

PROJECT MANUAL

NORTH SALUDA RESERVOIR OUTLET STRUCTURE IMPROVEMENTS

Greenville, South Carolina

for

Greenville Water

(Local Funds)

May 21, 2019

100% DESIGN

Prepared By

GMC

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GMC PROJECT NUMBER: CGRE180023

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NORTH SALUDA RESERVOIR OUTLET STRUCTURE IMPROVEMENTS

FOR

GREENVILLE WATER

GREENVILLE, SOUTH CAROLINA

GMC PROJECT NO. CGRE180023

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SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Phased construction.
- 4. Contractor-furnished.
- 5. Access to site.
- 6. Coordination with occupants.
- 7. Work restrictions.
- 8. Specification and drawing conventions.
- 9. Miscellaneous provisions.

B. Related Requirements:

- 1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: North Saluda Reservoir Outlet Structure Improvements

- 1. Project Location: Travelers Rest, SC

B. Owner: Greenville Water

- 1. Owner's Representative: Jon Sherer

C. Engineer: Goodwyn Mills & Cawood; Greenville, SC

D. Engineer's Consultants: The Engineer has retained the following design professionals who have prepared designated portions of the Contract Documents:

- 1. N/A

E. Contractor: TBD.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
 - 1. The construction and modifications consist of the following:
 - a. New modulating electric actuator for 60" slide valve at existing outlet structure.
 - b. New clamp-on ultrasonic flow meter at existing outlet structure.
 - c. New open/close electric actuator for 48" butterfly valve at existing treating station.
 - d. New radar level meter at existing weir structure.
 - e. New PLC in SCADA panel at existing treating station.
 - f. Electrical modifications.
 - g. Integration with existing SCADA system.
- B. Type of Contract:
 - 1. Project will be constructed as a design-bid-build contract.

1.5 CONTRACTOR-FURNISHED AND INSTALLED PRODUCTS

- A. Contractor shall furnish all products indicated in the bid documents. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.

1.6 WORK BY OWNER

- A. General: Cooperate fully with Owner so that work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

1.7 CONTRACTOR-FURNISHED AND INSTALLED PRODUCTS

- A. Contractor shall furnish all products indicated in the bid documents.
- B. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.

1.8 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other Contractors on portions of Project.
- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Driveways, Walkways and Entrances: Keep driveways and loading areas, 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 storage of materials.
 - a. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.9 COORDINATION WITH OCCUPANTS

- A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
 1. Engineer will prepare a Certificate of Substantial Completion for each specific phase of the project.
 2. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.

1.10 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Working hours shall be generally limited to 7am to 5pm; Contractor shall contact the Engineer/Owner when working hours are extended beyond normal business hours or when weekend construction is expected to occur.
- C. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to neighbors with the Owner.
 1. Obtain Engineer's written permission before proceeding with disruptive operations.
- D. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.

1.11 ADVERSE WEATHER

- A. General
 1. Notice of rain delay days with the documentation of the aforementioned sources herein and on-site records must be submitted by the Contractor to the Inspector/Engineer on the

first working day of every month for the previous month or at the monthly construction meeting as determined at the preconstruction meeting.

B. Definition

1. Adverse weather is defined as the occurrence of a condition that prevents construction activity exposed to weather conditions or access to the site for more than four (4) hours in a day.
2. Adverse weather may also include, if appropriate, “dry-out” or “mud” days.
3. Adverse weather includes days that temperature does not rise above the required temperature for a construction activity.

C. Qualifications

1. Adverse weather conditions having a direct effect due to precipitation are as follows:
 - a. Precipitation of 0.10 inch or more for a city within a 100-mile radius of the project’s location.
 - 1) If the 100-mile radius overlaps with a nearby city, then the city with the shortest radius from the project location shall be used.
 - 2) If the project location does not fall within a 100-mile radius, the following schedule shall be used as the default:

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
6	6	7	7	6	6	8	6	4	5	5	7
(Data from NOAA, >0.10” Daily Precipitation, January 2007 – December 2017, Greenville, SC)											

- b. Precipitation of 0.10 inches or more shall be determined by the precipitation gauge on-site and both logged and confirmed by the Owner/Inspector.
2. Adverse weather conditions having an indirect effect due to precipitation are as follows:
 - a. Precipitation that occurs beyond the standard baseline which results in “dry-out” or “mud” days.
 - 1) The standard baseline is based on the NOAA’s Point Precipitation Frequency (PPF) Estimate for the construction area using the latitude and longitude for a 1-year average recurrence interval and a 60-min time period. This can be found at <http://dipper.nws.noaa.gov/hdsc/pfds/>.
3. Adverse weather conditions due to temperature are as follows:
 - 1) Cold Weather concreting shall be per ACI 306.
 - a) The Contractor shall have a calibrated thermometer onsite which is logged by the inspector and Contractor prior to any concrete pours during cold weather.
4. Adverse weather conditions due to wind speeds are as follows:

- a. Wind speeds exceeding those permissible to use equipment or to perform certain tasks safely, including but not limited to operating crane(s) or other aerial equipment for construction or erection of a building structure.

- 1) The Contractor shall have a calibrated wind speed gauge on-site.

5. Adverse weather conditions resulting in compromised project site conditions are as follows:

- a. Project site conditions such as mud, pooling of water, ice, or standing snow subsequent to the actual precipitation days, prevent the performance of activities such as, but not limited to, mass grading, building pad grading, foundations, piping, excavations, backfill, concrete, masonry, etc. operations.

D. Weather Delay Days

1. Adverse weather delay day may be counted if adverse weather prevents work on the project during an event where:

- a. Precipitation days for a specific month is greater than the recorded monthly average for a project location indicated above.

- 1) The number of average rain days shall be subtracted from the number of recorded rain days and the difference shall be the allotted time.

- b. Precipitation for a given day is greater than the NOAA's PFF estimate indicated above.

- 1) One (1) day for each day or consecutive days of precipitation that exceeds the standard baseline.

- c. Precipitation of 3.0 inches over a 24-hour period.

- 1) The number of allotted days shall be at the discretion of the Engineer/Owner based on site conditions, working conditions, and type of construction.
- 2) Temperature per ACI 306.

E. Exceptions

1. The Contractor shall take into account that certain construction activities are more affected by adverse weather and seasonal conditions than other activities, and that "dry-out" or "mud" days are not eligible to be counted as an Adverse Weather Delay Day until the standard baseline is exceeded. Hence, the Contractor should allow for an appropriate number of additional days associated with the Standard Baseline days in which such applicable construction activities are expected to be prevented and suspended.

F. Record Keeping

1. All Adverse Weather events shall be recorded by the on-site management team.
2. On-site records of daily rain and/or temperature readings shall be kept by the Contractor and may be accepted to verify weather and/or temperature variations which prevent

earthwork, foundation and slabs, and/or roofing materials installation. The Inspector shall also be required to maintain on-site records of daily rain and/or temperature.

1.12 SPECIFICATION AND DRAWING 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. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. 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.

1.13 WARRANTIES

- A. Warranties shall conform to the requirements of the General Conditions.
- B. All equipment supplied by the Contractor under these Specifications shall be warranted by the Contractor and the equipment manufacturers for a period of one (1) year. Warranty period shall commence on the date of Substantial Completion.
- C. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail due to workmanship, design and materials during the warranty period, it shall be replaced by the Contractor and the unit(s) restored to service at no expense to the Owner.
- D. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining equipment warranties from each of the respective suppliers or manufacturers for all the equipment specified.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests for Information (RFIs).
 - 4. Project meetings.
- B. Each contractor shall participate in coordination requirements.
- C. Related Requirements:
 - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 01 70 00 "Execution and Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

- A. RFI: Request from Engineer seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: No less than fifteen (15) days prior to starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in

attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office and at existing treatment facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Engineer
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: As acceptable to the Engineer.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Engineer Action: Engineer will review each RFI, determine action required, and respond. Allow seven (7) working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within five days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log monthly. Include the following:

1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Engineer
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Engineer's response was received.
- F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within five days if Contractor disagrees with response.
1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.7 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within seven days of the meeting.
- B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than fifteen (15) days before mobilization.
1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.

- j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Sustainable design requirements.
 - m. Preparation of record documents.
 - n. Use of the premises.
 - o. Work restrictions.
 - p. Working hours.
 - q. Owner's occupancy requirements.
 - r. Responsibility for temporary facilities and controls.
 - s. Procedures for moisture and mold control.
 - t. Procedures for disruptions and shutdowns.
 - u. Construction waste management and recycling.
 - v. Parking availability.
 - w. Office, work, and storage areas.
 - x. Equipment deliveries and priorities.
 - y. First aid.
 - z. Security.
 - aa. Progress cleaning.
4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer and owner of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Sustainable design requirements.
 - i. Review of mockups.
 - j. Possible conflicts.
 - k. Compatibility requirements.
 - l. Time schedules.
 - m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.

- t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Engineer, but no later than 90 days prior to the scheduled date of Substantial Completion.
- 1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 - 2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for completing sustainable design documentation.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at minimum monthly intervals.
- 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these

- meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct Project coordination meetings as necessary. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these

- meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Change Orders.
 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 3. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 5. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 3. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Engineer's final release or approval.
 - g. Scheduled date of fabrication.
- B. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.
1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and record documents.
 - a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in Revit and CAD files.
- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

- a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Engineer's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
- E. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
 1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
 3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of subcontractor.
 - g. Name of supplier.
 - h. Name of manufacturer.
 - i. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a decimal and then a sequential number (e.g., 06 10 00.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06 10 00.01.A).
 - j. Number and title of appropriate Specification Section.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Other necessary identification.
 4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
 - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.

5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form.
 - a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
 - 1) Project name.
 - 2) Date.
 - 3) Destination (To:).
 - 4) Source (From:).
 - 5) Name and address of Engineer.
 - 6) Name of Construction Manager.
 - 7) Name of Contractor.
 - 8) Name of firm or entity that prepared submittal.
 - 9) Names of subcontractor, manufacturer, and supplier.
 - 10) Category and type of submittal.
 - 11) Submittal purpose and description.
 - 12) Specification Section number and title.
 - 13) Specification paragraph number or drawing designation and generic name for each of multiple items.
 - 14) Drawing number and detail references, as appropriate.
 - 15) Indication of full or partial submittal.
 - 16) Transmittal number
 - 17) Submittal and transmittal distribution record.
 - 18) Remarks.
 - 19) Signature of transmitter.
- F. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-06 10 00.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-06 10 00.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
 4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.

- g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.
 - j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - l. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.
 - n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.
 - s. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- G. Options: Identify options requiring selection by Engineer.
- H. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- I. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
- J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- K. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

1.5 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Submit electronic submittals via email as PDF electronic files.
 - a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 - 2. Action Submittals: Submit one paper copies of each submittal unless otherwise indicated. Engineer will not return copies.
 - 3. Informational Submittals: Submit one paper copies of each submittal unless otherwise indicated. Engineer will not return copies.
 - 4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 - 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - 5. Submit Product Data before or concurrent with Samples.
 - 6. Submit Product Data in the following format:

- a. PDF electronic file.
 - b. One (1) paper copies of Product Data unless otherwise indicated. Engineer will not return paper copies.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Engineer's digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
 - b. One opaque (bond) copies of each submittal.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.

- b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- 5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit one (1) set of samples to the Engineer and Owner for review.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."
- F. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- G. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 70 00 "Execution and Closeout Procedures."
- J. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."
- K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.
- L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

- M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- V. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads.

Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

1.6 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 70 00 "Execution and Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

- A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

- B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 01 33 00

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Quality control.
 - 2. Testing and inspection services.
 - 3. Manufacturers' field services.
 - 4. Shop Testing.
 - 5. Field Testing.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.

- C. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- D. Product Testing: Tests and inspections that are performed by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- E. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
 - 2. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 INSPECTION AND TESTING LABORATORY SERVICES

- A. Owner will employ and pay for the services of a resident Project representative (RPR)
- B. Contractor shall employ and pay for the services of an independent testing laboratory to perform all specified services and testing not specifically identified to be provided by Owner related to the design of mixes, products and equipment, to Engineer's review of proposed materials and equipment before, during and after incorporation in the Work and to retest materials and equipment which fail original tests.
 - 1. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the Work of the Contract

1.5 ACCEPTABLE TESTING AGENCIES

- A. Goodwyn Mills & Cawood; Greenville, SC
- B. Or Pre-Approved Equal

1.6 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Engineer.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Engineer.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

1.9 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.10 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- F. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 - 3. Notify testing agencies at least 48 hours in advance of time when Work that requires testing or inspecting will be performed.
 - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 - 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- G. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- H. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- I. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.

