# BRUNSWICK GLYNN JOINT WATER AND SEWER COMMISSION

## PUMP STATION REHABILITATION PS3101

TECHNICAL SPECIFICATIONS

2023

Kimley»Horn

# BRUNSWICK JOINT WATER AND SEWER COMMISSION
# PUMP STATION UPGRADES FOR PS3101
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**Civil Engineer of Record**
**Division 01, 02, 31, 33, 34**

Professional Engineer's Seal:


Signature

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05/30/2023
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Phone Number: 678 502-1865

**PROJECT NAME: PUMP STATION UPGRADES FOR PS3101**

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**Structural Engineer of Record**
**Divisions 03, 05**

Professional Engineer's Seal:


*Bala Gullipalli* 03/24/2023
Signature

Bala Gullipalli, P.E.
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Phone Number: 770 988-0400

**PROJECT NAME: PUMP STATION UPGRADES FOR PS3101**

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**Electrical and Instrumentation and Controls Engineer of Record**
**Division 26**

Professional Engineer's Seal:


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Signature

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# SECTION 01 11 00

SUMMARY OF WORK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Location of the Work:

1. The work is located in Brunswick, Georgia at the following location:

a. Pump Station 3101 - 293 South Port Parkway, Brunswick, GA 31523

B. The Work to be performed under this Contract includes, but is not limited to, executing the Work set forth in the Contract Documents and generally described as follows:

1. Pump Station 3101:

a. Erosion and sediment control.
b. General site work.
c. Demolish existing pump station electrical and controls.
d. Relocate existing power pole.
e. Install new pump station electrical and controls with shelter.
f. Relocate and bury overhead utilities.
g. Startup, testing, and commissioning.

C. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 - General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 APPLICABLE STANDARDS

A. In general, all work is intended to conform to OWNER's Standards for Water and Sewer Design and Construction, latest edition. In the event of a conflict between these project specifications, the aforementioned construction plans and the OWNER Standards, the project specifications and construction plans shall take precedence.

### 1.4 ADMINISTRATIVE REQUIREMENTS

A. Work Covered by Contract Documents

1. Work is to include furnishing all labor, materials, and equipment, and performing all Work necessary for this construction project as detailed in the Contract Documents.

B. Subsidiary Work

1. Any and all Work specifically governed by documentary requirements for the project, such as conditions imposed by the Drawings or Contract Documents in which no specific item for bid has been provided for in the Bid Form, then the item shall be considered as a subsidiary item of Work, the cost of which shall be included in the unit price bid for various bid items.

C. Use of Premises

1. Coordinate uses of premises under direction of the OWNER.
2. Assume full responsibility for protection and safekeeping of materials and equipment stored on the Site.
3. Use and occupy only portions of the public highways, streets, and alleys, or other public places or other rights-of-way as shown in the Contract Documents or as may be specifically authorized in writing by the OWNER.

    a. A reasonable amount of tools, materials, and equipment for construction purposes may be stored in such space, but no more than is necessary to avoid delay in the construction operations.
    b. Excavated and waste materials shall be stored in such a way as not to interfere with the use of spaces that may be designated to be left free and unobstructed and so as not to inconvenience occupants of adjacent property.

D. Work within Easements

1. Do not enter upon private property for any purpose without having previously obtained permission from the owner of such property.
2. Do not store equipment or material on private property unless and until the specified approval of the property owner has been secured in writing by the CONTRACTOR and a copy furnished to the OWNER.
3. Unless specifically provided otherwise, clear all rights-of-way or easements of obstructions which must be removed to make possible the proper prosecution of the Work.
4. Preserve and use every precaution to prevent damage to, all trees, shrubbery, plants, lawns, fences, culverts, curbing, and all other types of structures or improvements; to all water, sewer, and gas lines; to all conduits, overhead lines, or appurtenances thereof; and to all other public or private property adjacent to the Work.
5. Notify the proper representatives of the owners or occupants of the public or private lands which might be affected by the Work.

    a. Such notice shall be made at least 48 hours in advance of the beginning of the Work.
    b. Notices shall be applicable to both public and private utility companies and any corporation, company, individual, or other, either as owners or occupants, whose land or interest in land might be affected by the Work.
    c. The CONTRACTOR shall be responsible for all damage or injury to property resulting from any act, omission, neglect, or misconduct in the manner or method or execution of the Work, or at any time due to defective work, material, or equipment.

6. Fence

a. Restore all fences removed or damaged during construction of the Work to the original condition or better.
b. Erect temporary fencing in place of the fencing removed whenever the Work is not in progress, when the site is vacated overnight, and at all times to provide site security.
c. The cost for all temporary fence work and repair/replacement of existing fence shall be incidental to the various items bid.

E. Work by OWNER

1. OWNER will perform the following in connection with the Work:

a. Operate all existing valves, gates, pumps, equipment, and appurtenances that will affect OWNER's operation, unless otherwise shown or specified.

**1.5 SUBMITTALS [NOT USED]**
**1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.7 CLOSEOUT SUBMITTALS [NOT USED]**
**1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.9 QUALITY ASSURANCE [NOT USED]**
**1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.11 FIELD [SITE] CONDITIONS [NOT USED]**
**1.12 WARRANTY [NOT USED]**

**PART 2 - PRODUCTS [NOT USED]**
**PART 3 - EXECUTION [NOT USED]**

**END OF SECTION**

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# SECTION 01 22 00

## MEASUREMENT AND PAYMENT

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. All estimated quantities for unit price items, stipulated in the Proposal, or other Contract Documents, are approximate and are to be used as a basis for estimating the probable cost of the Work and for comparing the bids submitted for the Project. The actual amounts of work done, and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of the work done and material furnished as shown on the Plans. The CONTRACTOR agrees to make no claim for damages, anticipated profits or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished, and the estimated amounts included in the Proposal. The CONTRACTOR will provide assistance to the OWNER to check quantities and elevations when so requested.

B. All quantities are for unit price or lump sum items stipulated in the Bid Form. The Contactor, having read and understood the Bidding Documents and examined the Project Site and adjoining areas and being familiar with the obstacles and conditions that will affect proposed work, hereby offers and agrees to furnish all labor, products, and services needed to provide work in accordance with the Bidding Documents and will provide a properly itemized listing for each bid item, supported by sufficiently substantially data, to permit evaluation of partial pay requests.

### 1.2 RELATED PROVISIONS

A. Payments to CONTRACTOR: Refer to General Conditions, Supplemental Conditions, and Agreement.
B. Changes in Contract Price: Refer to General Conditions and Supplemental Conditions.
C. Schedule of Values: Refer to General Conditions, Supplemental Conditions, and Section 01 29 73, Schedule of Values.

### 1.3 BID ITEMS

A. Item 1 – Pump Station 3101 Upgrades Method of Measurements:

1. Mobilization, Demobilization, Insurance, and Bonds

a. Lump Sum (LS): The Lump Sum price for Item 1 shall be full compensation for mobilization, demobilization, insurance and bonds. There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. The lump sum price for this item shall not exceed 5% of the total of all bid items in the Base Bid. Payment shall include all compensation for mobilization, demobilization, insurance requirements and bonds for the project. Payment for 75% of the item shall be made when the contactor completes project mobilization and satisfies the insurance and bonding requirements to the satisfaction of the OWNER. Payment for the remaining 25% of the item shall be after demobilization and completion of the work to the satisfaction

2. Demolition

    a. There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials necessary for demolition of the existing structures, foundations, and utilities as shown on the drawings.

3. Temporary Bypass Pumping

    a. There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for temporary bypass pumping operations with temporary bypass pumps, as necessary to complete the work as described in the bid documents.

4. Electrical

    a. There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for complete installation of all electrical components per plans and bid documents.

5. Instrumentation/SCADA

    a. There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for complete installation of all instrumentation components per plans and bid documents.

6. Architectural and Structural Improvements

    a. There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for complete installation of all architectural and structural components per plans and bid documents.

7. Erosion Control

    a. There will be no separate measurement of the items under this heading. Payment for this item will be on the basis of the lump sum price in the Bid Form. Payment includes all labor, equipment and materials required for complete installation and permit compliance associated with Erosion Control plan. This includes all structural practices and vegetative measures directed by ENGINEER and/or as shown to ensure effective erosion control at the work site.

## 1.4 ADDITIVE BID ITEMS

OWNER may select Alternate Bid items as listed below, the Alternate Bid prices shall be added to or deducted from the Base Bid Price for the Work.

1. PS 3101 Alternate Bid Option 1 – Canopy and Foundation Structure

    a. Payment includes all labor, equipment and materials for complete installation of canopy and foundation structure per plans and bid documents.

**1.5 PRODUCTS [NOT USED]**

**1.6 EXECUTION [NOT USED]**

**END OF SECTION**

# SECTION 01 29 73

SCHEDULE OF VALUES

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Submit to ENGINEER for acceptance, a Schedule of Values allocated to the various portions of the Work.
B. Upon request of ENGINEER, support values with data, which will substantiate their correctness.
C. The Preliminary Schedule of Values is an itemized list that establishes the value or cost of each major part of the Work and the division of Work between CONTRACTOR and subcontractors.
D. The Preliminary Schedule of Values shall include all items of Work in the Contract Documents.
E. The Schedule of Values is a detailed itemized list that establishes the value or cost of each detailed part of the Work. It and the Progress Schedule Updates specified in Section 01 32 16, Construction Progress Schedule, shall be used as the basis for preparing progress payments. The Schedule of Values may be used as a basis for negotiations, concerning additional work or credits, which may arise during the construction. Quantities and unit prices shall be included in the Construction Progress Schedule, when approved by or required by the ENGINEER.
F. Include in Schedule of Values an itemized list of Work for each major work area included in the Work, for each lump sum payment item specified in Section 01 22 00, Measurement and Payment.

### 1.2 PREPARATION

A. Schedule of Values:

1. Schedule of Values shall show breakdown of quantities, labor, materials, equipment, and other costs used in preparation of the Bid for each item in the Schedule of Values.
2. Schedule of Values shall show all Work under the areas listed in Paragraph 1.1.F., above.
3. Costs shall be prepared by two methods, one for each Specification Section and one for each pump station. They shall be in sufficient detail to indicate separate amounts for each Specification Section and subsections therein and also separate amounts for each structure. Amounts shall be included for each type of Work specified, in a manner approved by the ENGINEER.
4. CONTRACTOR shall include separate pay items for Mobilization and Demobilization, as specified in the Contract Documents. Mobilization will be limited to four percent of the Contract Amount and will be include for payment at the rate of 25 percent over the first four payment applications. Demobilization shall be no less than one percent of the Contract Amount and shall be included with the final payment application. Mobilization shall include bonds and insurance and job mobilization.
5. Fifteen percent of the total cost of each item is allotted to the cost of Shop Drawing preparation, Operation and Maintenance Manuals, Testing and Training. The ENGINEER will release this amount upon approval. The total amount shall be apportioned as follows; three percent is apportioned to Testing and four percent each to the remaining items.
6. Schedule of Values shall be prepared on 8-1/2-inch by 11-inch white paper.

