B. All lubrication required for initial operation shall be furnished and applied in accordance with the Manufacturer's recommendations.

C. It is the intent of this Contract that the final installation shall be complete in all respects and the Contractor shall be responsible for minor details and any necessary special construction not specifically included in the drawings or specifications.

D. Equipment shall be installed in strict conformance with the manufacturer’s installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals and/or any pre-installation checklists.

E. Anchor bolts size shall be per manufacturer recommendation. Anchors, anchor bolts, nuts and washers shall be 316 stainless steel and furnished for each item of equipment by the Contractor.

1. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
2. Equipment manufacturer shall specify ample size and strength required to securely anchor each item of equipment. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
3. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

3.3 ELECTRICAL CONNECTIONS AND CONTROLS

A. Wiring and conduits for electrical power, control and instrumentation will be provided as shown in the Drawings and under Division 26 – Electrical and Division 40 – Process Integration Specifications.

3.4 TESTING

A. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative and shall demonstrate that the equipment is fully operational by picking up and depositing materials into specified containment.

B. Field certification shall include inspection of the following:

1. Verify equipment is properly aligned and anchored per the installation instruction and drawings. Assure all piping and valves are installed and properly connected, and the dewatering equipment is unobstructed with required clearances maintained.
2. Assure controls and instrumentation work in all modes.
3. Check equipment for proper operation as well as completion of the Start-Up requirements in the installation guide.

C. Performance Testing.

3.5 EQUIPMENT MANUFACTURER'S SERVICE REPRESENTATIVE

A. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative.

B. The equipment system supplier shall furnish the services at site of a factory-trained representative for a period of three (3) - eight (8) hours working days to the jobsite. Service shall be provided after the Contractor has installed the equipment. These services shall be furnished for the purposes of:

1. The equipment manufacturer’s inspection of the equipment following installation by others, and to certify that the equipment has been properly installed and is ready to operate.
2. Conduct the equipment Performance Testing.
3. To train the Owner’s personnel in the operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.

C. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.

D. After inspection of the installed equipment the Supplier shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

3.6 DEMONSTRATION AND INSTRUCTIONS

A. Provide the services of a qualified factory-trained manufacturer’s representative to conduct training covering operation, mechanical maintenance, electrical requirements, troubleshooting and etc.

3.7 OPERATION AND MAINTENANCE MANUALS

A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

END OF SECTION 467331