3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- J. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
- K. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- L. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Engineer.
 4. Identification of testing agency or special inspector conducting test or inspection.

- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 70 00 "Execution and Closeout Requirements."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one (1) week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 00 "Submittal Procedures."
 - b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

- A. Warranty requirements shall conform with the General Conditions followed by Section 01 10 00 – Summary.

1.8 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Engineer will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.
 4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with

requirements. Comparable products or substitutions for Contractor's convenience will be considered,

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

1.9 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:
 1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
 5. Samples, if requested.
 6. The Contractor shall also include in the price bid the modifications necessary for the comparable product to be utilized. This includes but is not limited to, electrical and mechanical changes, engineering time to assess the changes, modifications to buildings, programmable controls and structural modifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Product maintenance manuals.
 - 5. Systems and equipment maintenance manuals.
- B. Related Requirements:
 - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.

- a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
2. Two paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least fifteen (15) days before commencing demonstration and training. Engineer will return copy with comments.
 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within fifteen (15) days of receipt of Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
 1. List of documents.
 2. List of systems.
 3. List of equipment.
 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Engineer.
 - 8. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
 - 9. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch and 11 x 17 paper (Z folded); with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Precautions against improper use.
 9. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
 1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.

5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

2.4 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.

- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
 - 2. Comply with requirements of newly prepared record Drawings in Section 01 78 39 "Project Record Documents."

- E. Comply with Section 01 70 00 "Execution and Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 01 70 00 "Execution and Closeout Procedures" for general closeout procedures.
 - 2. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one (1) set of marked-up record prints.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Final Submittal:
 - 1) Submit one (1) paper-copy set of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and one (1) set of prints.
 - 3) Print each drawing, whether or not changes and additional information were recorded.
- B. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued. Contractor shall maintain a set of marked up prints on the job site for review prior to pay request approval.
1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Revisions to electrical circuitry.
 - d. Actual equipment locations.
 - e. Locations of concealed internal utilities.
 - f. Changes made by Change Order or Work Change Directive.
 - g. Changes made following Engineer's written orders.
 - h. Details not on the original Contract Drawings.
 - i. Field records for variable and concealed conditions.
 - j. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Engineer.
 - e. Name of Contractor.

2.2 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.
 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. Furnish demonstration and training instruction time as a subsidiary obligation of the price bid.

1.3 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training.

1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.

- f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, through Engineer with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Cleanup: Restore systems and equipment to condition existing before initial training use.

END OF SECTION 01 79 00

SECTION 03 20 00 – ANCHORAGE IN CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the requirements for mechanical and adhesive anchors for concrete.

1.2 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related work specified elsewhere includes:
1. Section 05 50 00 – Metal Fabrications
 2. Division 26 – Electrical

1.3 SUBMITTALS

- A. Submit product information to the Engineer for approval in accordance with Section 01 33 00.

PART 2 - PRODUCTS

2.1 WEDGE TYPE ANCHORS

- A. Anchors shall feature a stainless steel split expansion ring; a threaded stud body; and integral cone expander, nut and washer.
- B. Anchor bodies smaller than 3/4 inch, excluding countersunk anchors, shall be made from AISI 316 and shall have the following minimum bolt fracture loads:

Anchor Diameter (in.)	Minimum Fracture Load (lb)
1/4	2,900
3/8	7,200
1/2	12,400
5/8	21,900

- C. Anchor bodies 3/4 inch and larger, and all stainless steel post nut anchor bodies, shall be made from AISI 316 stainless steel and shall have the following minimum mechanical properties:

Anchor Diameter (in.)	Min. Tensile Strength (ksi)	Min. Yield Strength (ksi)
≤5/8	90	76
≥3/4	76	64

- D. All nuts shall meet the dimensional requirements of ASTM F 594.
- E. Washers shall meet the dimensional requirements of ANSI B18.22.1, Type A, plain.
- F. Expansion sleeve for anchors shall be made from AISI 316. All nuts and washers shall be made from AISI 316.
- G. Anchor size and depth shall be as shown on drawings.
- H. Manufacturers:
 - 1. Trubolt (as manufactured by ITW-Redhead, Inc.)
 - 2. Kwik Bolt 3 (as manufactured by Hilti, Inc.)
 - 3. Or Approved Equal

2.2 ADHESIVE ANCHOR SYSTEM

- A. Adhesive anchor system shall consist of an injectable two-part epoxy.
- B. Application system shall be in accordance with manufacturer's recommendations. System shall keep the two components separated until application of product directly into drilled hole. Proper cleaning of holes is critical to the performance of adhesive anchoring systems. Manufacturer's hole cleaning requirements shall be strictly followed.
- C. System shall thoroughly blend the two parts by means of a static mixer nozzle.
- D. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness.
- E. Anchor rods shall be as shown on drawings or as specified in other sections of these specifications.
 - 1. Anchor rods shall be furnished with chamfered ends so that either end will accept a nut and washer.
 - 2. Alternately, anchor rods shall be furnished with a 45° chisel point on one end to allow for easy insertion into the adhesive-filled hole.
- F. Nuts and washers shall be provided for anchor rods in the same material as the anchor rod.
- G. Manufacturers:
 - 1. HIT RE 500 Epoxy Adhesive Anchor as manufactured by Hilti, Inc.
 - 2. G5 Adhesive Anchoring System as manufactured by ITW-Redhead, Inc.
 - 3. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Layout anchors before drilling into concrete to ensure proper placement. Following manufacturer's recommendation for spacing of anchors. Notify Engineer of conflicts between existing conditions and requirements by manufacturer.
- B. Install anchors per manufacturer's recommendations.
- C. Embedment length shall be per manufacturer's recommendations for load conditions.
- D. Check all equipment anchors after equipment has operated. Retighten any loose anchors.

END OF SECTION 03 20 00

SECTION 03 60 00 - GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Portland cement grout.
2. Rapid-curing epoxy grout.
3. Nonshrink cementitious grout.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete for Buildings.
2. ACI 318 - Building Code Requirements for Structural Concrete.
3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

B. ASTM International:

1. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
2. ASTM C40/C40M - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
3. ASTM C150/C150M - Standard Specification for Portland Cement.
4. ASTM C191 - Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle.
5. ASTM C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
6. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
7. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
8. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

C. U. S. Army Corps of Engineers Concrete Research Division (CRD):

1. CRD-C621 - Non-Shrink Grout.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information regarding grout.

- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - 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.

1.5 AMBIENT CONDITIONS

- A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Maximum Conditions: Do not perform grouting if temperatures exceed manufacturer's recommendations.
- C. Minimum Conditions: Maintain minimum temperature per the manufacturer before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT GROUT

- A. Portland Cement: Comply with ASTM C150, Type I and II.
- B. Water:
 - 1. Potable.
 - 2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:
 - a. Corrosion of steel.
 - b. Volume change increasing shrinkage cracking.

- c. Efflorescence.
 - d. Excess air entraining.
- C. Fine Aggregate:
 - 1. Washed natural sand.
 - 2. Gradation:
 - a. Comply with ASTM C33.
 - b. Represented by smooth granulometric curve within required limits.
 - 3. Free from injurious amounts of organic impurities according to ASTM C40.
- D. Mix:
 - 1. Portland cement, sand, and water.
 - 2. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 RAPID-CURING EPOXY GROUT

- A. Manufacturers:
 - 1. L&M Construction Chemicals.
 - 2. Sika Corporation.
 - 3. WR Meadows.
 - 4. Or Approved Equal.
- B. Description:
 - 1. High-strength, three-component epoxy grout formulated with thermosetting resins and inert fillers.
 - 2. Rapid-curing, high adhesion, and resistant to ordinary chemicals, acids, and alkalis.
- C. Performance and Design Criteria:
 - 1. Compressive Strength:
 - a. 12,000 psi at seven (7) days.
 - b. Comply with ASTM C579.
 - 2. Minimum Tensile Strength:
 - a. 2,000 psi.
 - b. Comply with ASTM C307.
 - 3. Coefficient of Expansion:
 - a. 30×10^{-6} inch per degree F.
 - b. Comply with ASTM C531.
 - 4. Shrinkage:

- a. None.
- b. Comply with ASTM C827.

2.3 NONSHRINK CEMENTITIOUS GROUT

A. Manufacturers:

- 1. Euclid Chemical Company
- 2. Sika Corporation
- 3. L&M Construction Chemicals
- 4. Or Approved Equal.

B. Description:

- 1. Pre-mixed and ready-for-use formulation requiring only addition of water.
- 2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, and no chlorides.

C. Performance and Design Criteria:

- 1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to CRD-C621 for Type D nonshrink grout:
 - a. Setting Time:
 - 1) Initial: Approximately two (2) hours.
 - 2) Final: Approximately three (3) hours.
 - 3) Comply with ASTM C191.
 - b. Maximum Expansion: 0.10 to 0.40 percent.
 - c. Compressive Strength:
 - 1) One-Day: 4,000 psi.
 - 2) Seven-Day: 7,000 psi.
 - 3) 28-Day: 10,000 to 10,800 psi.
 - 4) Comply with CRD-C621.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify areas to receive grout.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Remove defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by brushing, hammering, chipping, or other similar means until sound and clean concrete surface is achieved.
- C. Roughen concrete lightly, but not to interfere with placement of grout.
- D. Remove foreign materials from metal surfaces in contact with grout.
- E. Align, level, and maintain final positioning of components to be grouted.
- F. Saturate concrete surfaces with clean water, and then remove excess water.

3.3 INSTALLATION

- A. Formwork:
 - 1. Construct leakproof forms anchored and shored to withstand grout pressures.
 - 2. Install formwork with clearances to permit proper placement of grout.
- B. Mixing:
 - 1. Portland Cement Grout:
 - a. Use proportions of two (2) parts sand and one part cement, measured by volume.
 - b. Prepare grout with water to obtain consistency to permit placing and packing.
 - c. Mix water and grout in two (2) steps:
 - 1) Premix using approximately 2/3 of water.
 - 2) After partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing two to three minutes.
 - d. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
 - e. Do not add additional water after grout has been mixed.
 - f. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.
 - 2. Rapid-Curing Epoxy Grout:
 - a. Mix and prepare according to manufacturer instructions.
 - b. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.
 - 3. Nonshrink Cementitious Grout:
 - a. Mix and prepare according to manufacturer instructions.
 - b. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.

4. Mix grout components in proximity to Work area and transport mixture quickly and in manner not permitting segregation of materials.

C. Placing of Grout:

1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or by using wet burlap method.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three days.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Inspection and Testing:

1. Comply with ACI 301 and as specified in Section.
2. Submit proposed mix design of each class of grout to Engineer of Record for review prior to commencement of Work.
3. Tests of grout components may be performed to ensure compliance with specified requirements.

END OF SECTION 03 60 00

SECTION 26 00 00 - ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Work under this item of the Contract shall include the furnishing of all labor, material, equipment, supplies, and services necessary to construct and install the complete electrical systems, including exterior and interior of buildings as shown on the drawings and specified herein.
- B. The Contractor shall base his proposal on the materials specified herein and on the drawings. Reference to a particular product by the manufacturer, trade name, or catalog number establishes the quality standards of materials and equipment required for this installation and is not intended to exclude products equal in quality and similar in design. Where two or more designations are listed, choice shall be optional with the Contractor. The Engineer reserves the sole right to decide the equality of materials proposed for use in lieu of those specified.

1.2 RELATED DOCUMENTS:

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

1.3 CODES, PERMITS, AND INSPECTIONS

- A. Comply with applicable laws of the community, with latest edition of NEC where not in conflict with those laws, and with the service rules of the local utility company. Obtain and pay for all permits required. After completion of the work, submit certificate of final inspection and approval from the local electrical inspector, certifying that the installation complies with all regulations governing same.

1.4 DRAWINGS AND SPECIFICATIONS

- A. Consider as complementary each to the other. What is called for by one shall be as binding as if called for by both. Where conflicts occur, secure clarification from Engineer in advance of bidding; otherwise provide the more expensive quality or quantity. Follow figures in preference to scale dimensions; verify all dimensions and existing conditions.