7. Use Table of Contents of the Specifications as basis for Schedule of Values format and identify each item with number and title in the Table of Contents. Also, use each structure as basis for schedule format. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
8. When requested by ENGINEER, support values with data that will substantiate their correctness.
9. The sum of the individual values shown on the Schedule of Values shall equal the total Contract Price.
10. Each item shall include a directly proportional amount of CONTRACTOR'S overhead and profit.
11. Schedule of Values shall show the purchase and delivery costs for materials and equipment that CONTRACTOR anticipates he shall request payment for prior to their installation.
12. CONTRACTOR shall include a separate pay item for Maintenance of Pump Station Operations Work for each Pump Station area.
13. CONTRACTOR shall include a separate pay item for: Construction Photographs; Temporary Facilities; Temporary Controls; Progress Schedule; General Conditions; and Field Engineering.
14. CONTRACTOR shall include a separate pay item for all Allowances and Extra Unit quantities.
15. The Schedule of Values shall be prepared to a level of detail equal to or greater than required by the Supplementary Conditions.

## 1.3 SUBMITTALS

A. Submit two copies of the Schedule of Values to ENGINEER for review within 10 days after the Notice to Proceed.
B. No payments will be made to CONTRACTOR until the Schedule of Values is finalized.

**PART 2 - PART 2 - PRODUCTS (NOT USED)**
**PART 3 - PART 3 - EXECUTION (NOT USED)**

**END OF SECTION**

# SECTION 01 31 20

PROJECT MEETINGS

## PART 1 – GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Provisions for project meetings throughout the construction period to enable orderly review of the progress of the Work and to provide for systematic discussion of potential problems

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Schedule, attend and administer as specified, periodic progress meetings, and specially called meetings throughout progress of the Work.
2. Representatives of CONTRACTOR, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
3. Meetings administered by Engineer may be recorded.

    a. If recorded, recordings will be used to prepare minutes and will be retained by Engineer for future reference.

4. Meetings, in addition to those specified in this Section, may be held when requested by the OWNER, Engineer, or CONTRACTOR.

B. Preconstruction Meeting

1. A preconstruction meeting will be held within 14 calendar days after the execution of the Agreement and before Work is started.

    a. The meeting will be scheduled and administered by the Engineer.

2. The Project Representative will preside at the meeting, prepare the notes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be circulated at the beginning of the meeting.
3. Attendance shall include:

    a. Project Representative
    b. CONTRACTOR’s project manager
    c. CONTRACTOR’s superintendent
    d. Design Engineer
    e. Construction Manager (Inspector)

f. Other OWNER representatives
g. Others as appropriate

4. Construction Schedule

   a. Prepare baseline construction schedule in accordance with Section 01 32 16 and provide at Preconstruction Meeting.

5. Preliminary Agenda may include:

   a. Introduction of Project Personnel
   b. General Description of Project
   c. Status of right-of-way, utility clearances, easements or other pertinent permits
   d. CONTRACTOR's work plan and schedule
   e. Contract Time
   f. Notice to Proceed
   g. Construction Staking
   h. Progress Payments
   i. Extra Work and Change Order Procedures
   j. Insurance Renewals
   k. Payroll Certification
   l. Material Certifications and Quality Control Testing
   m. Public Safety and Convenience
   n. Trench Safety Plans
   o. Confined Space Entry Standards
   p. Coordination with the OWNER's representative for operations of existing facilities
   q. Storm Water Pollution Prevention Plan
   r. Coordination with other CONTRACTORs
   s. Special Conditions applicable to the project
   t. Submittal Procedures
   u. Correspondence Routing
   v. Record Drawings
   w. Temporary construction facilities

C. Progress Meetings

1. Formal project coordination meetings will be held periodically. Meetings will be scheduled and administered by CONTRACTOR.
2. Additional progress meetings to discuss specific topics will be conducted on an as-needed basis. Such additional meetings shall include, but not be limited to:

   a. Coordinating shutdowns
   b. Installation of piping and equipment
   c. Coordination between other construction projects
   d. Resolution of construction issues
   e. Equipment approval

3. The CONTRACTOR will preside at progress meetings, prepare the notes of the meeting and distribute copies of the same to all participants who so request by fully completing the attendance form to be circulated at the beginning of each meeting.
4. Attendance shall include:

a. CONTRACTOR's project manager
b. CONTRACTOR's superintendent
c. Any subcontractor or supplier representatives whom the CONTRACTOR may desire to invite, or the Engineer may request
d. Engineer's representatives
e. OWNER's representatives
f. Others, as requested by the Project Representative

5. Preliminary Agenda may include:

a. Review of Work progress since previous meeting
b. Field observations, problems, conflicts
c. Items which impede construction schedule
d. Review of off-site fabrication, delivery schedules
e. Review of construction interfacing and sequencing requirements with other construction contracts
f. Corrective measures and procedures to regain projected schedule
g. Revisions to construction schedule
h. Progress, schedule, during succeeding Work period
i. Coordination of schedules
j. Review submittal schedules and status of submittals
k. Maintenance of quality standards
l. Pending changes and substitutions
m. Review proposed changes for:

1) Effect on construction schedule and on completion date
2) Effect on other contracts of the Project

n. Review Record Documents
o. Review monthly pay request
p. Review status of Requests for Information

6. Meeting Schedule

a. Progress meetings will be held monthly unless otherwise directed by the OWNER.

7. Meeting Location

a. The OWNER will establish a meeting location
b. To the extent practicable, meetings will be held at the site.

**1.4 SUBMITTALS [NOT USED]**
**1.5 ACTION SUBMITTALS / INFORMAL SUBMITTALS [NOT USED]**
**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE [NOT USED]**
**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD CONDITIONS [NOT USED]**

**1.11 WARRANTY [NOT USED]**

**PART 2 – PRODUCTS [NOT USED]**
**PART 3 – EXECUTION [NOT USED]**

**END OF SECTION**

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# SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

## PART 1 – GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. General requirements for the preparation, submittal, updating, status reporting and management of the Construction Progress Schedule

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES

A.Definitions

1. **Baseline Schedule** - Initial schedule submitted before work begins that will serve as the baseline for measuring progress and departures from the schedule.
2. **Progress Schedule** - Monthly submittal of a progress schedule documenting progress on the project and any changes anticipated.
3. **Schedule Narrative** - Concise narrative of the schedule including schedule changes, expected delays, key schedule issues, critical path items, etc.

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Baseline Schedule

1. General

a. Prepare a cost-loaded baseline Schedule using approved software and the Critical Path Method (CPM).
b. Review the draft cost-loaded Baseline Schedule with the OWNER and ENGINEER to demonstrate understanding of the work to be performed and known issues and constraints related to the schedule.
c. Designate an authorized representative (Project Scheduler) responsible for developing and updating the schedule and preparing reports.

B. Progress Schedule

1. Update the Progress Schedule monthly.
2. Prepare the Schedule Narrative to accompany the monthly Progress Schedule.
3. Change Orders

a. Incorporate approved change orders, resulting in a change of contract time, in the Baseline Schedule.

C. Responsibility for Schedule Compliance

1. Whenever it becomes apparent from the current progress Schedule and CPM Status Report that delays to the critical path have resulted and the Contract completion date will not be met, or when so directed by the ENGINEER, take some or all of the following actions at no additional cost to the OWNER:

    a. Submit a Recovery Plan to the ENGINEER for approval with revised Baseline Schedule outlining:

        1) A written statement of the steps proposed to remove or arrest the delay to the critical path in the approved schedule.
        2) Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work and return current Schedule to meet projected baseline completion dates.
        3) Increase the number of working hours per shift, shifts per day, working days per week, the amount of construction equipment, or any combination of the foregoing, sufficiently to substantially eliminate the backlog of work.
        4) Reschedule activities to achieve maximum practical concurrency of accomplishment of activities and comply with the revised schedule.

2. If no written statement of the steps intended to take is submitted when so requested, the OWNER may direct the CONTRACTOR to increase the level of effort in manpower (trades), equipment and work schedule (overtime, weekend and holiday work, etc.) to be employed by the CONTRACTOR in order to remove or arrest the delay to the critical path in the approved schedule.

    a. No additional cost for such work will be considered.

D. Coordinating Schedule with Other Contract Schedules

1. Where work is to be performed under this Contract concurrently with or contingent upon work performed on the same facilities or area under other contracts, the Baseline Schedule shall be coordinated with the schedules of the other contracts.

    a. Obtain the schedules of the other appropriate contracts from the OWNER for the preparation and updating of Baseline Schedule and make the required changes when required by changes in corresponding schedules.

2. In case of interference between the operations of different CONTRACTORs, the OWNER will determine the work priority of each CONTRACTOR and the sequence of work necessary to expedite the completion of the entire Project.

    a. In such cases, the decision of the OWNER shall be accepted as final.
    b. The temporary delay of any work due to such circumstances shall not be considered as justification for claims for additional compensation.

## 1.4 SUBMITTALS

A.Baseline Schedule

1. Submit Schedule in native file format and pdf format.

    a. Native file format includes:

        1) Microsoft Project unless otherwise approved by the ENGINEER.

2. Submit draft Baseline Schedule to ENGINEER prior to the pre-construction meeting and bring in hard copy to the meeting for review and discussion.

B. Progress Schedule

1. Submit Progress Schedule in native file format and pdf.
2. Submit Progress Schedule monthly no later than the last day of the month.

C. Schedule Narrative

1. Submit the Schedule Narrative in pdf format.
2. Submit Schedule Narrative monthly no later than the last day of the month.

D. Submittal Process
E. Submit schedule documents as specified in Section 01 33 00, Submittals.

**1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.7 CLOSEOUT SUBMITTALS [NOT USED]**
**1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.9 QUALITY ASSURANCE**

A. The person preparing and revising the Construction Progress Schedule shall be experienced in the preparation of schedules of similar complexity.
B. Schedule and supporting documents addressed in this Section shall be prepared, updated and revised to accurately reflect the performance of the construction.
C. CONTRACTOR is responsible for the quality of all submittals in this Section meeting the standard of care for the construction industry for similar projects.