1.5 CONFLICTS, COORDINATION AND CHANGES

- A. In the event that interferences or conflicts develop, the Engineer shall decide which equipment shall be relocated regardless of which was first installed. In the interest of avoiding such conflicts, the electrical sub-contractor who is using common space such as mechanical rooms, chases, ceiling space, etc., shall coordinate his work with all other trades and other parts of his own work. If, during this coordination, it is discovered that necessary or desirable changes should be made, advise the Engineer and secure his decision in writing.

1.6 SUBMITTALS

- A. The Electrical Contractor shall submit five copies of a list of items proposed for use. The Electrical Contractor shall also submit five copies of catalog data and shop drawings on proposed substitutions and on panelboards, exhaust fans, transformers, motor control centers, switchboards, light fixtures, electric heaters, safety switches, surge suppressors, lightning arrestors, etc. Where substitutions alter the design or space requirements, the Electrical Contractor shall defray all items of cost for the revised design and construction including costs of all allied trades involved.
- B. The Electrical Contractor shall include in his submittals layout drawings of all electrical rooms, layout drawings of all common space rooms, and/or layout drawings of all backboards or any other space where electrical equipment is mounted showing that he has taken into account other trades that may share this space.
- C. Record Drawings: Provide, and in such detail as required.
- D. Operations and Maintenance Manuals: Provide, and in such detail as required.

1.7 WARRANTY

- A. Warrant the entire electrical system in proper working order. Replace, without additional charge, all work or material which may develop defects (ordinary wear and tear or damage resulting from improper handling excepted) within a period of one year from date of final acceptance.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall be new and shall be listed as approved by the Underwriter's Laboratories, Inc. in every case where a standard has been established for the particular type of material in question. All work shall be executed in workmanlike manner and shall present a neat and mechanical appearance when completed.

2.2 ELECTRICAL SERVICE

- A. General: Coordinate with Utility Company. Provide all material and labor not supplied by Utility Company so as to produce a complete installation meeting the Utility regulations. The Electrical Contractor shall be responsible for including all fees associated with bringing power to this site in their original bid. A copy of the bill showing the cost to provide the electrical service shall be given to the owner for verification of the cost.
- B. Characteristics of Service: Existing 277/480 volt, 60 cycle, 3 phase, 4 wire, with a ground to remain.
- C. Metering: Existing to remain.
- D. Main Service Equipment: Existing to remain.
- E. Service Feeder: Existing to remain.

- F. Transformer: Existing to remain.

PART 3 - EXECUTION

3.1 VISIT TO SITE

- A. Before submitting a bid, visit the site and ascertain all existing conditions. Make such adjustments in work as are required by the actual conditions encountered.

3.2 CUTTING AND CHASING

- A. Where possible all work shall be built in as the job progresses. Where this is not possible, secure approval and do necessary cutting, chasing, etc. required. Do not cut through any structural members without securing approval in advance; such holes shall be neatly cut or drilled – not chipped.

3.3 TRENCHING AND BACKFILLING

- A. Do all excavating necessary for installation of work; backfill trenches and excavations after work has been installed and inspected. Backfill within the building and under paved areas shall meet compaction requirements and fill material shall be pit run gravel or similar granular material.

3.4 SALVAGE MATERIAL

- A. All metals and devices removed from the project that can be returned for scrap shall be the property of the owner. Owner shall have first right of refusal on all items that are to be demolished, removed or scrapped from the project. Contractor shall provide a list of such items in written form to the owner. Prior to the Contractor salvaging any material for his own gain, the contractor shall obtain written approval from the Owner.

END OF SECTION 26 00 00

SECTION 26 03 00 - CONTROLS AND SYSTEM INTEGRATION

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes the requirements for the control equipment and system integrations for the Table Rock and North Saluda Outlet Structure Improvements project as shown on the drawings and specified herein.

1.2 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related work specified elsewhere includes:
 - 1. Division 40
 - 2. Division 26
 - 3. Section 26 03 30

1.3 SUBMITTALS

- A. Hardware Submittals: Before any components are fabricated, and/or integrated into assemblies or shipped to the job site, furnish to the Engineer, for their review, submittal documents in accordance with Section 01 33 00. Submittals shall include full details, shop drawings, catalog cuts and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these specifications. Specifically, the Contractor shall submit the following materials:
 - 1. Block diagram and operational description of the system showing all major components and their interconnections and interrelationships. Label each diagram and specify all external power and communications interfaces. All diagrams shall be in an 11 by 17 format. Required documentation sets shall be furnished in bound hardcopy and final documentation shall also be provided in electronic format.
 - 2. Drawings of equipment to be supplied shall include, as a minimum: overall dimension details for each panel, console, etc., including internal and external arrangements and door mounted operator devices with name plate designations. Wiring diagrams of equipment including field device connections shall be included and specific installation/wiring requirements identified.
 - 3. Operational Description shall include the principal functions/capabilities of the PLC's as configured /programmed. Included shall be a description of system communications.
 - 4. Provide a detailed Bill of Materials along with descriptive literature identifying component name, manufacturer, model number, and quantity supplied.
 - 5. Training Material
- B. Test Outlines and Procedures Submittals: Test descriptions shall be in sufficient detail to fully describe the specific tests to be conducted to demonstrate conformance with this specification.
- C. Operations and Maintenance Data: At a minimum, include the following information.
 - 1. Operating and Calibration instructions.
 - 2. PLC commented code.
 - 3. Troubleshooting Information.
 - 4. Wiring Diagrams with wire numbers and termination point.

1.4 COORDINATION

- A. All programming and wire termination shall be performed by an approved systems integrator.

1.5 QUALITY ASSURANCE

- A. The Contractor's attention is directed to the fact that all specified instruments and controls must form a completely integrated system and, as such, the system integrator shall become familiar with requirements necessary to provide equipment specified for the system regardless of manufacture, and shall be responsible to the Contractor for the complete and satisfactory operation of the entire instrumentation and control system.
 - 1. These specifications cover the intended function of the equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. The manufacturer shall supply all devices and appurtenances necessary to provide a complete, operable and satisfactory system as indicated or specified.
- B. Contractor shall use one of the approved Systems Integrators. The System Integrator shall be responsible for all final terminations from the new equipment and instruments to the I/O termination points. Electrical Contractor shall pull all wires to this point, label each wire, and provide this list to the System Integrator.
- C. Individual Responsibilities
 - 1. System Integrator
 - a. The system integrator shall have the authority to organize the data layout within each individual device used in the user interface system. This said data layout will be based on the device provider's listing of available data points for monitor and control. The system integrator will dictate the data used and the layout needed to facilitate the most efficient system possible. This efficient system methodology will be to minimize the number of queries needed to retrieve the necessary information. The system integrator may also require the separation of status and control registers to more easily facilitate expansion and/or changes to the data structure.
 - b. The system integrator does not have the authority to change the program algorithm for the subsystem device. The actual functionality of the system is under direct control of the Engineer and the pertinent specifications. The system integrator is responsible for contacting each device provider and attaining the listing of data available and then communicating with the provider the proper organization of data in the system.
 - 2. Device Providers
 - a. Device providers must generate a listing of all pertinent data available for monitor and control within the user interface system. It is the device provider's responsibility to be in contact with the system integrator to ensure proper operation within the integrators scope of work. The device provider has direct control over the program algorithm for the portion of the system the said device is specified.
- D. Approved System Integrator/Supplier(s):
 - 1. MR Systems, Norcross, Ga
 - 2. Or Approved Equal.
- E. All components shall be from the same manufacturer and supplied by a single source, the system integrator.

PART 2 PRODUCTS

- 2.1 PROGRAMABLE LOGIC CONTROLLER (PLC)
- 2.2 PLC-BASED I/O SUBSYSTEM ENCLOSURES

- A. It is the intent of this specification to modify minimum requirements for a solid-state programmable logic controller designed to provide high reliability for this application.
1. The internal wiring of the controller is to be fixed.
 2. All field wiring terminations are made to terminal strips capable of accommodating up to #12 AWG wire. Terminal strips shall be mounted using DIN rails. Terminal strips are manufactured by Phoenix Contact, Allen-Bradley, Square D or equal. Printed labels are used to designate terminal numbers for each terminal.
 3. A limit switch is mounted on the door of the Remote I/O Panel enclosure. The limit switch is wired to a non-relay-isolated input of the RTU to provide a "RTU Door Open" signal.
 4. All analog inputs, shall be protected from surges using three separate levels of surge/transient suppression. The first level of protection shall be via a 1/4 Amp 3AG size fast acting fuse. Secondary and tertiary protection shall be fulfilled using combination gas discharge and metallic oxide varistor (MOV) surge protection with current limiting resistors. Terminals shall be installed to allow each of the four analog inputs and outputs to be configured for 2-wire or 4-wire process transmitters and to produce either 4 to 20 mA or 1 to 5 VDC outputs to the PLC and any future display or signal conversion devices. Terminals shall be installed adjacent to the analog surge protection to provide 24 VDC for connections of future 2-wire transmitters.
 5. All digital inputs, shall be isolated from field wiring through terminal strips and mechanical relays. Minimum contact rating for relays shall be 10 Amps at 250 VAC.
 6. All digital outputs, shall be isolated from field wiring through terminal strips and electro-mechanical relays with contact ratings of 10 Amps at 250 VAC minimum.
 7. Communications Protocol
 - a. In order to insure future expandability of the system all communications shall be via Modbus TCP communications protocol.
- B. PLC Hardware
1. The Programmable Logic Controller and Components will be supplied by the systems integrator in the locations indicated on the plans, to the meet the following specifications:
 - a. Main Treating Station PLC (Existing PLC components to be upgraded and modified as shown below)

POWER SUPPLY	GE# GEFIC695PSA040 RX3i Power Supply 120/240VAC and 125VDC, 40W	SCADA CONTRACTOR
CPU	GE# GEFIC695CPE305 CPE305 CPU, 1.1GHz Processor, 5Meg user memory, 1-RS-232 port, 1 – Ethernet Port and 1-USB master port	SCADA CONTRACTOR
Base	GE# EFIC695CH2012 RX3i 12 slot universal base. Two (2) of these will be needed for the full upgrade of this panel)	SCADA CONTRACTOR
	GE# IC695NKT001 RX3i Ethernet Module for Modbus TCP communications.	
Fiber Patch Panel	8-port configuration by Cisco, or Approved Equal.	SCADA CONTRACTOR
8RJ-45 Ports, 2-single mode fiber optic	Extreme Networks, Or Approved Equal.	SCADA CONTRACTOR

ports.		
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b. Remote I/O Panels (As shown on the Network Diagram)

Power Supply	120VAC Input, 24VDC Output, 5A, Power Supply by Phoenix Contact, GE, Or Approved Equal.	SCADA CONTRACTOR
Network Adapter	Modbus TCP, GE# EPXMBE001	SCADA CONTRACTOR
Remote I/O	Analog Input Module GE# EP-3124	SCADA CONTRACTOR
Remote I/O	Analog Output Module GE# EP-4264	SCADA CONTRACTOR
Remote I/O	Digital Input Module GE#EP1804 (Provide 2 of these)	SCADA CONTRACTOR
Remote I/O	Digital Output Module GE# EP-2714 (Provide 2 of these)	SCADA CONTRACTOR
UPS, 1200VA, 120VAC	Falcon, Sola HD, APC, Or Approved Equal.	SCADA CONTRACTOR
Fiber Patch Panel	8-port configuration by Cisco, or Approved Equal.	SCADA CONTRACTOR
8RJ-45 Ports, 2-single mode fiber optic ports.	Extreme Networks, Or Approved Equal.	SCADA CONTRACTOR

2.3 REQUIRED I/O FOR EACH PLC LOCATION:

- A. As shown on the plan sheets (See the P&ID drawings for all I/O and functionality).
- B. In addition to the I/O and data shown on the plan sheets, the following I/O and data shall be gathered by the SCADA system and made available at the HMI system for each of the types of devices or processes indicated:
 1. Main Treating Station PLC I/O Modifications (add the following I/O points to the modified PLC and I/O cards)
 - a. V2002 – Valve Open Position Indication – DI (120VAC Input)
 - b. V2002 – Valve Close Position Indication – DI (120VAC Input)
 - c. V2002 – Open/Close Command – DO (120VAC Relay Output)
 - d. V2002 – Percent Open Command – AO (4-20mA Output)
 - e. V2002 – Percent Open Feedback Signal – AI (4-20mA Input)
 - f. River Structure Radar Level/Flow Measurement – AI (4-20mA loop powered radar level device with display as specified measuring level over a weir structure to convert to a flow measurement)

2. Outlet Structure Remote I/O
 - a. V2002 – Valve Open Position Indication – DI (120VAC Input)
 - b. V2002 – Valve Close Position Indication – DI (120VAC Input)
 - c. V2002 – Open/Close Command – DO (120VAC Relay Output)
 - d. V2002 – Percent Open Command – AO (4-20mA Output)
 - e. V2002 – Percent Open Feedback Signal – AI (4-20mA Input)
 - f. Outlet Structure Ultrasonic Clamp On Flow Measurement – AI (4-20mA Input, transmitter is 120V powered via separate source as indicated on the plans)
 - g. Door Switch Status – DI (120VAC Input indicating if the enclosure door is opened)

2.4 MANUFACTURERS

A. PLC

1. As manufactured by GE.
2. Or Approved Equal.

B. Input/Output Modules

1. Components as manufactured by GE.
2. Or Approved Equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install the work of this Section in strict accordance with the original design and the manufacturer's recommended installation procedures as approved by the Engineer, anchoring all components firmly into position for long life under hard use
- B. Unload, unpack and transport equipment to prevent damage or loss.
- C. Replace damaged components as directed by Engineer.
- D. Protect from dust and other harmful materials.
- E. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Provide all required cables, cords, and connective devices for interface with other control system components.
- B. Coordinate size and configuration of enclosure to meet project requirements.