**PART 2 – PRODUCTS [NOT USED]**
**PART 3 – EXECUTION [NOT USED]**

**END OF SECTION**

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# SECTION 01 32 33

PRECONSTRUCTION PHOTOGRAPHY AND VIDEO

## PART 1 – GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for:

   a. Preconstruction Photography.
   b. Preconstruction Videos.

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Preconstruction Video

1. Produce a preconstruction video of the site/alignment, including all areas in the vicinity of and to be affected by construction.

   a. Submit a digital copy of the video to the OWNER in accordance with Section 01 33 00.

2. Retain a copy of the preconstruction video until the end of the maintenance surety period.

B. Preconstruction Photographs

1. Provide preconstruction Photographs of the site/alignment, including all areas in the vicinity of and to be affected by construction.

   a. Submit a digital copy of the photographs to the ENGINEER in accordance with Section 01 33 00.

2. Retain a copy of the preconstruction photographs until the end of the maintenance surety period.

C. Construction Photographs

1. Photographs shall be taken in strict conformance with this Section and shall be furnished to the ENGINEER with each payment application.
2. Photographs shall be taken at each of the major stages of construction listed below.

   a. Completion of site restoration.
   b. Installation of material, equipment, and facilities as directed by the ENGINEER.

3. Views and Quantities Required:

    a. Two (2) views of each item listed in Article 1.03(B) above.
    b. Five (5) views of overall Project Site daily, where Work is in progress.
    c. Each time photographs are taken, at least one (1) photograph shall be taken from the same overall view as was taken during the previous photograph session.
    d. The CONTRACTOR shall consult with the ENGINEER for instructions concerning views required.

4. Electronic Photo Files:

    a. The CONTRACTOR shall maintain electronic photo files of the photos and convey copies of the files to the ENGINEER within thirty (30) days after Substantial Completion of entire Project.

5. Digital Images: Deliver two (2) complete set of digital image electronic files on portable flash drives or portable hard drives to ENGINEER with Project Record Documents. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as sensor, uncropped.

    a. Digital Images: Uncompressed JPEG format, produced by digital camera with minimum sensor size of 4.0 megapixels, and image resolution of not less than 1600 by 1200 pixels.
    b. Date and Time: Include date and time in filename for each image.

**1.4 SUBMITTALS [NOT USED]**
**1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE [NOT USED]**
**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD [SITE] CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 PRODUCTS [NOT USED]**
**PART 3 EXECUTION [NOT USED]**

**END OF SECTION**

# SECTION 01 33 00

SUBMITTALS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. General methods and requirements of submissions applicable to the following Work-related submittals:

   a. Shop Drawings
   b. Product Data (including Standard Product List submittals)
   c. Samples
   d. Mock Ups

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. CONTRACTOR's Responsibilities

1. The CONTRACTOR shall be responsible for the accuracy and completeness of the information contained in each submittal and shall ensure that the material or equipment shall be as described in the submittal. The CONTRACTOR shall verify in writing that all features of all products conform to the requirements of the drawings and specifications. Submittal documents shall be clearly edited to indicate only those items which are being submitted for review. All extraneous material shall be crossed out or otherwise obliterated. The CONTRACTOR shall ensure that there is no conflict with other submittals and shall notify the OWNER in each case where his submittal may affect the work of another CONTRACTOR or the OWNER. The CONTRACTOR shall ensure coordination of submittals among the related crafts and subcontractors.
2. Before each submittal, the CONTRACTOR shall have determined and verified all field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar information with respect thereto; all materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the work; and all information relative to the CONTRACTOR's sole responsibilities in respect of means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto.
3. Submittal documents common to more than one piece of equipment shall be identified with the appropriate equipment numbers and specification section and paragraph. Each submittal shall bear a stamp or written indication that the CONTRACTOR's obligations under the contract with respect to the CONTRACTOR's review and approval of that submittal have been met. Any deviations from the requirements of the drawings and specifications shall be noted

on the submittals. The CONTRACTOR shall submit six copies of all specified information. Submittals which do not have all the information required to be submitted including deviations, are not acceptable and will be returned without review.

B. Coordination

1. Notify the ENGINEER in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
2. Coordination of Submittal Times

    a. Prepare, prioritize, and transmit each submittal sufficiently in advance of performing the related Work or other applicable activities, or within the time specified in the individual Work Sections, of the Specifications.
    b. CONTRACTOR is responsible such that the installation will not be delayed by processing times including, but not limited to:

        1. Disapproval and resubmittal (if required)
        2. Coordination with other submittals
        3. Testing
        4. Purchasing
        5. Fabrication
        6. Delivery
        7. Similar sequenced activities

    c. No extension of time will be authorized because of the CONTRACTOR's failure to transmit submittals sufficiently in advance of the Work.
    d. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other contractor.

C. Routing of Submittals

1. Submittals and routing correspondence shall be routed as follows:

    a. Supplier to CONTRACTOR
    b. CONTRACTOR to ENGINEER/OWNER
    c. ENGINEER/OWNER to CONTRACTOR
    d. CONTRACTOR to Supplier

D. Submittal Log

1. At the discretion of OWNER, a submittal log shall be created and issued to the CONTRACTOR as the complete listing of submittals required for the project.

E. Submittal Numbering

1. When submitting shop drawings or samples, utilize a 9-character submittal cross-reference identification numbering system in the following manner:

    a. Use the first 6 digits of the applicable Specification Section Number.
    b. For the next 2 digits number use numbers 01-99 to sequentially number each initial separate item or drawing submitted under each specific Section number.

c. Last, use a letter, A-Z, indicating the resubmission of the same drawing (i.e. A=2nd submission, B=3rd submission, C=4th submission, etc.). A typical submittal number would be as follows:

03 30 00-08-B

8. 03 30 00 is the Specification Section for Cast-In-Place Concrete
9. 08 is the eighth initial submittal under this Specification Section
10. B is the third submission (second resubmission) of that particular shop drawing

F. Contractor Certification

1. Review shop drawings, product data and samples, including those by Subcontractors, prior to submission to determine and verify the following:

a. Field measurements
b. Field construction criteria
c. Catalog numbers and similar data
d. Conformance with the Contract Documents

2. Provide each shop drawing, sample, and product data submitted by the CONTRACTOR with a Certification Statement affixed including:

a. The CONTRACTOR's Company name
b. Signature of submittal reviewer
c. Certification Statement

11. “By this submittal, I hereby represent that I have determined and verified field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings."

G. Submittal Format

1. Fold shop drawings larger than 8 ½ inches x 11 inches to 8 ½ inches x 11inches.
2. Bind shop drawings and product data sheets together.
3. Order

a. Cover Sheet

12. Description of Packet
13. CONTRACTOR Certification

b. List of items / Table of Contents
c. Product Data /Shop Drawings/Samples /Calculations

H. Submittal Content

1. The date of submission and the dates of any previous submissions.
2. The Project title and number.
3. CONTRACTOR identification.
4. The names of:

a. CONTRACTOR
b. Supplier
c. Manufacturer

5. Identification of the product, with the Specification Section number, page, and paragraph(s).
6. Field dimensions clearly identified as such.
7. Relation to adjacent or critical features of the Work or materials.
8. Applicable standards, such as ASTM or Federal Specification numbers.
9. Identification of deviations from Contract Documents.
10. Identification by highlighting of revisions on resubmittals.
11. An 8-inch x 3-inch blank space for CONTRACTOR and ENGINEER stamps.

I. Shop Drawings

1. As specified in individual Work Sections includes, but is not limited to:

a. Custom-prepared data such as fabrication and erection/installation (working) drawings.
b. Scheduled information.
c. Setting diagrams.
d. Actual manufacturing instructions.
e. Custom templates.
f. Special wiring diagrams.
g. Coordination drawings.
h. Individual system or equipment inspection and test reports including:

14. Performance curves and certifications

i. As applicable to the Work.

2. Details

a. Relation of the various parts to the main members and lines of the structure.
b. Where correct fabrication of the Work depends upon field measurements

15. Provide such measurements and note on the drawings prior to submitting for approval.

J. Product Data

1. Product Data may include, but is not limited to:

a. Standard prepared data for manufactured products (sometimes referred to as catalog data)

16. Such as the manufacturer's product specification and installation instructions
17. Availability of colors and patterns
18. Manufacturer's printed statements of compliances and applicability
19. Roughing-in diagrams and templates
20. Catalog cuts
21. Product photographs

22. Standard wiring diagrams
23. Printed performance curves and operational-range diagrams
24. Production or quality control inspection and test reports and certifications
25. Mill reports
26. Product operating and maintenance instructions and recommended spare-parts listing and printed product warranties
27. As applicable to the Work

K. Samples

1. As specified in individual Sections, include, but are not limited to:

a. Physical examples of the Work such as:

28. Sections of manufactured or fabricated Work
29. Small cuts or containers of materials
30. Complete units of repetitively used products color/texture/pattern swatches and range sets
31. Specimens for coordination of visual effect
32. Graphic symbols and units of Work to be used by the ENGINEER for independent inspection and testing, as applicable to the Work

L. No fabrication or installation shall occur for any work requiring a shop drawing, sample or product data nor any material to be fabricated or installed prior to the approval or qualified approval of such item.

1. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data is at the CONTRACTOR's risk.
2. Neither the OWNER nor the ENGINEER will be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
3. Complete project Work, materials, fabrication, and installations in conformance with approved shop drawings, applicable samples, and product data.

M. Submittal Distribution

1. Hard Copy Distribution

a. Submit seven (7) copies of all submittals
b. If CONTRACTOR requires more than three (3) copies of Shop Drawings returned, CONTRACTOR shall submit more than the number of copies listed above.
c. Distributed to the ENGINEER

2. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the ENGINEER.

a. Provide number of copies as directed by the ENGINEER but not exceeding the number previously specified.
b. In lieu of hard copies, submittals may be made electronically via email to hpatel@bgjwsc.org The routing of submittals shall remain as specified in paragraph 1.3C of this section.

N. Submittal Review

1. The review of shop drawings, data, and samples will be for general conformance with the design concept and Contract Documents. This is not to be construed as:

    a. Permitting any departure from the Contract requirements.
    b. Relieving the CONTRACTOR of responsibility for any errors, including details, dimensions, and materials.
    c. Approving departures from details furnished by the ENGINEER, except as otherwise provided herein.

2. The review and approval of shop drawings, samples, or product data by the OWNER and ENGINEER does not relieve the CONTRACTOR from responsibility with regard to the fulfillment of the terms of the Contract.

    a. All risks of error and omission are assumed by the CONTRACTOR, and the OWNER and ENGINEER will have no responsibility, therefore.

3. The CONTRACTOR remains responsible for details and accuracy, for coordinating the Work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly and for performing Work in a safe manner.
4. If the shop drawings, data, or samples as submitted describe variations and show a departure from the Contract requirements which ENGINEER finds to be in the interest of the OWNER and to be so minor as not to involve a change in Contract Price or time for performance, the ENGINEER may return the reviewed drawings without noting an exception.
5. Submittals will be returned to the CONTRACTOR under one of the following codes:

    a. Code 1

        33. "NO EXCEPTIONS TAKEN" is assigned when there are no notations or comments on the submittal.

            a) When returned under this code the CONTRACTOR may release the equipment and/or material for manufacture.

    b. Code 2

        34. "EXCEPTIONS NOTED". This code is assigned when a confirmation of the notations and comments IS NOT required by the CONTRACTOR.

            a) The CONTRACTOR may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

    c. Code 3

        35. "REVISE AND RESUBMIT". This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package.

            a) This resubmittal is to address all comments, omissions and non-conforming items that were noted.

b) Resubmittal is to be received by the ENGINEER within 15 Calendar Days of the date of the ENGINEER's transmittal requiring the resubmittal.

d. Code 4

36. "REJECTED" is assigned when the submittal does not meet the intent of the Contract Documents.

a) The CONTRACTOR must resubmit the entire package revised to bring the submittal into conformance.
b) It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

e. Code 5

37. “FOR INFORMATION ONLY” is assigned when submittals and other similar data are for ENGINEER's information, do not require ENGINEER's responsive action, and will not be reviewed or returned with comment.

6. Resubmittals

a. CONTRACTOR shall follow the same procedures set forth for original submittals.

38. Corrections or changes shall be marked with revision triangle or other similar method.

b. Submittals for each item will be reviewed no more than twice at the OWNER’s expense.

39. All subsequent reviews will be performed at times convenient to the OWNER and at the CONTRACTOR's expense, based on the OWNER's or OWNER Representative’s then prevailing rates.
40. Provide CONTRACTOR reimbursement to the OWNER within 30 Calendar Days for all such fees invoiced by the OWNER.

c. The need for more than 1 resubmission or any other delay in obtaining ENGINEER's review of submittals, will not entitle the CONTRACTOR to an extension of Contract Time.

7. Partial Submittals

a. ENGINEER reserves the right to not review submittals deemed partial, at the ENGINEER’s discretion.
b. Submittals deemed by the ENGINEER to be not complete will be returned to the CONTRACTOR and will be considered "Not Approved.”
c. The ENGINEER may at its option provide a list or mark the submittal directing the CONTRACTOR to the areas that are incomplete.

8. If the CONTRACTOR considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, then written notice must be provided thereof to the ENGINEER at least seven (7) Calendar Days prior to release for manufacture.

9. When the shop drawings have been completed to the satisfaction of the ENGINEER, the CONTRACTOR may carry out the construction in accordance therewith and no further changes except upon written instructions from the ENGINEER.

O. Mock ups

1. Mock Up units as specified in individual Sections, include, but are not necessarily limited to, complete units of the standard of acceptance for that type of Work to be used on the Project. Remove at the completion of the Work or when directed.

P. Qualifications

1. If specifically required in other Sections of these Specifications, submit a Professional Engineering Certification for each item required.

Q. Request for Information (RFI)

1. CONTRACTOR may request for additional information:

    a. Clarification or interpretation of the Contract Documents.
    b. When the CONTRACTOR believes there is a conflict within Contract Documents
    c. When the CONTRACTOR believes there is a conflict between the Drawings and Specifications

        41. Identify the conflict and request clarification

2. Use the Request for Information (RFI) form provided by the OWNER.
3. Numbering of RFI

    a. Prefix with “RFI” followed by series number, “-xxx”, beginning with “001” and increasing sequentially with each additional transmittal.

4. Sufficient information shall be attached to permit a written response without further information.
5. The ENGINEER will log each request and will review the request.

    a. If review of the project information request indicates that a change to the Contract Documents is required, the OWNER will issue a Field Order or Change Order, as appropriate.

**1.4 SUBMITTALS [NOT USED]**
**1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE [NOT USED]**
**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 - PRODUCTS [NOT USED]**
**PART 3 - EXECUTION [NOT USED]**

**END OF SECTION**

# SECTION 01 35 13

SPECIAL PROJECT PROCEDURES

## PART 1 – GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. The procedures for special project circumstances that includes, but is not limited to:

   a. Work near High Voltage Lines
   b. Confined Space Entry Program
   c. Dust Control
   d. Employee Parking

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. Health and Safety Code, Title 9. Safety, Subtitle A. Public Safety, Chapter 752. High Voltage Overhead Lines.

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Work near High Voltage Lines

1. Regulatory Requirements

   a. CONTRACTOR shall comply with all federal, state, and local regulations.

2. Warning sign

   a. Provide sign of sufficient size meeting all OSHA requirements.

3. Equipment operating within 10 feet of high voltage lines will require the following safety features.

   a. Insulating cage-type of guard about the boom or arm.
   b. Insulator links on the lift hook connections for back hoes or dippers.
   c. Equipment must meet the safety requirements as set forth by OSHA and the safety requirements of the owner of the high voltage lines.

4. Work within 6 feet of high voltage electric lines:

   a. Notification shall be given to:

1) The power company.

a) Maintain an accurate log of all such calls to power company and record action taken in each case.

b. Coordination with power company:

1) After notification coordinate with the power company to erect temporary mechanical barriers, de-energize the lines, or raise or lower the lines

c. No personnel may work within 6 feet of a high voltage line before the above requirements have been met.

B. Confined Space Entry Program

1. Provide and follow approved Confined Space Entry Program in accordance with OSHA requirements.
2. Confined Spaces include:

a. Manholes and wet wells
b. All other confined spaces in accordance with OSHA's Permit Required for Confined Spaces

C. Utility Coordination

1. Coordinate any activity that will require connecting to or the operation of any existing facility with the OWNER.

D. Dust Control

1. Use acceptable measures to control dust at the Site.

a. If water is used to control dust, capture and properly dispose of wastewater.
b. If wet saw cutting is performed, capture and properly dispose of slurry.

E. Employee Parking

1. Provide parking for employees at locations approved by the ENGINEER.

**1.4 SUBMITTALS [NOT USED]**
**1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE [NOT USED]**
**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 – PRODUCTS [NOT USED]**
**PART 3 – EXECUTION [NOT USED]**

**END OF SECTION**

# SECTION 01 45 23

TESTING AND INSPECTION SERVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Testing and inspection services procedures and coordination

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Testing

1. Complete testing in accordance with the Contract Documents.
2. CONTRACTOR shall pay for:

a. Tests not specifically indicated in the Contract Documents as being OWNER's responsibility.
b. Tests made for CONTRACTOR's convenience.
c. Repeat tests required because of CONTRACTOR's negligence or defective Work and retesting after failure of test for the same item to comply with the Contract Documents.

3. Coordination

a. CONTRACTOR shall be responsible for all coordination associated with testing activities.

4. Distribution of Testing Reports

a. Electronic Distribution

1) Confirm development of Project directory for electronic submittals to be uploaded to a site determined by OWNER.
2) Upload test reports to designated project directory and notify appropriate OWNER representatives via email of submittal posting.
3) Hard Copies

a) One (1) copy for all submittals submitted to the OWNER's Representative.

b. Hard Copy Distribution (if required in lieu of electronic distribution)

1) Tests performed by OWNER

a) Distribute 1 hard copy to the CONTRACTOR

2) Tests performed by the CONTRACTOR

a) Distribute 3 hard copies to OWNER's Representative

**1.4 SUBMITTALS [NOT USED]**
**1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE**

A. Qualifications

1. Testing Laboratory:

a. Comply with applicable requirements of ASTM E329.
b. Testing laboratory shall be licensed to operate in the same jurisdiction as the Site. Where applicable, laboratory shall be certified by the authority having jurisdiction for the types of testing required.
c. Testing equipment used by laboratory shall be calibrated at intervals of not more than twelve months by devices of accuracy traceable to one of the following: NIST SRM, ISO/IEC 17025, certified by state or local bureau of weights and measures, or values of natural physical constants generally accepted in the engineering and scientific community.

**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 - PRODUCTS [NOT USED]**
**PART 3 - EXECUTION [NOT USED]**

**END OF SECTION**

# SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Provide temporary facilities and controls needed for the Work including, but not necessarily limited to:

   a. Temporary utilities
   b. Sanitary facilities
   c. Storage Sheds and Buildings
   d. Dust control
   e. Temporary fencing of the construction site
   f. Temporary protection of construction
   g. Security

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Temporary Utilities

1. Obtaining Temporary Service

   a. Make arrangements with utility service companies for temporary services.
   b. Abide by rules and regulations of utility service companies or authorities having jurisdiction.
   c. Be responsible for utility service costs until Work is approved for Final Acceptance.

      1) Included are fuel, power, light, heat and other utility services necessary for execution, completion, testing, and initial operation of Work.

2. Water

   a. CONTRACTOR to provide water required for and in connection with Work to be performed and for specified tests of piping, equipment, devices, or other use as required for the completion of the Work.
   b. Provide and maintain adequate supply of potable water for domestic consumption by CONTRACTOR personnel and OWNER’s Representatives.
   c. CONTRACTOR Payment for Construction Water

      1) CONTRACTOR shall coordinate supply and pay for all water required for completion of the Work.

3. Electricity and Lighting

    a. Provide and pay for electric powered service as required for Work, including testing of Work.

        1) Provide power for lighting, operation of equipment, or other use.

    b. Electric power service includes temporary power service or generator to maintain operations during scheduled shutdown.

4. Telephone

    a. Provide emergency telephone service at Site for use by CONTRACTOR personnel and others performing work or furnishing services at Site.

5. Temporary Heat and Ventilation

    a. Provide temporary heat as necessary for protection or completion of Work.
    b. Provide temporary heat and ventilation to assure safe working conditions.

B. Sanitary Facilities

1. Provide and maintain sanitary facilities for persons on Site.

    a. Comply with regulations of State and local departments of health.

2. Enforce use of sanitary facilities by construction personnel at the Site.

    a. Enclose and anchor sanitary facilities.
    b. No discharge will be allowed from these facilities.
    c. Collect and store sewage and waste so as not to cause nuisance or health problem.
    d. Haul sewage and waste off-site at no less than weekly intervals and properly dispose in accordance with applicable regulation.