3.4 STARUP SERVICE

- A. Upon final completion of all components determine date of start-up jointly with Engineer, Owner and Contractor.

3.5 CLEANING

- A. Clean units as recommended by manufacturer.

END OF SECTION 26 03 00

SECTION 26 03 30 - SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. This section covers work necessary for the modification, design, documentation, assembly, test, installation, field testing, startup, training, and final documentation for the Table Rock and North Saluda Outlet Structure Improvements project as shown on the drawings and specified herein.

1.2 DESCRIPTION

- A. Work included: Provide modifications to the existing pump stations with appurtenant equipment and accessories as indicated, specified, and as necessary for a complete and proper operating system.
 - 1. Work includes, but is not necessarily limited to, the following:
 - a. All PLC hardware, programmable logic controller I/O Boards and other appurtenances as indicated and specified herein and as required by the pump stations descriptions.
 - b. All engineering, hardware and software development, installation, startup, calibration services, programming and necessary supervision required.
 - c. New operator workstations complete with accessories was described herein.
 - d. Testing and operational demonstrations as specified.
 - e. Training programs as specified.
 - f. Preparation of instruction manuals.

1.3 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related work specified elsewhere includes:
 - 1. Division 40
 - 2. Division 26
 - 3. Section 26 03 00

1.4 SUBMITTALS

- A. Hardware Submittals: Before any components are fabricated, and/or integrated into assemblies or shipped to the job site, furnish to the ENGINEER, for their review, submittal documents in accordance with Section 01 33 00. Submittals shall include full details, shop drawings, catalog cuts and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these specifications. Specifically, the CONTRACTOR shall submit the following materials:
 - 1. Block diagram and operational description of the system showing all major components and their interconnections and interrelationships. Label each diagram and specify all external power and communications interfaces. All diagrams shall be in an 11 by 17 format. Required documentation sets shall be furnished in bound hardcopy and final documentation shall also be provided in electronic format.
 - 2. Drawings of equipment to be supplied shall include, as a minimum: overall dimension details for each panel, console, etc., including internal and external arrangements and door mounted operator devices with nameplate designations. Wiring diagrams of equipment including field device connections shall be included and specific installation/wiring requirements identified.

3. Operational Description shall include the principal functions/capabilities of the personal computer (PC) and PLC's as provided and configured /programmed. Included shall be a description of system communications.
 4. Provide a detailed Bill of Materials along with descriptive literature identifying component name, manufacturer, model number, and quantity supplied.
 5. Provide Warranty information for entire installation.
- B. Software Submittals:
1. Provide complete user manuals for all supplier configured software and firmware. For ancillary software such as operating systems, spreadsheets, etc. being supplied under this contract, only a listing of the manuals, which will be included with the Operations and Maintenance documentation is required.
 2. Sample communication and control database programs for project in hardcopy form. As a minimum, hardcopy form shall be fully documented, including code, comments, addressing data and cross-references, etc. Every line or section of code shall be accompanied by a comment describing its function.
 3. Provide initial graphic display and report format layouts as described later in this specification. List and briefly describe all operator interface functions provided at the PC, including: alarm annunciation and acknowledgment, status displays, control capabilities, report generation, event logging, charting and trending, etc.
- C. Operation and Maintenance Manuals
1. The CONTRACTOR shall provide hard-covered, ring bound loose-leaf O&M manuals in accordance with Section 01 78 20. In addition to "as-built" system drawings, the manuals shall include internal wiring diagrams and operating and maintenance literature for all components provided under this section.
 2. The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, programming and configuration, adjustment, calibration, testing and maintenance of each component and/or instrument.
 3. Operation and Maintenance manuals shall include copies of all commented PLC programs written to accomplish the monitoring and control functions specified, as well as all passwords associated with the SCADA system. Programs shall be updated after startup is complete, with the program(s) provided to the OWNER in electronic format. Two (2) copies to be provided.
 4. The contents of the O&M manuals shall be generally organized as follows:
 - a. System Hardware/Installation
 - b. System Software, including all passwords
 - c. Operation
 - d. Maintenance and Troubleshooting
- D. Test Outlines and Procedures Submittals: Test descriptions shall be in sufficient detail to fully describe the specific tests to be conducted to demonstrate conformance with this specification.
- E. Spares and Expendable Recommendations: The CONTRACTOR shall provide a list of recommended spares and expendable items. The list shall be exclusive of any spares furnished under this Contract.

1.5 QUALITY ASSURANCE

- A. The CONTRACTOR'S attention is directed to the fact that all specified instruments and controls must form a completely integrated system and, as such, the system integrator shall become familiar

with requirements necessary to provide equipment specified for the system regardless of manufacture, and shall be responsible to the CONTRACTOR for the complete and satisfactory operation of the entire plant instrumentation and control system.

1. These specifications cover the intended function of the equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. The manufacturer shall supply all devices and appurtenances necessary to provide a complete, operable and satisfactory system as indicated or specified.
 2. The Control System Integrator shall have a minimum of five years experience in providing similar operational systems of which a listing may be requested.
- B. The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired. Alternate equipment shall be submitted to the ENGINEER at least 14 days prior to bid (in accordance with the following prebid submittal requirements and Section 01625). The ENGINEER will issue an addendum prior to bid listing approved alternate control systems.
- C. Control System Integrator
1. It is the intent of these specifications and drawings that the Contractor shall engage an approved and qualified Control System Integrator to provide the system as specified and indicated.
 2. The Control System Integrator shall design and furnish a complete, integrated and functionally operating system, warranted to perform the intended functions as herein specified.
 3. Provide or supply all hardware and software specified herein or required and provide all required and specified collateral services in connection with the system such as testing, calibration, start-up, operation and maintenance manuals, and operator training without additional cost to the OWNER.
 4. Provide system integration for control systems by other equipment manufacturers supplying control equipment.
- D. Individual Responsibilities
1. System Integrators
 - a. The system integrator shall have the authority to organize the data layout within each individual device used in the user interface system. This said data layout will be based on the device provider's listing of available data points for monitor and control. The system integrator will dictate the data used and the layout needed to facilitate the most efficient system possible. This efficient system methodology will be to minimize the number of queries needed to retrieve the necessary information. The system integrator may also require the separation of status and control registers to more easily facilitate expansion and/or changes to the data structure. The system integrator does not have the authority to change the program algorithm for the subsystem device. The actual functionality of the system is under direct control of the ENGINEER and the pertinent specifications. The system integrator is responsible for contacting each device provider and attaining the listing of data available and then communicating with the provider the proper organization of data in the system.
 2. Device Providers

- a. Device providers must generate a listing of all pertinent data available for monitor and control within the user interface system. Based on this listing, the system integrator shall direct the provider on how the data shall be made public and also how to efficiently organize data as needed by the user interface. Device must be capable of communicating this data over the deemed standard protocol for this job such as Modbus TCP. The device provider is responsible for making the said device to respond properly and safely to changes made in control variables. It is the device provider's responsibility to be in contact with the system integrator to ensure proper operation within the integrators scope of work. The device provider has direct control over the program algorithm for the portion of the system the said device is specified.

- E. System Integrator/Supplier(s)
 1. MR Systems, Norcross, Ga
 2. Or Approved Equal.

1.6 RESPONSIBILITY FOR COMPLETE SYSTEM

- A. The CONTRACTOR shall be responsible for and shall provide for the design, supply, delivery, installation, certification, calibration and adjustment, software configuration, testing and startup, OWNER training, warranty and routine future field services, of a complete coordinated system which shall perform the specified functions.
- B. The OWNER and the ENGINEER will review system technical information as submitted by the CONTRACTOR for software; operating system, database, control strategies and the graphical user interface, i.e. report and log formats, graphics, trends, alarming, etc. for complete compliance with these specifications.

1.7 WARRANTY

- A. Systems supplier shall furnish a hardware and software maintenance contract for the computer system, providing for an 8-hour response time in normal working hours, five days per week for the length of the warranty period.
 1. For any service visit during this period, provide the OWNER and ENGINEER with a written report stating the reason for equipment failure and recommendations to prevent recurrence.
- B. At the end of this period, the maintenance contract shall be made available for transfer to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

- A. Major components of this system shall include the specified software, materials, equipment, and installation required to implement a complete and operational SCADA system along with any associated panel or field modifications.
- B. In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, to the greatest extent possible, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.
- C. Requirements for the electrical work associated with the installation of the SCADA system and associated instrumentation equipment are as specified in Division 26 – ELECTRICAL.
- D. The functions and features specified herewith are the minimum acceptable requirements for the SCADA system. The provided system shall equal or exceed each requirement.

- E. In some cases, the specifications may allow the accomplishing of certain functions by means of more than one hardware/firmware/software approach. No other approach may be taken that is different from that specified.
- F. The total control and monitoring system shall consist of a series of individual control and monitoring sub-systems, each configured to perform a specific function associated with the total system operational scheme.
- G. All equipment and materials shall be new, unused and proved by previous use of similar products to be completely suitable for the service intended.
- H. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the SCADA system. The completed system shall be compatible with the functions required and other equipment furnished by the CONTRACTOR.
- I. System manufacturer to supply "as-built" drawings containing all necessary information for proper maintenance and operation of the system.
 - 1. Wire log table showing connections (wire terminations) between all furnished components to be supplied to facilitate field wiring.
 - 2. Interconnection information between system components and equipment found in other sections of these Specifications shall be complete with all necessary interconnection information.
 - 3. Notes, which refer to equipment manufacturer's drawings for proper interconnection will not be acceptable.

2.2 TREATING STATION SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

A. System Description and System Components:

- 1. The existing Supervisory Control and Data Acquisition (SCADA) System shall be modified as described herein:
 - a. Upgraded existing PLC at the Treating Station and new Remote I/O Panel at the Outlet Structure.
 - b. The remainder of the existing plant that is to remain online shall remain connected to the system as is currently done. If changing of this connection is required, contact the Engineer for approval.
 - c. Main Computers and Graphics modified as follows:
 - 1) The existing SCADA software and control algorithms shall be modified to include the new instrumentation and process equipment in the existing outlet structure process area, the new instrumentation at the existing river structure process area, and the new process equipment at the existing treating station process area.
 - 2)

2.3 HUMAN-MACHINE INTERFACE (HMI) SOFTWARE PACKAGE

- A. The supervisory control and data acquisition (SCADA) system shall be modified by the System Integrator specifically for the I/o and PLC equipment additions noted in Section 26 03 00. As a minimum, the following graphics shall be required:
 - 1. Provide Updated System Overview Screen for the Treating Station Site, including the new Remote I/O panel at the Outlet Structure and the new River Structure Level/Flow Transmitter.
 - 2. New Display Screen for each Location
 - 3. Individual Control for each Location and Process Equipment
 - 4. Real Time Trend Screens for each new tagged variable.

5. An updated “Alarm Screen” which shows all signals which are presently in alarm and the status of each (i.e. “Acknowledged” or “Unacknowledged”) of the new signals and the alarms associated with them.