3. Locate facilities near Work Site and keep clean and maintained throughout Project.
4. Remove facilities at completion of Project

C. Storage Sheds and Buildings

1. Provide adequately ventilated, watertight, weatherproof storage facilities with floor above ground level for materials and equipment susceptible to weather damage.
2. Storage of materials not susceptible to weather damage may be on blocks off ground.
3. Store materials in a neat and orderly manner.

    a. Place materials and equipment to permit easy access for identification, inspection and inventory.

4. Equip facility with lockable doors and lighting and provide electrical service for equipment space heaters and heating or ventilation as necessary to provide storage environments acceptable to specified manufacturers.
5. Fill and grade site for temporary structures to provide drainage away from temporary and existing buildings.

6. Remove facility from site prior to Final Acceptance.

D. Temporary Fencing

1. Provide and maintain for the duration of construction when required in Contract Documents.

E. Dust Control

1. CONTRACTOR is responsible for maintaining dust control through the duration of the project.

    a. CONTRACTOR remains on-call at all times
    b. Must respond in a timely manner

F. Temporary Protection of Construction

1. CONTRACTOR or Subcontractors are responsible for protecting Work from damage due to weather.

G. Security

1. CONTRACTOR shall protect all Work, materials, equipment, and property from loss, theft, damage, and vandalism. CONTRACTOR's duty includes safely guarding OWNER's property in vicinity of the Work and Site, and other private property in the vicinity of the Site from injury and loss in connection with performance of the Work.
2. Employ watchmen as required to provide required security and prevent unauthorized entry.
3. Costs for security required under this Section shall be paid by CONTRACTOR.
4. Pay full compensation for, or repair or replace, damage to property of OWNER and others arising from failure to furnish adequate security.
5. Provide temporary fencing as required in accordance with the Contract Documents.

**1.4 SUBMITTALS [NOT USED]**
**1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE [NOT USED]**
**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD [SITE] CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 - PRODUCTS [NOT USED]**
**PART 3 - EXECUTION [NOT USED]**

**3.1 INSTALLERS [NOT USED]**
**3.2 EXAMINATION [NOT USED]**
**3.3 PREPARATION [NOT USED]**
**3.4 INSTALLATION**

A. Temporary Facilities

1. Maintain all temporary facilities for duration of construction activities as needed.

**3.5 REPAIR / RESTORATION [NOT USED]**
**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD [OR] SITE QUALITY CONTROL [NOT USED]**
**3.8 SYSTEM STARTUP [NOT USED]**
**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING [NOT USED]**
**3.11 CLOSEOUT ACTIVITIES**

A. Temporary Facilities

1. Remove all temporary facilities and restore area after completion of the Work, to a condition equal to or better than prior to start of Work.

**3.12 PROTECTION [NOT USED]**
**3.13 MAINTENANCE [NOT USED]**
**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

# SECTION 01 57 13

STORM WATER POLLUTION PREVENTION

## PART 1 – GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Procedures for Storm Water Pollution Prevention Plans

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements
2. Section 31 25 00 – Erosion and Sediment Control

### 1.2 REFERENCES

A. Abbreviations and Acronyms

1. Notice of Intent: NOI
2. Notice of Termination: NOT
3. Storm Water Pollution Prevention Plan: SWPPP
4. Georgia Environmental Protection Division: GAEPD
5. Georgia Soil and Water Conservation Commission: GSWCC

B. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. CONTRACTOR shall adhere to Glynn County Stormwater Management Manual (GSMM) and the Coastal Stormwater Supplement (CSS) requirements.
3. CONTRACTOR shall adhere to the "Manual for Erosion and Sediment Control in Georgia" from the Georgia Soil and Water Conservation Commission (GSWCC).

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. General

1. CONTRACTOR is responsible for resolution and payment of any fines associated with non-compliance to stormwater regulations.

B. Construction Activities resulting in:

1. Less than 1 acre of disturbance:

a. Provide erosion and sediment control in accordance with Section 31 25 00 and Drawings.

2. 1 to less than 5 acres of disturbance:

a. GEPD Small Construction Storm Water General Permit

b. Complete SWPPP in accordance with GEPD requirements.
c. A copy of the Small Construction Storm Water General Permit and SWPPP shall remain on site at all times during performance of the Work.
d. Only submit permit and SWPPP upon GEPD request.

## 1.4 SUBMITTALS

A. SWPPP

1. Submit in accordance with Section 01 33 00, except as stated herein.

a. Prior to the Preconstruction Meeting, submit a draft copy of SWPPP to the ENGINEER.

B. Modified SWPPP

1. If the SWPPP is revised during construction, resubmit modified SWPPP to the ENGINEER in accordance with Section 01 33 00.

**1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**
**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE [NOT USED]**
**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 – PRODUCTS [NOT USED]**
**PART 3 – EXECUTION [NOT USED]**

**END OF SECTION**

# SECTION 01 66 00

## PRODUCT STORAGE AND HANDLING REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Scheduling of product delivery
2. Packaging of products for delivery
3. Protection of products against damage from:

    a. Handling
    b. Exposure to elements or harsh environments

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]
### 1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]
### 1.4 SUBMITTALS [NOT USED]
### 1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
### 1.6 CLOSEOUT SUBMITTALS [NOT USED]
### 1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
### 1.8 QUALITY ASSURANCE [NOT USED]
### 1.9 DELIVERY AND HANDLING

A. Delivery Requirements

1. Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.
2. Provide appropriate personnel and equipment to receive deliveries.
3. Delivery trucks will not be permitted to wait extended periods of time on the Site for personnel or equipment to receive the delivery.
4. Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.
5. Clearly and fully mark and identify as to manufacturer, item, and installation location.
6. Provide manufacturer's instructions for storage and handling.

B. Handling Requirements

1. Handle products or equipment in accordance with these Contract Documents and manufacturer’s recommendations and instructions.

C. Storage Requirements

1. Store materials in accordance with manufacturer's recommendations and requirements of the Contract Documents.
2. Make necessary provisions for safe storage of materials and equipment.

    a. Place loose soil materials and materials to be incorporated into Work to prevent damage to any part of Work or existing facilities and to maintain free access at all times to all parts of Work and to utility service company installations in vicinity of Work.

3. Keep materials and equipment neatly and compactly stored in locations that will cause minimum inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants.

    a. Arrange storage to provide easy access for inspection.

4. Restrict storage to areas available on construction site for storage of material and equipment as shown on Drawings or approved by the ENGINEER.
5. Provide off-site storage and protection when on-site storage is not adequate.

    a. Provide addresses of and access to off-site storage locations for inspection by the ENGINEER.

6. Do not use lawns, grass plots, or other private property for storage purposes without written permission of property owner or other person in possession or control of premises.
7. Store in manufacturers' unopened containers.
8. Neatly, safely, and compactly stack materials delivered and stored along line of Work to avoid inconvenience and damage to property owners and general public and maintain at least 3 feet from fire hydrants.
9. Keep public and private driveways and street crossings open.
10. Repair or replace damaged lawns, sidewalks, streets, or other improvements to satisfaction of ENGINEER.

    a. Total length which materials may be distributed along route of construction at one time is 500 linear feet, unless otherwise approved in writing by the ENGINEER.

**1.10 FIELD CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 - PRODUCTS [NOT USED]**
**PART 3 - EXECUTION**

**3.1 INSTALLERS [NOT USED]**
**3.2 EXAMINATION [NOT USED]**
**3.3 PREPARATION [NOT USED]**
**3.4 ERECTION [NOT USED]**
**3.5 REPAIR / RESTORATION [NOT USED]**
**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD QUALITY CONTROL**

A. Tests and Inspections

1. Inspect all products or equipment delivered to the site prior to unloading.

B. Non-Conforming Work

1. Reject all products or equipment that are damaged, used or in any other way unsatisfactory for use on the project.

**3.8 SYSTEM STARTUP [NOT USED]**
**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING [NOT USED]**
**3.11 CLOSEOUT ACTIVITIES [NOT USED]**
**3.12 PROTECTION**

A. Protect all products or equipment in accordance with manufacturer's written directions.
B. Store products or equipment in location to avoid physical damage to items while in storage.
C. Protect equipment from exposure to elements and keep thoroughly dry if required by the manufacturer.

**3.13 MAINTENANCE [NOT USED]**
**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

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# SECTION 01 71 23

## CONSTRUCTION STAKING AND AS-BUILT SURVEY

## PART 1 – GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Requirements for construction staking and construction survey

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.3 REFERENCES

A. Definitions

1. Construction Survey - The survey measurements made prior to or while construction is in progress to control elevation, horizontal position, dimensions, and configuration of structures/improvements included in the Project Drawings.
2. As-built Survey –The measurements made after the construction of the improvement features are complete to provide position coordinates for the features of a project.
3. Construction Staking – The placement of stakes and markings to provide offsets and elevations to cut and fill in order to locate on the ground the designed structures/improvements included in the Project Drawings. Construction staking shall include staking easements and/or right of way if indicated on the plans.
4. Survey "Field Checks" – Measurements made after construction staking is completed and before construction work begins to ensure that structures marked on the ground are accurately located per Project Drawings.

### 1.4 ADMINISTRATIVE REQUIREMENTS

A. CONTRACTOR shall utilize a Professional Surveyor licensed in the State of Georgia.

### 1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.
B. All submittals shall be received and reviewed by the ENGINEER prior to delivery of work.
C. Submit monthly progress for as-built survey with each invoice.

### 1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Field Quality Control Submittals:

1. Documentation verifying accuracy of field engineering work, including coordinate conversions if plans do not indicate grid or ground coordinates.

B. Professional Surveyor:

1. Submit name of firm and name of Professional Surveyor.
2. Submit evidence of current Georgia license.

## 1.7 CLOSEOUT SUBMITTALS

A. As-built Drawing Submittal

1. Submit As-Built Survey Drawings documenting the locations/elevations of constructed improvements signed and sealed by Professional Surveyor (RPLS) responsible for the work.
2. CONTRACTOR shall submit the proposed as-built and completed redline drawing submittal one (1) week prior to scheduling the project final inspection for ENGINEER review and comment. Revisions, if necessary, shall be made to the as-built redline drawings and resubmitted to the ENGINEER prior to scheduling the construction final inspection.
3. As-built Drawing Data shall be submitted in electronic format as specified herein.

## 1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

## 1.9 QUALITY ASSURANCE

A. In no case shall minimum survey accuracy be less than the minimum standards established by the Rules and Regulations established by the Georgia State Board of Registration for Professional Engineers and Land Surveyors.

B. Construction Staking

1. Construction staking will be performed by the CONTRACTOR.
2. Coordination

a. Notify ENGINEER at least one week in advance of beginning Construction Staking.
b. It is the CONTRACTOR's responsibility to coordinate staking such that construction activities are not delayed or negatively impacted.
c. CONTRACTOR is responsible for preserving and maintaining stakes and existing benchmarks. The CONTRACTOR shall restore any damaged benchmark at no cost to the OWNER.

C. Construction Survey

1. Construction Survey will be performed by the CONTRACTOR.
2. General

a. Construction survey will be performed in order to construct the work shown on the Drawings and specified in the Contract Documents.
b. For construction methods other than open cut, the CONTRACTOR shall perform construction survey and verify control data including, but not limited to, the following:

1) Verification that established benchmarks and controls are accurate.
2) Use of Benchmarks to furnish and maintain all reference lines and grades for tunneling.
3) Use of line and grades to establish the location of the pipe.

4) Submit to the ENGINEER copies of field notes used to establish all lines and grades, if requested, and allow the ENGINEER to check guidance system setup prior to beginning each tunneling drive.
5) Provide access for the ENGINEER, if requested, to verify the guidance system and the line and grade of the carrier pipe.
6) The CONTRACTOR remains fully responsible for the accuracy of the work and correction of it, as required.
7) Monitor line and grade continuously during construction.
8) Record deviation with respect to design line and grade once at each pipe joint and submit daily records to the ENGINEER.
9) If the installation does not meet the specified tolerances, immediately notify the ENGINEER, and correct the installation in accordance with the Contract Documents.

D. As-Built Survey

1. As-Built Survey will be performed by the CONTRACTOR.
2. Coordination:

a. It is the CONTRACTOR's responsibility to coordinate the as-built survey and required measurements for items that are to be buried such that construction activities are not delayed or negatively impacted.

3. General

a. The CONTRACTOR shall provide as-built survey including the elevation and location of construction features including the following:

1) Water Lines

a) Top of pipe elevations and coordinates for waterlines and force mains at the following locations:

i. Minimum every 250 linear feet.
ii. Horizontal and vertical points of inflection, curvature, etc.
iii. Blowoff valves.
iv. Air Release valves.
v. Pipe tees.
vi. Valves.
vii. Plugs, stub-outs, dead-end lines.
viii. Casing pipe (each end) and all buried fittings.

b) Locations of all exposed existing utilities and features adjacent to or crossing the Work.
c) Other features as directed by the ENGINEER.

**1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.11 FIELD CONDITIONS [NOT USED]**
**1.12 WARRANTY [NOT USED]**

**PART 2 – PRODUCTS**

**2.1 GENERAL**

A. A construction survey will produce, but will not be limited to:

1. Recovery of relevant control points, points of curvature, and points of intersection.
2. Establish temporary horizontal and vertical control elevations (benchmarks) sufficiently permanent and located in a manner to be used throughout construction.
3. The location of planned facilities, easements, and improvements.

    a. Establishing final line and grade stakes for piers, floors, grade beams, parking areas, utilities, streets, highways, tunnels, and other construction.
    b. A record of revisions or corrections noted in an orderly manner for reference.
    c. A drawing indicating the horizontal and vertical location of facilities, easements, and improvements, as built.

4. Digital As-Built survey files shall be submitted to the ENGINEER in AutoCAD (.dwg) format.
5. Survey files shall include vertical and horizontal data tied to original project control and benchmarks and shall include feature descriptions.

## PART 3 – EXECUTION

### 3.1 INSTALLERS

A. Tolerances:

1. The staked location of any improvement or facility should be as accurate as practical and necessary. The degree of precision required is dependent on many factors all of which must remain judgmental. The tolerances listed hereafter are based on generalities and, under certain circumstances, shall yield to specific requirements. The surveyor shall assess any situation by review of the overall plans and through consultation with responsible parties as to the need for specific tolerances.

    a. Earthwork: Grades for earthwork or rough cut should not exceed 0.1 ft. vertical tolerance. Horizontal alignment for earthwork and rough cut should not exceed 1.0 ft. tolerance.
    b. Horizontal alignment on a structure shall be within 0.1ft tolerance.
    c. Paving or concrete for streets, curbs, gutters, parking areas, drives, alleys and walkways shall be located within the confines of the site boundaries and, occasionally, along a boundary or any other restrictive line. Away from any restrictive line, these facilities should be staked with an accuracy producing no more than 0.05ft. tolerance from their specified locations.
    d. Underground and overhead utilities, such as sewers, gas, water, telephone, and electric lines, shall be located horizontally within their prescribed areas or easements. Within assigned areas, these utilities should be staked with an accuracy producing no more than 0.1 ft tolerance, horizontally and vertically, from a specified location.

B. Surveying instruments shall be kept in close adjustment according to manufacturer's specifications or in compliance to standards. The ENGINEER reserves the right to request a calibration report at any time.

1. Field measurements of angles and distances shall be done in such fashion as to satisfy the closures and tolerances expressed in Part 3.1.A.

2. Vertical locations shall be established from a pre-established benchmark and checked by closing to a different benchmark on the same datum.
3. Construction survey field work shall correspond to the Drawings. Irregularities or conflicts found shall be reported promptly to the ENGINEER.
4. Revisions, corrections, and other pertinent data shall be logged for future reference.

**3.2 EXAMINATION [NOT USED]**
**3.3 PREPARATION [NOT USED]**
**3.4 APPLICATION [NOT USED]**
**3.5 REPAIR / RESTORATION**

A. If the CONTRACTOR's work damages or destroys one or more of the control monuments/points set by the OWNER, the monuments shall be immediately replaced by the CONTRACTOR.

**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD QUALITY CONTROL**

A. It is the CONTRACTOR's responsibility to maintain all stakes and control data placed by the OWNER in accordance with this Specification. This includes easements and right of way, if noted on the plans.
B. Do not change or relocate stakes or control data without approval from the ENGINEER.

**3.8 SYSTEM STARTUP**

A. Survey Checks

1. The OWNER reserves the right to perform a Survey Check at any time deemed necessary.
2. Checks by OWNER personnel or 3rd party contracted surveyor are not intended to relieve the CONTRACTOR of his/her responsibility for accuracy.

**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING [NOT USED]**
**3.11 CLOSEOUT ACTIVITIES [NOT USED]**
**3.12 PROTECTION [NOT USED]**
**3.13 MAINTENANCE [NOT USED]**
**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

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# SECTION 01 74 23

CLEANING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Intermediate and final cleaning for Work not including special cleaning of closed systems specified elsewhere.

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Scheduling

1. Schedule cleaning operations so that dust and other contaminants disturbed by cleaning process will not fall on newly painted surfaces.
2. Schedule final cleaning upon completion of Work and immediately prior to final inspection.

### 1.4 SUBMITTALS [NOT USED]

### 1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

### 1.6 CLOSEOUT SUBMITTALS [NOT USED]

### 1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

### 1.8 QUALITY ASSURANCE [NOT USED]

### 1.9 STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Store cleaning products and cleaning wastes in containers specifically designed for those materials.

### 1.10 FIELD CONDITIONS [NOT USED]

### 1.11 WARRANTY [NOT USED]

## PART 2 - PRODUCTS

### 2.1 OWNER-FURNISHED PRODUCTS [NOT USED]

### 2.2 MATERIALS

A. Cleaning Agents

1. Compatible with surface being cleaned
2. New and uncontaminated
3. For manufactured surfaces

a. Material recommended by manufacturer

**2.3 ACCESSORIES [NOT USED]**
**2.4 SOURCE QUALITY CONTROL [NOT USED]**

**PART 3 - EXECUTION**

**3.1 INSTALLERS [NOT USED]**
**3.2 EXAMINATION [NOT USED]**
**3.3 PREPARATION [NOT USED]**
**3.4 APPLICATION [NOT USED]**
**3.5 REPAIR / RESTORATION [NOT USED]**
**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD QUALITY CONTROL [NOT USED]**
**3.8 SYSTEM STARTUP [NOT USED]**
**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING**

A. General

1. Prevent accumulation of wastes that create hazardous conditions.
2. Conduct cleaning and disposal operations to comply with laws and safety orders of governing authorities.
3. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains or sewers.
4. Dispose of degradable debris at an approved waste disposal site.
5. Dispose of nondegradable debris at an approved waste disposal site or in an alternate manner approved by OWNER and regulatory agencies.
6. Handle materials in a controlled manner with as few handlings as possible.
7. Thoroughly clean, sweep, wash, and polish all Work and equipment associated with this project.
8. Remove all signs of temporary construction and activities incidental to construction of required permanent Work.
9. If project is not cleaned to the satisfaction of the OWNER, the OWNER reserves the right to have the cleaning completed at the expense of the CONTRACTOR.
10. Do not burn on-site.

B. Intermediate Cleaning during Construction

1. Sweep roadway to remove all rocks, pieces of asphalt, concrete, or any other object that may hinder or disrupt the flow of traffic along the roadway.
2. Keep Work areas clean so as not to hinder health, safety, or convenience of personnel in existing facility operations.
3. At maximum weekly intervals, dispose of waste materials, debris, and rubbish.
4. Confine construction debris daily in strategically located container(s):

    a. Cover to prevent blowing by wind.
    b. Store debris away from construction or operational activities.
    c. Haul from site at a minimum of once per week.

5. Vacuum clean interior areas when ready to receive finish painting.

    a. Continue vacuum cleaning on an as-needed basis, until Final Acceptance.

6. Prior to storm events, thoroughly clean site of all loose or unsecured items, which may become airborne or transported by flowing water during the storm.

C. Interior Final Cleaning

1. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed surfaces.
2. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean.
3. Wash and shine glazing and mirrors.
4. Polish glossy surfaces to a clear shine.
5. Ventilating systems

    a. Clean permanent filters and replace disposable filters if units were operated during construction.
    b. Clean ducts, blowers and coils if units were operated without filters during construction.

6. Replace all burned out lamps.
7. Broom clean process area floors.
8. Mop office and control room floors.

D. Exterior (Site or Right of Way) Final Cleaning

1. Remove trash and debris containers from site.

    a. Re-seed areas disturbed by location of trash and debris containers.