2.3 SOFTWARE ALARMS

- A. All analog inputs to the SCADA system shall have the capability for low and high software alarms. Where low and/or high software alarms are not specified elsewhere in this document, they shall initially be turned off or set for 0% (low alarm) and 100% (high alarm) of the signal range. This will help eliminate nuisance alarms during checkout and start-up. All software alarms shall be reviewed with the Owner, or his designee, during panel start-up. The System Integrator shall change all software alarm set-point values as instructed by the plant superintendent. For critical alarms, the System Integrator shall configure the associated graphic symbol to flash or change color when in an alarm condition. Critical software alarms that provide equipment interlock, (i.e., pump low level stop) will be generated in the (PLC) but set-points will be set at the HMI.

2.4 CONTROL STRATEGY

- A. General
 1. The Instrumentation and Controls System Integrator shall coordinate actual control strategy requirements and implementation with site constraints, equipment vendors, contractors and operations personnel.
 2. Coordinate with process drawings and specifications for a complete control scenario. Also, the systems integrator is required to have process control meetings with the owner, operators, and engineers prior to starting work so that the SCADA system functions as desired.

PART 3 EXECUTION

3.1 GENERAL

- A. Coordinate all work with the ENGINEER and OWNER to avoid conflicts, errors, delays and unnecessary interference with operation of the process during installation, testing, cutover and startup.

3.2 SURFACE CONDITIONS

- A. Systems Integrator shall visit site prior to bid to examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.3 INSTALLATION OF SYSTEM

- A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B. Install the work of this Section in strict accordance with the original design and the manufacturer's recommended installation procedures as approved by the ENGINEER, anchoring all components firmly into position for long life under hard use.

3.4 SOFTWARE REDEVELOPMENT

- A. Human-Machine Interface (HMI) software shall be fully configured by the instrumentation and control system vendor to integrate the new data. Reports, graphics displays, real-time trends, historical trends, security, and alarming shall be developed by the instrumentation and control system vendor through a collaborative effort between the ENGINEER, OWNER, and control system vendor. Graphics displays shall be designed by the instrumentation and control system vendor.

3.5 SYSTEM DISPLAY AND REPORTS

A. Graphic Display Design Meeting and Submittal

1. (1) One-day graphic display design and process control strategy meeting shall be held with the Engineer and Owner's personnel to discuss specific details of overall design of the graphic displays including discussions of the particular signals which are to be displayed on each graphic display and also specific control strategies for the redeveloped system. The meeting shall be held at the Owner's facility. There shall be an initial development meeting, followed by a comment and review period. Once that has been accomplished, a second review shall be done to make any final comments before implementation.
2. Prior to the meeting the instrumentation and control system vendor shall submit a detailed narrative for each of the proposed control strategies to the Engineer for review.
3. Travel and living costs to/from the Owner's facility shall be borne by each party.

3.6 TRAINING

- A. System supplier to provide operation and maintenance training for Owner's personnel to ensure their adequate knowledge of use of the system.
- B. Training to be conducted on-site by instructors thoroughly familiar with operation of the system.
- C. Analog and digital hardware maintenance training:
 - a. Instruct Owner's maintenance personnel in the proper preventative maintenance and repair tasks associated with system maintenance.
 - b. For analog instrumentation, include detailed instruction of calibration and checking along with familiarization training for basic repair and maintenance tasks that are expected to be encountered.
 - c. For computer hardware maintenance, include general familiarization with computer hardware and peripheral devices with instruction in preventative maintenance tasks associated primarily with peripheral devices. It is not intended that this course will produce trained computer maintenance technicians.
 - d. Include detailed instruction in maintenance and repair work associated with the computer process I/O sub-system.
 - e. Minimum training time for this material to be Four (4) hours.
2. Operator familiarization training:
 - a. Instruct Owner's operating personnel in the proper use of the analog and digital process control system.
 - b. Include instruction in the system control steps and basic interface with the computer system.
 - c. Provide sufficient training to Owner's operating personnel so they can respond to the normal tasks required for operation of the plant.
 - d. Minimum training time for this material to be Four (4) hours.
3. Provide supervisory service of a factory trained service engineer, specifically trained on the type of equipment herein specified, for a period of not less than one (1) 8-hour day during construction to assist the Contractor in the location of mounting brackets, methods of installing conduit and special cable, mounting, piping, and wiring of one of each type of service, and the methods of protecting all of the equipment prior to placing it into service.
4. Upon completion of equipment installation, provide services of the above service engineer for a period of not less than one (1) 8-hour day for calibration and start-up of the equipment and instructing the operating personnel.

3.7 STARTUP SERVICES

- A. All elements of the SCADA system shall be tested to demonstrate that the total system satisfies all of the requirements of this Specification. The CONTRACTOR shall provide all special testing materials and equipment. The CONTRACTOR shall coordinate and schedule all of his testing and startup work with the OWNER. As a minimum, the testing shall include both a factory test and a field test. Testing requirements are as follows:
 - 1. Field Tests:
 - a. All system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. Witnessed field tests shall be performed on the complete system. Each function shall be demonstrated to the satisfaction of the OWNER and ENGINEER on a paragraph-by-paragraph basis.
 - b. Each test shall be witnessed and signed off by the CONTRACTOR and the ENGINEER upon satisfactory completion. The CONTRACTOR shall notify the OWNER at least one (1) week prior to the commencement date of the field tests.
- B. Upon final completion of all components determine date of start-up jointly with ENGINEER, OWNER and CONTRACTOR.
- C. System supplier to be responsible for placing of SCADA equipment and systems in operation.
- D. System supplier to provide qualified personnel on the job site until successful operation of system is attained.

3.8 DEFINITION OF ACCEPTANCE

- A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:
 - 1. All O&M documentation has been submitted, reviewed and approved.
 - 2. The complete SCADA system and instrumentation have successfully completed all testing requirements specified herein and have successfully been started up.
 - 3. All OWNER'S staff personnel training programs have been completed.
 - 4. OWNER/ENGINEER sign a document indicating SCADA system has formally been accepted.

END OF SECTION 26 03 30

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Copper building wire rated 600 V or less.
- 2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

- 1. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer's authorized service representative.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden Inc.
 - 2. General Cable Technologies Corporation.
 - 3. Okonite Company (The).
 - 4. Southwire Company.
 - 5. Or Approved Equal.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type NM: Comply with UL 83 and UL 719.
 - 2. Type RHW-2: Comply with UL 44.
 - 3. Type SE: Comply with UL 854.
 - 4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 - 5. Type THHN and Type THWN-2: Comply with UL 83.
 - 6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 - 7. Type UF: Comply with UL 83 and UL 493.
 - 8. Type XHHW-2: Comply with UL 44.
- F. Shield:
 - 1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M Electrical Products.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 4. TE Connectivity Ltd.
 - 5. Thomas & Betts Corporation; A Member of the ABB Group.
 - 6. Or Approved Equal.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- F. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- G. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- F. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- G. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- J. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- K. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation prior to installing conductors and cables.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. All wire terminations at motor leads and at motor starters shall be made with insulated ring or fork type terminals and insulated for 600 volts with heat shrink sleeves.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors feeding the following critical equipment and services for compliance with requirements:
 - 3. Perform each of the following visual and electrical tests:

- a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:
- 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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. Backboards.
 - 2. Category 6 twisted pair cable.
 - 3. Twisted pair cabling hardware.
 - 4. RS-485 cabling.
 - 5. Low-voltage control cabling.
 - 6. Control-circuit conductors.
 - 7. Identification products.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector, certified cabling agent and installer.
- B. Source quality-control reports.

- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

2.2 BACKBOARDS

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
- B. Painting: Paint plywood on all sides and edges with black alkyd paint. Comply with requirements in Section 09 96 00 – High-Performance Coatings.

2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division/NORDX.
 2. General Cable; General Cable Corporation.
 3. Mohawk; a division of Belden Networking, Inc.
 4. Or Approved Equal.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables. All network cabling shall be certified and installed by a certified installer.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).
- F. Cable Rating: Plenum.
- G. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Belden CDT Networking Division/NORDX.
 2. General Cable; General Cable Corporation.
 3. Hubbell Premise Wiring.
 4. Leviton Manufacturing Co., Inc.
 5. Mohawk; a division of Belden Networking, Inc.
 6. Or Approved Equal.
- C. General Requirements for Twisted Pair Cable Hardware:
1. Comply with the performance requirements of Category 6.
 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- E. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.

2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:
 - a. Category 5e, unshielded twisted pair cable shall comply with IEC 60603-7-2.
 - b. Category 5e, shielded twisted pair cable shall comply with IEC 60603-7-3.
 - c. Category 6, unshielded twisted pair cable shall comply with IEC 60603-7-4.
 - d. Category 6, shielded twisted pair cable shall comply with IEC 60603-7.5.
 - e. Category 6a, unshielded twisted pair cable shall comply with IEC 60603-7-41.
 - f. Category 6a, shielded twisted pair cable shall comply with IEC 60603-7.51.
4. Marked to indicate transmission performance.

H. Faceplate:

1. Two port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic.
4. Metal Faceplate: Stainless steel.
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

I. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.

3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test cables on receipt at Project site.
 1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
 2. Outlet boxes for cables shall be no smaller than 4 inches square by 1-1/2 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 1. Comply with TIA-568-C Series of standards.
 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."

3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding 30 inches and not more than six (6) inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
10. Support: Do not allow cables to lie on removable ceiling tiles.
11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
12. All terminations shall be made with ring or fork type terminals.

C. Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 27 15 13 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of five (5) inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of six (6) inches.

- c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
- 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of three (3) inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of six (6) inches.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of five (5) inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 FIRESTOPPING

- A. Comply with TIA-569-D, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping" Chapter.

3.6 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.

END OF SECTION 26 05 23

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.
 - 3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1) Test wells.
 - 2) Ground rods.
 - 3) Ground rings.
 - 4) Grounding arrangements and connections for separately derived systems.
 - b. Instructions for periodic testing and inspection of grounding features at ground rings and test well based on NFPA 70B.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Burndy; Part of Hubbell Electrical Systems.
 2. ERICO International Corporation.
 3. O-Z/Gedney; a brand of Emerson Industrial Automation.
 4. Thomas & Betts Corporation; A Member of the ABB Group.
 5. Or Approved Equal.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with socket set screw.
- J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

- L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- N. Straps: Solid copper, copper lugs. Rated for 600 A.
- O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.
- P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- Q. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with stainless-steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.
- B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install barecopper conductor, No. 3/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
 - 2. Duct-Bank Grounding Conductor: Bury twelve (12) inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three (3) bands of green and two (2) bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers two (2) inches minimum from wall, six (6) inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from two (2) inches above to six (6) inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than six (6) inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are two (2) inches below finished floor or final grade unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect

- grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level shall be no more than ten (10) OHMS at all locations covered by these specifications, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two (2) full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- F. Grounding system will be considered defective if resistance is more than ten (10) OHMS and it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Report measured ground resistances that exceed values as listed on the plans.

- I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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 slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.3 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 the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

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

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.5.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- B. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- C. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) MKT Fastening, LLC.
 - 3) Or Approved Equal.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) B-line, an Eaton business.
 - 2) Hilti, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Or Approved Equal.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA 101
 3. NECA 102.
 4. NECA 105.
 5. NECA 111.
- B. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than four (4) inches larger in both directions than supported unit, and so anchors will be a minimum of ten (10) bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: 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 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 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 1. Structural members in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit; a part of Atkore International.
 2. O-Z/Gedney; a brand of Emerson Industrial Automation.
 3. Perma-Cote.
 4. Plasti-Bond.
 5. Southwire Company.
 6. Thomas & Betts Corporation; A Member of the ABB Group.
 7. Wheatland Tube Company.
 8. Or Approved Equal.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. FMC: Comply with UL 1; zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- G. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CANTEX INC.
 - 2. RACO; Hubbell.
 - 3. Thomas & Betts Corporation; A Member of the ABB Group.
 - 4. Or Approved Equal.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fiberglass:
 - 1. Comply with NEMA TC 14.
 - 2. Comply with UL 2515 for aboveground raceways.
 - 3. Comply with UL 2420 for belowground raceways.
- D. ENT: Comply with NEMA TC 13 and UL 1653.
- E. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- F. LFNC: Comply with UL 1660.
- G. Rigid HDPE: Comply with UL 651A.
- H. Continuous HDPE: Comply with UL 651A.
- I. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- J. RTRC: Comply with UL 2515A and NEMA TC 14.
- K. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- L. Fittings for LFNC: Comply with UL 514B.
- M. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Hoffman; a brand of Pentair Equipment Protection.
 - 2. Square D.
 - 3. Rittal

- 4. Or Approved Equal.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 12 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Moulded Products, Inc.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. Or Approved Equal.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Crouse-Hinds, an Eaton business.

2. Hoffman; a brand of Pentair Equipment Protection.
3. Hubbell Incorporated; Wiring Device-Kellems.
4. O-Z/Gedney; a brand of Emerson Industrial Automation.
5. Plasti-Bond.
6. Thomas & Betts Corporation; A Member of the ABB Group.
7. Wiremold / Legrand.
8. Or Approved Equal.

- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- D. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- F. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- G. Gangable boxes are allowed.
- H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Fiberglass.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- I. Cabinets:
1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Oldcastle Precast, Inc.
 - b. Quazite: Hubbell Power Systems, Inc.
 - c. Or Approved Equal.
 2. Standard: Comply with SCTE 77.
 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 6. Cover Legend: Molded lettering, "ELECTRIC."
 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Above ground: NEMA 250, Type 3R, unless otherwise noted.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: GRC.
 2. Exposed, Not Subject to Severe Physical Damage: GRC.
 3. Exposed and Subject to Severe Physical Damage: GRC.
 4. Concealed in Ceilings and Interior Walls and Partitions: GRC.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew, cast-metal fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least six (6) inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within twelve (12) inches of changes in direction.

- G. Conceal conduit and within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within twelve (12) inches of enclosures to which attached.
- I. Underground Raceways shall be PVC, Unless noted otherwise. All vertical turnups shall be 90 degree GRC bends with a bitumastic coating below grade (this applies for entry into underground or open bottom junction/pull boxes as well).
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two (2) supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:
 - 1. Install in each run of above ground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two (2) framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill.
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
 - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures one (1) inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 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 electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.

- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on a white field.
 - 2. Legend: Indicate voltage.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 240-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - 4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 5. Color for Neutral: White or gray.
 - 6. Color for Equipment Grounds: Green.
 - 7. Colors for Isolated Grounds: Green with white stripe.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on a white background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brother International Corporation.
 - c. Panduit Corp.
 - d. Or Approved Equal.
2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 BANDS AND TUBES

A. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Panduit Corp.
 - c. Or Approved Equal.
 - d. All wires and cables shall have heat-shrink identification at all terminations and splices.

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. Panduit Corp.
 - c. Or Approved Equal.
- B. Underground-Line Warning Tape:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Seton Identification Products.
 - c. Or Approved Equal.
 2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
 4. Tag: Type I:
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Thickness: 4 mils.
 - d. Weight: 18.5 lb./1000 sq. ft.
 - e. Tensile according to ASTM D 882: 30 lbf and 2500 psi.
 5. Tag: Type II:

- a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Thickness: 12 mils.
 - d. Weight: 36.1 lb./1000 sq. ft.
 - e. Tensile according to ASTM D 882: 400 lbf and 11,500 psi.
- 6. Tag: Type ID:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 5 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 28 lb./1000 sq. ft.
 - f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.
- 7. Tag: Type IID:
 - a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 8 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 34 lb./1000 sq. ft.
 - f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be one (1) inch.

2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. Seton Identification Products.
 - d. Or Approved Equal.

2.7 SIGNS

A. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Or Approved Equal.
2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches.

2.8 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Marking Services, Inc.
2. Panduit Corp.
3. Or Approved Equal.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. Paragraphs below specify requirements unique to identification products.
- M. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels two (2) inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
 - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

Y. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

Z. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

AA. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum two (2) inches high.

BB. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels two (2) inches high.

CC. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels two (2) inches high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch-high, black letters on 20-inch centers.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot maximum intervals.
- D. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage.
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- J. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- K. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- L. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- M. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- N. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- O. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- P. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.
1. Apply to exterior of door, cover, or other access.
 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- Q. Arc Flash Warning Labeling: Self-adhesive labels.
- R. Operating Instruction Signs: Metal-backed, butyrate warning signs.
- S. Emergency Operating Instruction Signs: Metal-backed, butyrate warning signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- T. Equipment Identification Labels:
1. Indoor Equipment: Metal-backed butyrate signs.
 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.

- k. Enclosed circuit breakers.
- l. Enclosed controllers.
- m. Variable-speed controllers.
- n. Push-button stations.
- o. Power-transfer equipment.
- p. Contactors.
- q. Remote-controlled switches, dimmer modules, and control devices.
- r. Battery-inverter units.
- s. Battery racks.
- t. Power-generating units.
- u. Monitoring and control equipment.
- v. UPS equipment.

END OF SECTION 26 05 53

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.3 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; by Schneider Electric.
 - 2. Or Approved Equal.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Three Pole, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 7. Service-Rated Switches: Labeled for use as service equipment.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12), unless otherwise indicated on plans.
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than seven (7) days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
 - 4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Wash-Down Areas/Corrosive Environment: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two (2) following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

- a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:

- 1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
 - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

- g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
- 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports.
 - 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 27 05 28.29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

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 slotted support systems for communication raceways.
2. Aluminum slotted support systems for communication raceways.
3. Nonmetallic slotted support systems for communication raceways.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.3 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 the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.

B. Seismic Qualification Certificates: For hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M.
 - 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation; A Member of the ABB Group.
 - e. Unistrut; Part of Atkore International.
 - f. Or Approved Equal.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel in non-corrosive areas. Stainless Steel, Type 316 in corrosive areas.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 9. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Stainless-steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) MKT Fastening, LLC.
 - 3) Or Approved Equal.
 2. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) B-line, an Eaton business.
 - 2) Hilti, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Or Approved Equal.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Use expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 PAINTING

- A. Touchup: 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 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 27 05 28.29

SECTION 27 15 23 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

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. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
 - 2. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
 - 3. Optical fiber cable connecting hardware, patch panels, and cross-connects.
 - 4. Grounding.
 - 5. Cabling identification products.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

- A. Optical fiber horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the equipment.

- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration Drawings and printouts.
 - 4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.
- C. Fiber optic cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

- B. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Connecting Blocks: One of each type.
 - 2. Jacks: Ten of each type.
 - 3. Patch-Panel Units: One of each type.
 - 4. Plugs: Ten of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Certified by BICSI.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
 - 2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.11 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

1.13 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

- A. Description: Multimode, 50/125-micrometer, strand count as defined on the plans, nonconductive, tight buffer, optical fiber cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden CDT Networking Division/NORDX.
 - 2. Corning Cable Systems.
 - 3. Or Approved Equal.
- C. Conductive cable shall be steel armored type.
- D. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
- E. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- F. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.
- G. Jacket:
 - 1. Jacket Color: Aqua.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

H. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAC for detailed specifications.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit.
4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.
5. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
6. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
7. Plenum Rated, Conductive: Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.3 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division/NORDX.
2. Corning Cable Systems.
3. Or Approved Equal.

B. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Connector Type: Type SC complying with TIA-604-3-B, connectors.

D. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single fiber optic cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

E. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single fiber optic cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

F. Faceplate:

1. Four -port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Ten -port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic.
4. Metal Faceplate: Stainless steel.
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

- a. Flush mounting jacks, positioning the cord at a 45-degree angle.

G. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

H. Patch Cords: Factory-made, single-fiber cables in 36-inch lengths.

2.4 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.
- C. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 301.
- B. General Requirements for Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568-C.1 and TIA-568-C.3.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 9. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
 - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

- D. Group connecting hardware for cables into separate logical fields.

3.3 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Optical Fiber Cable Tests:

- a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
 - 2) Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- G. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.

END OF SECTION 27 15 23

SECTION 40 05 57 - ACTUATORS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual actuators.
2. Electric motor actuators.

B. Related Requirements:

1. Section 05 50 00 - Metal Fabrications
2. Section 09 96 00 - High-Performance Coatings
3. Division 40 - Process Integration

1.2 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 Water Works Association:

1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
2. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
3. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.

C. NFPA:

1. NFPA 70 - National Electrical Code.

1.3 COORDINATION

A. Section 01 31 00 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with installation of valves and accessories.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

- B. Product Data: Submit manufacturer information for actuator with model number and size indicated.
- C. Shop Drawings:
 - 1. Indicate parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams, control system, and control system schematics on assembly drawings.
 - 2. Submit actuator Shop Drawings with valve and gate submittal.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer Instructions: Submit special procedures and placement requirements.
- F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Qualifications Statements:
 - 1. Submit qualifications for manufacturer and installer.
 - 2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations and types of actuators.

1.6 QUALITY ASSURANCE

- A. Valve Actuators in NEC Class I, Group D, Division 1 for areas where flammable gases, vapors or liquids can exist all of the time or some of the time under normal operating conditions.
- B. Valve Actuators in NEC Class I, Group D, Division 2 for areas where flammable gases, vapors or liquids are not likely to exist under normal operating conditions.
- C. Locations: Comply with NFPA 70.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - 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. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
 - 3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 ELECTRIC MOTOR ACTUATORS

- A. Manufacturers:
 - 1. Rotork; Rochester, NY
 - 2. Auma Actuators, Inc.; Canonsburg, PA
 - 3. Or Approved Equal.
- B. Description:
 - 1. Actuators shall be supplied to jobsite by local actuator manufacturer's representative. All services shall be included with supply of products.
 - 2. Motor, reduction gearing, torque switches, limit switches, auxiliary hand wheel, starter, digital display, and accessories. For quarter turn applications over 24" diameter, the actuator shall be multi-turn with separable quarter turn gearbox.

3. Comply with AWWA C542.
4. Open-close operation or modulation, as specified, or as shown on the Drawings.
5. Valve closing time will be 15-minutes, unless otherwise noted. The valve closing time should be adjustable both locally and in SCADA.
6. Actuators will be capable of operating in an ambient temperature range of -13 to +158 degrees F.
7. All actuators in open/close service will be furnished with integral, motor controls consisting of reversing starters, control transformer, phase rotation correction, monitor relay, positioner, "open-stop-close-reset" selector, "local-off-remote" selector switch in addition to red and green indicating LED's. Actuators shall have comprehensive position and diagnostic display that can be seen even when main power is not present. Modulating valves shall be equipped with a positioner capable of accepting a 4~20 mADC signal from the controller and positioning the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer mounted inside the actuator. The positioner shall be field adjustable with deadband adjustment, adjustable motion inhibit timer, and adjustable to fail in the "open", "closed" or "last" position on loss of 4~20 mADC command signal. A 4-20 MA output to indicate actuator position shall also be provided. All calibration changes shall be accomplished via the actuator display.

C. Enclosure:

1. Motor and all electrical enclosure shall be available to meet NEMA 4/6 and IP68 submersible.
2. Mounting: Attached actuator housing using flanged ISO adapter.
3. All settings shall be accessible without the removal of any actuator covers. Bluetooth setting tools shall be provided for actuator settings.

D. Motors:

1. Type:
 - a. Open/Close or modulating, as specified, or as shown on the Drawings.
 - b. Open/Close duty actuators shall be rated for no less than 60 starts/hour.
 - c. Modulating duty actuators shall be rated for no less than 1200 starts/hour.
 - d. Totally enclosed, non-ventilated, high starting torque, low inertia.
 - e. Full-voltage starting.
2. Electrical Characteristics:
 - a. Connections: As specified in Division 26 – Electrical.
 - b. Torque: A running torque per valve manufacturer's recommendation.
 - c. Sufficient horsepower to open or close a valve against the maximum specified differential pressure when voltage to the motor is $\pm 10\%$ of nominal voltage with a factor of safety of 1.5.
 - d. Voltage: 480 V, three phase, 60 Hz.
 - e. Lubrication: Pre-lubricated.
 - f. Bearings Type: Anti-friction
 - g. Motor Rating: 15-minute duty.
 - h. Electrical connection shall be double sealed.

E. Reduction Gearing:

1. Description: Single-reduction unit of helical gears and worm-gearing.
2. Lubrication: Oil or grease in actuators, grease in secondary gearboxes.
3. Bearings:
 - a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
 - b. Minimum L10 Life: 100,000 hours.