2. Sweep roadway to remove all rocks, pieces of asphalt, concrete, or any other object that may hinder or disrupt the flow of traffic along the roadway.
3. Clean any interior areas including, but not limited to, vaults, manholes, structures, junction boxes, and inlets.
4. If no longer required for maintenance of erosion facilities, and upon approval by ENGINEER, remove erosion control from Site.
5. Clean signs, lights, signals, etc.

**3.11 CLOSEOUT ACTIVITIES [NOT USED]**
**3.12 PROTECTION [NOT USED]**
**3.13 MAINTENANCE [NOT USED]**
**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

# SECTION 01 77 19

CLOSEOUT REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. The procedure for closing out a contract.

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Procedures for requesting and documenting Substantial Completion are in the General Conditions, as may be modified by the Supplemental Conditions.
B. Procedures for requesting and documenting the final inspection are in the General Conditions, as may be modified by the Supplemental Conditions.

### 1.4 SUBMITTALS

A. Submit all required documentation to ENGINEER.

### 1.5 INFORMATIONAL SUBMITTALS [NOT USED]

### 1.6 CLOSEOUT SUBMITTALS [NOT USED]

## PART 2 - PRODUCTS [NOT USED]

## PART 3 - EXECUTION

### 3.1 INSTALLERS [NOT USED]

### 3.2 EXAMINATION [NOT USED]

### 3.3 PREPARATION [NOT USED]

### 3.4 CLOSEOUT PROCEDURE

A. Submit request for final payment in accordance with the Agreement and General Conditions, as may be modified by the Supplemental Conditions.
B. Request for final payment shall include:

1. Documents required in the General Conditions, as may be modified by the Supplemental Conditions.
2. Releases or Waivers of Lien Rights:

a. When submitting releases or waivers of Lien rights, provide release or waiver by CONTRACTOR and each Subcontractor and Supplier that provided CONTRACTOR with labor, material, or equipment totaling $1,000.00 or more.
b. Provide list of Subcontractors and Suppliers for which release, or waiver of Lien is required.

c. Each release or waiver of Lien shall be signed by an authorized representative of the entity submitting release or waiver to CONTRACTOR, and shall include Subcontractor's or Supplier's corporate seal, when applicable.
d. Release or waiver of Lien may be conditional upon receipt of final payment.

**3.5 REPAIR / RESTORATION [NOT USED]**
**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD QUALITY CONTROL [NOT USED]**
**3.8 SYSTEM STARTUP [NOT USED]**
**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING [NOT USED]**
**3.11 CLOSEOUT ACTIVITIES [NOT USED]**
**3.12 PROTECTION [NOT USED]**
**3.13 MAINTENANCE [NOT USED]**
**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

# SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Product data and related information appropriate for OWNER's maintenance and operation of products furnished under Contract

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Schedule

1. Submit manuals in final form to the OWNER within 30 calendar days of product shipment to the Site.

### 1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00. All submittals shall be approved by the OWNER prior to delivery.

### 1.5 INFORMATIONAL SUBMITTALS

A. Submittal Form

1. Prepare data in form of an instructional manual for use by OWNER personnel.
2. Format

a. Size: 8 ½ inches x 11 inches
b. Paper

1) 40 pound minimum, white, for typed pages
2) Holes reinforced with plastic, cloth or metal

c. Text: Manufacturer’s printed data, or neatly typewritten
d. Drawings

1) Provide reinforced punched binder tab, bind in with text
2) Reduce larger drawings and fold to size of text pages.

e. Provide fly-leaf for each separate product, or each piece of operating equipment.

1) Provide typed description of product, and major component parts of equipment.

2) Provide indexed tabs.

f. Cover

1) Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS".
2) List:

a) Title of Project
b) Identity of separate structure as applicable
c) Identity of general subject matter covered in the manual

3. Binders

a. Commercial quality 3-ring binders with durable and cleanable plastic covers
b. When multiple binders are used, correlate the data into related consistent groupings.

4. If available, provide an electronic form of the O&M Manual.

B. Manual Content

1. Neatly typewritten table of contents for each volume, arranged in systematic order

a. CONTRACTOR, name of responsible principal, address and telephone number
b. A list of each product required to be included, indexed to content of the volume
c. List, with each product:

1) The name, address and telephone number of the subcontractor or installer
2) A list of each product required to be included, indexed to content of the volume
3) Identify area of responsibility of each
4) Local source of supply for parts and replacement

d. Identify each product-by-product name and other identifying symbols as set forth in Contract Documents.

2. Product Data

a. Include only those sheets which are pertinent to the specific product.
b. Annotate each sheet to:

1) Clearly identify specific product or part installed
2) Clearly identify data applicable to installation
3) Delete references to inapplicable information

3. Drawings

a. Supplement product data with drawings as necessary to clearly illustrate:

1) Relations of component parts of equipment and systems
2) Control and flow diagrams

b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
c. Do not use Project Record Drawings as maintenance drawings.

4. Written text, as required to supplement product data for the particular installation:

a. Organize in consistent format under separate headings for different procedures.
b. Provide logical sequence of instructions of each procedure.

5. Copy of each warranty, bond and service contract issued

a. Provide information sheet for OWNER personnel giving:

1) Proper procedures in event of failure
2) Instances which might affect validity of warranties or bonds

C. Manual for Materials and Finishes

1. Submit 5 copies of complete manual in final form.
2. Content, for architectural products, applied materials and finishes:

a. Manufacturer's data, giving full information on products

1) Catalog number, size, composition
2) Color and texture designations
3) Information required for reordering special manufactured products

b. Instructions for care and maintenance

1) Manufacturer's recommendation for types of cleaning agents and methods
2) Cautions against cleaning agents and methods which are detrimental to product
3) Recommended schedule for cleaning and maintenance

3. Content, for moisture protection and weather exposure products:

a. Manufacturer's data, giving full information on products

1) Applicable standards
2) Chemical composition
3) Details of installation

b. Instructions for inspection, maintenance and repair

D. Manual for Equipment and Systems

1. Submit 5 copies of complete manual in final form.
2. Content, for each unit of equipment and system, as appropriate:

a. Description of unit and component parts

1) Function, normal operating characteristics and limiting conditions
2) Performance curves, engineering data and tests
3) Complete nomenclature and commercial number of replaceable parts

b. Operating procedures

1) Start-up, break-in, routine and normal operating instructions
2) Regulation, control, stopping, shut-down and emergency instructions
3) Summer and winter operating instructions
4) Special operating instructions

c. Maintenance procedures

1) Routine operations
2) Guide to "trouble shooting"
3) Disassembly, repair and reassembly
4) Alignment, adjusting and checking

d. Servicing and lubrication schedule

1) List of lubricants required

e. Manufacturer's printed operating and maintenance instructions
f. Description of sequence of operation by control manufacturer

1) Predicted life of parts subject to wear.
2) Items recommended to be stocked as spare parts.

g. As installed control diagrams by controls manufacturer.
h. Each CONTRACTOR's coordination drawings

1) As installed color coded piping diagrams.

i. Charts of valve tag numbers, with location and function of each valve.
j. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
k. Other data as required under pertinent Sections of Specifications.

3. Content, for each electric and electronic system, as appropriate:

a. Description of system and component parts

1) Function, normal operating characteristics, and limiting conditions
2) Performance curves, engineering data and tests
3) Complete nomenclature and commercial number of replaceable parts

b. Circuit directories of panelboards

1) Electrical service
2) Controls
3) Communications

c. As installed color coded wiring diagrams
d. Operating procedures

1) Routine and normal operating instructions
2) Sequences required
3) Special operating instructions

e. Maintenance procedures

1) Routine operations
2) Guide to "trouble shooting"
3) Disassembly, repair and reassembly
4) Adjustment and checking

f. Manufacturer's printed operating and maintenance instructions
g. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage
h. Other data as required under pertinent Sections of Specifications

4. Prepare and include additional data when the need for such data becomes apparent during instruction of OWNER's personnel.

**1.6 CLOSEOUT SUBMITTALS [NOT USED]**
**1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**
**1.8 QUALITY ASSURANCE**

A. Provide operation and maintenance data by personnel with the following criteria:

1. Trained and experienced in maintenance and operation of described products.
2. Skilled as technical writer to the extent required to communicate essential data.
3. Skilled as draftsman competent to prepare required drawings.

**1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]**
**1.10 FIELD CONDITIONS [NOT USED]**
**1.11 WARRANTY [NOT USED]**

**PART 2 - PRODUCTS [NOT USED]**
**PART 3 - EXECUTION [NOT USED]**

**END OF SECTION**

# SECTION 01 78 39

PROJECT RECORD DOCUMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Work associated with the documenting the project and recording changes to project documents, including, but not limited to, Record Drawings.
2. Record documents include but are not limited to the following:

   a. Drawings
   b. Specifications
   c. Change orders and other modifications to the Contract
   d. OWNER field orders or written instructions, including requests for information (RFI) and clarification memos
   e. Reviewed shop drawings, product data and samples
   f. Test records

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES [NOT USED]
### 1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]
### 1.4 SUBMITTALS

A. Prior to submitting a request for Final Inspection, deliver Project Record Documents to OWNER's Project Representative.

### 1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
### 1.6 CLOSEOUT SUBMITTALS [NOT USED]
### 1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
### 1.8 QUALITY ASSURANCE

A. Accuracy of Records

1. Thoroughly coordinate changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to show the change properly.
2. Accuracy of records shall be such that future search for items shown in the Contract Documents may rely reasonably on information obtained from the approved Project Record Documents.
3. To facilitate accuracy of records, make entries within 24 hours after receipt of information that the change has occurred.
4. Provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive site measurement, investigation and examination.

5. Maintain documents in a clean, dry legible condition and in good order. Do not use record documents for construction purposes. Record documents shall at all times be available for inspection by the OWNER. Failure to maintain record documents in a satisfactory manner may be cause for withholding of a certificate for payment.
6. Each document shall be labeled "PROJECT RECORD" in neat, large, printed letters. All record information shall be kept concurrently with construction progress. Do not conceal any work until the project information is recorded.

### 1.9 STORAGE AND HANDLING

A. Storage and Handling Requirements

1. Maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the Work and transfer of all recorded data to the final Project Record Documents.
2. In the event of loss of recorded data, use means necessary to again secure the data to the OWNER's approval.

    a. In such case, provide replacements to the standards originally required by the Contract Documents.