F. Limit Switches:

1. Type: Microprocessor controlled, adjustable contact.
2. Actuation: Absolute encoder.
3. Compartment: Totally enclosed and equipped with double sealed terminal compartment to prevent entry of moisture and contamination from the conduit.
4. Switches shall be SPDT and rated 5A at 120 VAC or as specified.
5. Actuating Point: Adjustable at any point of valve between fully open and fully closed.
6. Adjustment: Capable of quick adjustment with setting tool.
7. Contacts: Two sets of normally open and two sets of normally closed contacts will be furnished and available for use by the plant control system at each end of travel or as indicated. Contact shall be capable of reliably switching a low voltage DC source from the control system furnished by other.

G. Torque Limiting Switches:

1. Torque limiting shall be provided.
2. Torque limiting shall be responsive to the mechanical torque developed in seating, backseating, or by obstruction.
3. Accuracy: Within $\pm 5\%$
4. Calibration: The use of torque wrenches for calibration shall not be required. Calibrated by use of a test rig after manufacture in order to accurately predict the output of the actuator.
5. A calibration tag stating the maximum torque rating of the actuator shall be permanently affixed to the actuator housing.

H. Hand Wheel Operation:

1. A permanently attached hand wheel shall be provided for emergency manual operation.
2. A seized or inoperable motor shall not prevent manual operation.
3. The hand wheel shall not rotate during electrical operation.
4. Maximum Torque Required: 60 lb-ft.
5. Maximum Force Required: 60 lbs.
6. Inscription: An arrow and either the word OPEN or CLOSE shall be cast in the hand wheel to indicate the direction to turn hand wheel.
7. Minimum Diameter: 8 inches.
8. Declutch mechanism shall be push button style.
9. Energizing the motor shall automatically disengage the handwheel and re-engage the motor gearing.

I. Preventive Maintenance and Asset Management:

1. The actuators shall be optimized for preventive maintenance and asset management and shall include a datalogger where comprehensive data is stored and available for download and analysis for maintenance and troubleshooting. Asset management data (Actuator life statistics) shall also be stored within the actuator and available for download. Download shall be accomplished using Bluetooth setting tool provided with the actuators. Windows based Software used to view the downloaded datalogger files shall be available as a free of charge download from the actuator supplier.

2.2 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assemblies.
- C. 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. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that field dimensions are as indicated on Shop Drawings.

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 operating floor level.
- C. Start-Up Services:
 1. Commissioning and field set-up verification shall be performed by the actuator manufacturers factory authorized representative service technician. A minimum of two (2) days shall be provided.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

- B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. After installation, inspect for proper supports and interferences.
- D. Repair damaged coatings with material equal to original coating as specified in Section 09 96 00 - High-Performance Coatings.

END OF SECTION 40 05 57

SECTION 40 70 23 – PROCESS CONTROL NARRATIVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Process control narratives for facility processes.
- B. Related Requirements:
 - 1. Division 01 – General Requirements
 - 2. Division 26 – Electrical
 - 3. Division 40 – Process Interconnections

1.2 REFERENCES

- A. International Society of Automation (ISA)
- B. National Institute of Standards and Technology (NIST)

1.3 DEFINITIONS/ACRONYMS

- A. Definitions are defined as follows:
 - 1. LOCAL vs REMOTE, AUTO vs MANUAL: Most devices (e.g. motors, gates, valves) can be controlled from two locations: at the device and at the control system HMI. External to the PLC, a hand switch is provided to either control the device ‘locally’ or to control the device remotely via at the HMI. The PLC will not attempt to control any device that is in the LOCAL position. When in REMOTE, the device will be controlled through the PLC. When a device is in REMOTE, it can be operated in either Manual or Auto modes. Remote Manual mode means that the operator has taken control of the device and the process. When in Remote Auto mode, the PLC will control the device based on the automatic logic.
 - a. Local Manual – operator input at local device
 - b. Remote Manual – operator input at SCADA
 - c. Local Auto – PLC or algorithm input at local device
 - d. Remote Auto – PLC or algorithm input at SCADA
 - 2. ALARM: Indicate the alarm condition on appropriate HMI displays, and add to the HMI alarm summary display. Upon acknowledgement, indicate the alarm condition on appropriate HMI displays and the alarm summary display. Remove acknowledged alarms from the alarm summary once they are cleared. Log alarm occurrence, acknowledgement, and clearance in the alarm log file.

3. ON (RUNNING): The equipment or adjustable speed motor is ON when the equipment or motor drive ON status contact is closed. A constant speed motor is ON when a motor normally open auxiliary motor contact (M-Contact) from the motor is closed.
4. TREND: At intervals appropriate for the variable being trended (JCESD standard is one minute intervals), place the current value of analog variable, along with a time and date stamp, into a historical trend file for that variable. Display the trend on selectable HMI screens with appropriate scaling and units.
5. CLOSE FAIL: A valve is commanded-to-close, but is not confirmed closed within a preset time. Unless otherwise noted, a valve is confirmed closed by receiving Closed limit switch contact from the valve.
6. POSITION FAIL: A modulating valve is commanded to a set point position, but the valve is not confirmed to be within a preset percentage of set point within a preset time.
7. OPEN FAIL: A valve is commanded-to-open, but is not confirmed open within a preset time. Unless otherwise noted, a valve is confirmed open by receiving OPEN limit switch contact from the valve.
8. RUN FAIL: A motor is commanded-to-run, but is not confirmed running within a preset time. Unless otherwise noted, running is confirmed by receiving an ON status M-contact from the motor's starter.
9. START: Issue a maintained Run command.
10. STOP: Cease the maintained Run command.
11. TOTALIZE: Integrate flow type variable with respect to time. Unless otherwise noted, includes password protected operator reset that sets the totalized value to zero.
12. ELAPSED RUN TIME: Calculate the total time (in tenths of an hour) that a motor or piece of equipment has been in operation. For equipment and constant speed motors, use starter M-contacts to detect when the equipment or motor is running. For adjustable speed motors, use ON status contacts from the drive that close when the drive is in operation. For valves, calculate the time that the valve is open. Unless otherwise noted, include password protected operator reset that sets elapsed run times to zero.
13. CYCLE COUNT: Count the number of cycles a piece of equipment, valve, or motor undergoes. For equipment and motors, one cycle is defined as the transition from OFF to ON. For valves, one cycle is defined as the transition from CLOSED to OPEN.
14. INTERLOCKS: Safety interlocks are designed to prevent damage to equipment and injury to plant personnel. Hard-wired interlocks, such as high temperatures and pump overloads will stop the equipment and prevent it from running, until the alarm condition has been reset in the field. Software (PLC generated) interlocks, such as pump watchdogs or valve failure alarms, must be reset by the Operator at the HMI, before the equipment is allowed to be operated again in any REMOTE mode.

B. Acronyms are defined as follows:

1. HMI: Human Machine Interface
2. LCP: Local Control Panel
3. MCC: Motor Control Center
4. PID: Proportional-Integral-Derivative
5. P&ID: Process and Instrumentation Diagram
6. PLC: Programmable Logic Controller
7. SCADA: Supervisory Control and Data Acquisition
8. VFD: Variable Frequency Drive

1.4 SYSTEM DESCRIPTION

- A. The control loop descriptions provide the functional requirements of the control loops represented in the Contract Documents.
 - 1. Descriptions are provided as follows:
 - a. Control system overview and general description.
 - b. Major equipment to be controlled.
 - c. Major field mounted instruments (does not include local gauges).
 - d. Manual control functions.
 - e. Automatic control functions/interlocks.
 - f. Major indications provided at local control panels and motor starters/VFD's.
 - g. Remote indications and alarms.
- B. The control loop descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions but are rather intended to supplement and complement the Drawings and other Specification Sections.
 - 1. The control loop descriptions shall not be considered equal to a bill of materials.
- C. Provide instrumentation hardware and software as necessary to perform control function specified herein and shown on Drawings.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Control Strategy for Record Documents:
 - 1. Obtain this Section 40 70 23 – Process Control Narratives in electronic format (Microsoft Word) from Engineer at beginning of Project.
 - 2. Revise and update the file monthly during construction and start-up to reflect all changes that occur due to specific equipment and systems supplied on the Project.
 - a. Show all revisions in 'track change' mode.
 - b. Change Specification Section Title to read "Control Loop Descriptions – Contractor Record Document."
 - c. Reference all changes by Request for Information (RFI) number or Change Order Request (COR) number.
 - d. Submit revised file monthly to Engineer for review.
 - 3. Deliver the revised and updated file as a final control loop description Record Document in the Operation and Maintenance Manual described in Section 01 78 23 – Operation and Maintenance Data.
 - 4. Provide both paper copy and electronic copy (on CD or USB) of the Record Document control loop descriptions in the Operation and Maintenance Manual described in Section 01 78 23 – Operation and Maintenance Data.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. The Process & Instrumentation Diagrams (P&ID's) in the Drawings do not indicate all PLC and/or SCADA functions. Major requirements and elements are illustrated.
- B. Index for Process Control Narratives:
 - 1. North Saluda Reservoir (I-101)
- C. Equipment/Communication Failure
 - 1. In the event of a plant power failure, the SCADA will store the active setpoints and duty statuses, allowing the Operator to restart the plant with the prior configuration.
 - 2. In the event of a communication failure between a PLC and the HMI, the continued operation of the equipment will depend on the equipment control mode prior to the communications failure, as defined below:
 - a. If the equipment was operating in Remote Auto mode prior to the communications failure, the PLC will continue to operate the equipment based on the Operators defined process setpoints. The state of the equipment can be changed if the Operator switches the equipment to Local mode at the equipment's local control panel and start/stops equipment, using field mounted controls.
 - b. If the equipment was operating in Remote Manual mode prior to the communications failure, the equipment will revert to Remote Auto mode upon loss of communication continuing operation, using the last known setpoints.
 - c. If the equipment was operating in Local Manual mode, it is the Operator's responsibility to manually operate this device or place it back into Remote Auto or it will not function via PLC control.
 - d. When running in Local Manual mode, the device will continue operating in its current state (running/stopped) until a hard-wired interlock stops the equipment.
 - e. Any failed equipment will issue an alarm. Vendor package control panels that lose communication with their parent PLC (Remote Auto) will trigger a communication alarm, and continue to operate locally (Local Auto), if possible.
 - 3. An alarm will be displayed at the HMI, indicating the failed communication link.

3.2 PROCESS CONTROL NARRATIVES

- A. North Saluda Reservoir (I-101)
 - 1. General:

- a. The process control narrative describes the operation of facilities at the North Saluda Reservoir that provides raw water to the L.B. Stovall Water Treatment Plant (WTP) and releases water to the North Saluda River. Water that is released to the river shall be controlled by an automatically-actuated 60-inch regulating slide valve, flow measured by an ultrasonic transit time clamp-on flow measuring system at the outlet structure, and radar level meter at the weir structure. Water that is sent to the Stovall WTP is to be controlled by an automatically-actuated 48-inch open/close butterfly valve.
2. Major Equipment:
 - a. Electric actuator for 60-inch slide valve (V2001).
 - b. Electric actuator for 48-inch butterfly valve (V2002).
3. Major Instrumentation:
 - a. Flow Element/Transmitter: FE/FIT2010
 - b. Level Element/Transmitter: LE/LIT2030
4. Control Strategy:
 - a. Local Manual:
 - 1) Control is from Hand/Off/Auto selector switches on LCP.
 - a) In Hand, each of the actuators shall position the valve as directed by the local push buttons.
 - b) In Off, the actuators shall not be operational.
 - b. Remote Manual:
 - 1) The Operator controls the position of each valve through SCADA interface.
 - c. Local Auto:
 - 1) For V2001, the actuator shall modulate the valve to produce the required flow as set by the operator at the local control panel (0 – 320,000 gpm). The actuator shall modulate the valve based on flow output from FE/FIT2010.
 - 2) For V2002, the actuator shall position the valve as set by the operator at the local control panel.
 - d. Remote Auto:
 - 1) For V2001, process control shall be the same as Local Auto, except with input provided in SCADA, instead of local control panel.
 - 2) For V2002, process control shall be the same as Local Auto, except with input provided in SCADA, instead of local control panel.
 - e. Interlocks:
 - 1) Software Interlocks:

- a) Flow Transmitter (FE/FIT2010) at the outlet structure shall be interlocked with the position-controller on V2001 actuator.
- f. Alarms:
 - 1) V2001 FAIL
 - 2) V2002 FAIL
- g. HMI/PLC:
 - 1) V2001 POSITION (% OPEN)
 - 2) V2001 HAND
 - 3) V2001 REMOTE
 - 4) V2002 POSITION (O/C)
 - 5) FE/FIT2010 FLOW
 - 6) FE/FIT2010 FLOW (DAILY TOTAL, PREVIOUS)
 - 7) LE/LIT2030 LEVEL
 - 8) FI/LIT2030 FLOW
 - 9) FI/LIT2030 FLOW (DAILY TOTAL, PREVIOUS)
 - 10) Alarms

END OF SECTION 40 70 23

SECTION 40 71 66 – ULTRASONIC TRANSIT TIME CLAMP-ON FLOW MEASURING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Ultrasonic clamp-on flow measurement system designed for non-intrusive, external-to-pipe measurement of water and wastewater media. The system shall utilize a transit time ultrasonic principle of measurement mounted on the customer pipe from which the volume flow rate can be derived. The ultrasonic flow meter will be suitable for flow velocities from 0 - 33 fps.

1.2 REFERENCE STANDARDS

- A. American Water Works Association:
 - 1. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
 - 2. AWWA M33 - Flowmeters in Water Supply.
- B. ASME International:
 - 1. ASME PTC 19.5 - Flow Measurement.
- C. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals. Section 01 33 00 - Submittal Procedures: Requirements for submittals. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Furnish complete Product Data, Test Reports, Operating Manuals, Record Drawings, Manufacturer's Certifications, and Manufacturer's Field Reports.
- C. Product Data:
 - 1. Dimensional Drawings.
 - 2. Materials of Construction.
 - 3. Measurement accuracy.
 - 4. Range and range ability.
 - 5. Enclosure Rating.
 - 6. Classification Rating.
 - 7. Power:
 - a. Voltage.
 - b. Wattage.

8. Output options.

1.4 QUALITY ASSURANCE

- A. Ensure that materials of construction of wetted parts are compatible with process liquid.
- B. Manufacture instruments facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.
- C. Any instruments that are not stored in strict conformance with the Manufacturer's recommendation shall be replaced by the purchaser.
 1. Submit manufacturer information for actuator with model number and size indicated.
 2. Submit valve cavitation limits.

1.6 PROJECT OR SITE CONDITIONS

- A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.7 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish factory commissioned three-year manufacturer's warranty for ultrasonic transit-time flow meters.

1.8 MAINTENANCE

- A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.
- B. The ultrasonic transducers may require to be re-coupled to the pipe with new acoustic gel every 12 to 24 months depending on the installation location.

1.9 LIFECYCLE MANAGEMENT

- A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 ULTRASONIC FLOW METERS

- A. Manufactures
 - 1. Endress+Hauser - Prosonic Flow 93W.
 - 2. Or Approved Equal.
- B. Description: Separate and nonintrusive transmitting and receiving transducers clamped to outside of process pipe. The flow measuring system shall consist of: a clamp-on sensor pair(s), sensor holders, sensor cables, transmitter, mounting clamps/straps, installation aids.
 - 1. The flow measuring system shall have a menu-guided ultrasonic sensor mounting procedure to ensure precise measuring results.
 - 2. The flow measuring system shall support remote configuration.
- C. The sensors shall be selectable for pipe diameters in the range of 2" to 160" (DN 50 to 4000) and meet the application requirements.
 - 1. The sensor shall be rated for NEMA 4X service.
 - 2. The sensors shall be manufactured from materials suitable for continuous submersion.
 - 3. The sensors shall be suitable for composite, metal, plastic, lined or unlined pipes.
 - 4. The sensors shall utilize an integral spring mechanism to maintain correct contact pressure with the mating pipe surface during operation.
 - 5. The sensor positioning on the pipe shall be prescribed by the transmitter via the HMI display and communications protocol (where employed).
 - 6. The sensors shall locate mechanically and lock within the sensor holder to preclude incorrect sensor orientation during installation or accidental dislocation due to vibration during operational service.
 - 7. The sensor shall be of the proper nominal operating frequency to measure the design flow rate thru the mating piping and shall be noted in the instrument schedule.
- D. The transmitter shall integrate, control and allow setup of the measurement system. The outputs and source power shall be noted in the drawings in one of the following formats:
 - 1. Output: 4-20mA HART + Pulse/Frequency.
 - 2. Input: 85 - 260 VAC.
- E. The transmitter shall provide:

1. A NEMA 4X die cast, aluminum powder coated housing.
 2. A minimum a 4-line x 16 character backlit LCD display.
 3. A simultaneous display of flow rate and total flow in user-selectable engineering units, readout of diagnostic error messages.
 4. A safeguard against entering invalid data for the particular meter size and all programming parameters.
 5. An AUTOGAIN function to ensure adequate signal strength for reliable measurement during liquid condition variations.
 6. Protection against voltage spikes from the power source with internal transient protection.
 7. Power consumption of no more than 12 VA, independent of process line size.
 8. User access-code protection.
- F. The flow measuring system shall automatically adjust its nominal operating frequency within an available frequency band, so as to optimize the actual operational frequency in respect of pipe material, wall thickness, liner (if present) and fluid condition.
- G. The flow measuring system shall retain all setup parameters and accumulated measurements internally in non-volatile memory.

2.2 SOURCE QUALITY CONTROL & CALIBRATIONS

- A. Each flow measuring system shall be verified at a facility traceable to the National Institute of Standards and Technology (NIST) accredited to ISO 17025.
- B. The flow measuring system maximum measured error under factory reference conditions shall be $\pm 0.5\%$ of reading at any flow velocity greater than 1 ft/sec to the stated maximum.
- C. The technique of sensor and transmitter verification must be by a traceable method per NIST or ISO.
- D. Provide complete documentation covering the traceability of all calibration instruments.
- E. Provide ISA data sheet ISA-TR20.00.01. Use the latest revision of form 20F2321. Complete the form with all known data and model codes, and dash out the inapplicable fields. Incomplete data sheets submitted will be result in a rejected submittal.

2.3 ACCESSORIES

- A. Stainless steel tag - labeled to match the Contract Documents.
- B. Acoustic coupling medium suitable for ultrasonic sensor supplied.
- C. During mounting and commissioning a clamp-on measuring point, information on the liquid and piping is needed. If liquid or pipe data is not already programmed, additional accessories may be needed.

2.4 SAFETY

- A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, NATIONAL ELECTRIC CODE, latest edition.
- B. All devices shall be certified for use in hazardous areas: FM non-incendive for Class I, Division 2, Groups A-D.
- C. All devices shall be suitable for use as non-incendive devices when used with appropriate non-incendive associated equipment.
- D. Electrical equipment housing shall conform to NEMA 4x classification.
- E. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as FM, UL, ETL, CSA, etc. for the specified electrical area classification.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.
- B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

- A. As shown on installation details and mechanical Drawings.
- B. As recommended by the manufacturer's installation and operation manual.
- C. Specific attention should be given to the following technical requirements:
 - 1. Proper undisturbed straight run before and after the point of measurement.

3.3 FIELD QUALITY CONTROL

- A. Demonstrate the performance of all instruments to the Engineer before commissioning.
- B. Engineer may witness all instrument calibration and verification performed in the field.
- C. Each instrument shall be tested before commissioning and the Engineer shall witness the interface capability in the PLC control system and associated registers.
 - 1. The manufacturer shall offer an FDT based and FDT Group certified FDT frame tool capable of supporting HART, Profibus and Foundation fieldbus protocols.

2. Each instrument shall be supported with a device type manager (DTM) allowing direct integration in the PLC.
3. Each instrument shall be capable of operational configuration directly through the PLC.
4. Each instrument shall provide direct control of totalizer reset functions through the PLC.

D. Manufacturer's Field Services:

1. Manufacturer's representative shall verify installation of all installed sensors and transmitters.
2. Notify the Engineer in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer's representative shall perform an electronic verification at the time of installation in respect of the transmitter, with simulated flow values, to confirm correct function of device amplifier, display and outputs. A report will be generated for each meter.

3.4 ADJUSTING

- A. Verify factory set up of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

- A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning:
1. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 71 66

SECTION 40 72 23 – RADAR LEVEL/OPEN CHANNEL FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Radar-level measurement devices.
2. Transmitters.

1.2 REFERENCE STANDARDS

A. International Electrotechnical Commission:

1. IEC 61508 - Functional safety of electrical/electronic/programmable electronic safety-related systems.
2. IEC 61511 - Corrigendum 1 - Functional safety - Safety instrumented systems for the process industry sector.

B. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports.

C. Product Data:

1. Dimensional drawings.
2. Materials of construction.
 - a. Transmitter housing
 - b. Antenna or Horn
3. Measurement accuracy.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
 - a. Voltage
 - b. Wattage

8. Output options.

1.4 QUALITY ASSURANCE

- A. Manufacture instruments facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - 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.

1.6 PROJECT OR SITE CONDITIONS

- A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.7 CALIBRATION AND WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish factory commissioned three-year manufacturer's warranty for radar-level measurement devices.

1.8 MAINTENANCE

- A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.9 LIFECYCLE MANAGEMENT

- A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific

information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 RADAR LEVEL OPEN CHANNEL FLOW METERS

A. Manufacturer:

1. Endress+Hauser - Micropilot FMR10 / FMR20
2. Or Approved Equal

2.2 MANUFACTURED UNITS

- A. The pulsed time of flight radar transmitter shall operate at 26 GHz using 2-wire technology for level measurement and/or open channel flow measurement.
- B. Description:
1. Measuring Range: Up to 16 feet.
 2. Operating Temperature Range: -40 to 150 degree F.
 3. Operating Pressure Range: Up to 23 psig.
 4. Accuracy: Plus or minus 0.4 inch.
 5. Certified according to IEC 61508 and IEC 61511.
- C. Operation: Menu guided
- D. Transmitters:
1. Selected by sensor manufacture to match sensor
 2. Visual Display: Four digit.
 3. Output signal: 4-20 mA/Hart
 4. Location: As indicated on Drawings.
 5. Enclosure: IP66 or NEMA 4x.
 6. Alarm signal: 22.5 mA.
- E. The process connection shall be 1"NPT, 1.5"NPT, 2"NTP or 3"-6" ANSI flange connection by application.
- F. The radar shall have a linearization function with up to 32 value pairs entered allowing conversion of the measured value into any unit of length, weight, flow or volume.
- G. The radar sensor body material shall be made of PVDF.
- H. The radar sensor must have hermetically sealed wiring and fully potted electronics eliminating water ingress.

2.3 ACCESSORIES

- A. Weather protection cover in PVDF
- B. Ceiling mounting bracket in 316L
- C. Flooding Protection Tube
- D. Remote RIA 15 digital display EX or Non EX rated
- E. Adjustable Mounting Bracket in 316L
- F. Service-specific accessories

2.4 REQUIRED INSTRUMENTS

- A. FIT/LE-2030

2.5 SOURCE QUALITY CONTROL AND CALIBRATION

- A. Provide ISA data sheet ISA-TR20.00.01. Use the latest revision of form 20F2321. Complete the form with all known data, and dash out the inapplicable fields. Incomplete data sheets submitted will be result in a rejected submittal.

2.6 SAFETY

- A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.
- B. All devices shall be capable of being certified for use in hazardous areas: Class I, II, III, Div. 2, Groups A-G.
- C. All devices shall be suitable for use as non-incentive devices when used with appropriate non-incentive associated equipment. Devices with intrinsically safe ratings will normally be acceptable with vendor's approval.
- D. Transmitter housing shall conform to NEMA 4x classification.
- E. Non- intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as FM, UL, ETL, CSA, etc. for the specified electrical area classification.
- F. Electrical equipment specified as intrinsically safe shall qualify as "simple apparatus" or NRTL approved intrinsically safe equipment per ANSI/ISA-RP12.6 "Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations", latest edition.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.
- B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

- A. As shown on installation details and mechanical drawings.
- B. As recommended by the manufacturer's installation and operation manual.
- C. Specific attention should be given to the following technical requirements:
 - 1. Verify the nozzle height, dimension, and location where the transmitter has been installed.

3.3 FIELD QUALITY CONTROL

- A. Demonstrate the performance of all instruments to the Engineer before commissioning.
- B. Engineer to witness all instrument calibration verification in the field.
- C. Each instrument shall be tested before commissioning and the Engineer shall witness the response in the PLC control system and associated displays.
- D. Manufacturer's Field Services:
 - 1. Manufacturer's representative shall verify installation of all installed transmitters.
 - 2. Notify the Engineer in writing of any problems or discrepancies and proposed solutions.

3.4 ADJUSTING

- A. Verify set-up and configuration of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

- 1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.
 - a. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 72 23