### 1.10 FIELD CONDITIONS [NOT USED]
### 1.11 WARRANTY [NOT USED]

## PART 2 - PRODUCTS

### 2.1 OWNER-FURNISHED PRODUCTS

A. Owner to provide SCADA RTU panel assy.

B. Owner to provide water meter, contractor to reuse existing water meters as appropriate.

### 2.2 RECORD DOCUMENTS

A. Job Set:

1. Promptly following receipt of the Notice to Proceed, secure from the OWNER, at no charge to the CONTRACTOR, one (1) complete set of all Documents comprising the Contract.

B. Final Record Documents:

1. At a time nearing the completion of the Work and prior to Final Inspection, provide the OWNER one (1) complete set of all Final Record Drawings in the Contract.

### 2.3 ACCESSORIES [NOT USED]
### 2.4 SOURCE QUALITY CONTROL [NOT USED]

## PART 3 - EXECUTION

### 3.1 INSTALLERS [NOT USED]
### 3.2 EXAMINATION [NOT USED]
### 3.3 PREPARATION [NOT USED]
### 3.4 MAINTENANCE DOCUMENTS

A. Maintenance of Job Set

1. Immediately upon receipt of the job set, identify each of the Documents with the title, "RECORD DOCUMENTS - JOB SET".
2. Preservation

    a. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for new entries and for examination, and the conditions under which these activities will be performed, devise a suitable method for protecting the job set.
    b. Do not use the job set for any purpose except entry of new data and for review by the OWNER, until start of transfer of data to final Project Record Documents.
    c. Maintain the job set at the Site.

3. Coordination with Construction Survey

    a. At a minimum, in accordance with the intervals set forth in Section 01 71 23, clearly mark any deviations from Contract Documents associated with installation of the infrastructure.

4. Making entries on Drawings

    a. Record any deviations from Contract Documents.
    b. Identify locations of pipe segments with repaired damage.
    c. All notes shall be made in AutoCAD in a version suitable to the OWNER.
    d. Date all entries.
    e. Call attention to the entry by a "cloud" drawn around the area or areas affected.
    f. In the event of overlapping changes, use different colors for the overlapping changes.

5. Conversion of schematic layouts

    a. In some cases, on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items, are shown schematically and are not intended to portray precise physical layout.

        1) Final physical arrangement is determined by the CONTRACTOR, subject to the OWNER's approval.
        2) However, design of future modifications of the facility may require accurate information as to the final physical layout of items which are shown only schematically on the Drawings.

    b. Show on the job set of Record Drawings, by dimension accurate to within 1 inch, the centerline of each run of items.

        1) Final physical arrangement is determined by the CONTRACTOR, subject to the OWNER's approval.
        2) Show, by symbol or note, the vertical location of the Item ("under slab", "in ceiling plenum", "exposed", and the like).
        3) Make all identification sufficiently descriptive that it may be related reliably to the Specifications.

c. The OWNER may waive the requirements for conversion of schematic layouts where, in the OWNER's judgment, conversion serves no useful purpose. However, do not rely upon waivers being issued except as specifically issued in writing by the OWNER.

B. Final Project Record Documents

1. Transfer of data to Drawings

a. Carefully transfer change data shown on the job set of Record Drawings to the corresponding final documents, coordinating the changes as required.
b. Clearly indicate at each affected detail and other Drawing a full description of changes made during construction, and the actual location of items.
c. Call attention to each entry by drawing a "cloud" around the area or areas affected.
d. Make changes neatly, consistently and with the proper media to assure longevity and clear reproduction.

2. Transfer of data to other Documents

a. If the Documents, other than Drawings, have been kept clean during progress of the Work, and if entries thereon have been orderly to the approval of the OWNER, the job set of those Documents, other than Drawings, will be accepted as final Record Documents.
b. If any such Document is not so approved by the OWNER, secure a new copy of that Document from the OWNER at the OWNER's usual charge for reproduction and handling, and carefully transfer the change data to the new copy to the approval of the OWNER.

**3.5 REPAIR / RESTORATION [NOT USED]**
**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD QUALITY CONTROL [NOT USED]**
**3.8 SYSTEM STARTUP [NOT USED]**
**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING [NOT USED]**
**3.11 CLOSEOUT ACTIVITIES [NOT USED]**
**3.12 PROTECTION [NOT USED]**
**3.13 MAINTENANCE [NOT USED]**
**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

# SECTION 02 41 13

SELECTIVE SITE DEMOLITION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Removing concrete structures
2. Removing equipment pads
3. Removing electrical equipment
4. Disposal of removed materials

B. The CONTRACTOR shall examine the various Drawings regarding the existing site, visit the project site and determine for himself the extent of the work affected therein and all conditions under which he is required to perform the various operations.

C. Related Specification Sections include, but are not necessarily limited to:

1. Division 01 – General Requirements

### 1.2 REFERENCES [NOT USED]

### 1.3 SUBMITTALS [NOT USED]

### 1.4 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

### 1.5 CLOSEOUT SUBMITTALS [NOT USED]

### 1.6 PERMITS AND NOTICES

A. Permits and Licenses: CONTRACTOR shall obtain all necessary permits and licenses for performing the work and shall furnish a copy of same to the OWNER and ENGINEER prior to commencing the work. The CONTRACTOR shall comply with the requirements of the permits.

B. Notices: CONTRACTOR shall issue written notices of planned demolition to companies or local authorities owning utility conduit, wires or pipes running to or through the project site. Copies of said notices shall be submitted to the OWNER and ENGINEER.

C. Utility Services: CONTRACTOR shall notify utility companies or local authorities furnishing gas, water, electrical, telephone or sewer service to remove any equipment owned by them in structures to be demolished and to remove, disconnect, cap or plug their services to facilitate demolition.

### 1.7 FIELD CONDITIONS

A. The OWNER and the ENGINEER assume no responsibility for the actual condition of the structures to be demolished or modified.

### 1.8 DAMAGE

A. Promptly repair damage caused to adjacent facilities by demolition operations as directed by the ENGINEER and at no cost to the OWNER.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Fill Material: See Section 33 05 10.

## PART 3 - EXECUTION

## 3.1 PREPARATION

A. Notify affected utility companies before starting Work and comply with applicable requirements.
B. Mark location and termination of utilities.
C. Prevent movement of existing structures, utilities, or other facilities pertaining or adjacent to demolition activities; provide temporary bracing and shoring required.

## 3.2 GENERAL

A. Conduct demolition and/or removal operations, and the removal of equipment and debris to ensure minimum interference with roadways, walkways, and parking areas both onsite and offsite, and to ensure minimum interference with occupied or used facilities.
B. Maintain protected ingress and egress to adjacent existing buildings, parking areas, and driveways at all times.
C. Do not close or obstruct roadways, driveways, parking areas, or sidewalks without prior written approval from the ENGINEER and the agency having jurisdiction.

## 3.3 REMOVAL

A. Remove Concrete Structures

1. Remove concrete structures according to drawings.
2. Cut reinforcement close to the portion of the concrete to remain in place.
3. Break or perforate the bottom of structures to remain to prevent the entrapment of water.

B. Disposal

1. The CONTRACTOR shall remove from the Site and dispose of demolished materials.
2. Disposal of removed materials shall be in accordance with all applicable local, state, and federal regulations.

## 3.4 REPAIR [NOT USED]
## 3.5 RE-INSTALLATION [NOT USED]
## 3.6 SITE QUALITY CONTROL [NOT USED]
## 3.7 SYSTEM STARTUP [NOT USED]
## 3.8 ADJUSTING [NOT USED]
## 3.9 CLEANING [NOT USED]
## 3.10 CLOSEOUT ACTIVITIES [NOT USED]
## 3.11 PROTECTION [NOT USED]
## 3.12 MAINTENANCE [NOT USED]
## 3.13 ATTACHMENTS [NOT USED]

**END OF SECTION**

# SECTION 03 01 30

MAINTENANCE OF CAST-IN-PLACE CONCRETE

## 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.

B. SECTION 03 60 00 – STRUCTURAL/STRUCTURALLY ENHANCED LINING

C. SECTION 03 70 00 – EMBEDDED GALVANIC ANODES

### 1.2 SUMMARY

A. Section Includes:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor joint repair.
3. Epoxy crack injection.
4. Corrosion-inhibiting treatment.
5. Polymer overlays.
6. Polymer sealers.
7. Composite structural reinforcement.

### 1.3 REFERENCES

A. ICRI No. 110.2-2020 Guide Specifications for Epoxy Injection

B. ICRI Guideline 310.1R - Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion

C. ACI Concrete Repair Manual

D. ACI 546R Concrete Repair Guide

E. ACI 546.3R Guide for the Selection of Materials for the Repair of Concrete

F. ACI RAP-1 Structural Crack Repair by Epoxy Injection

G. ACI RAP-2 Crack Repair by Gravity Feed with Resin

H. ACI RAP-3 Spall Repair by Low-Pressure Spraying

I. ACI RAP-4 Surface Repair Using Form-and-Pour Techniques

J. ACI RAP-5 Surface Repair Using Form-and-Pump Techniques

K. ACI RAP-6 Vertical and Overhead Spall Repair by Hand Application

L. ACI RAP-7 Spall Repair of Horizontal Concrete Surfaces

M. ACI RAP-8 Installation of Embedded Galvanic Anodes

N. ACI RAP-9 Spall Repair by the Preplaced Aggregate Method

O. ACI RAP-10 Leveling and Reprofiling of Vertical and Overhead Surfaces

P. ACI RAP-11 Slabjacking

Q. ACI RAP-12 Concrete Repair by Shotcrete Application

R. ACI RAP-13 Ethacrylate Flood Coat

S. ACI RAP-14 Concrete Removal Using Hydrodemolition

T. ICRI Guideline 310.1R Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion

U. ICRI Guideline 310.2 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

## 1.4 ALLOWANCES

A. Field quality-control testing is part of testing and inspecting allowance.

## 1.5 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 01 22 00 "Measurement and Payment."

1. Unit prices apply to authorized work covered by (SQ. FT.) (100 SQ. FT.).
2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

B. General: Unit prices include the cost of preparing existing construction to receive the work indicated and costs of field quality control required for units of work completed.

## 1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete maintenance including, but not limited to, the following:

a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Quality-control program.
d. Coordination with building occupants.

## 1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.

B. Samples: Cured Samples for each exposed product and for each color and texture specified, in manufacturer's standard size appropriate for each type of work.

C. Samples for Initial Selection: Cured Samples for each exposed product and for each color and texture.

1. Include sets of patching-material Samples in the form of briquettes, at least 3 inches long by 1-1/2 inches wide representative of the range of concrete colors on the building. Document each Sample with product, mix, and or other information necessary to replicate it.

2. Include sets of Samples for epoxy crack-injection adhesive and capping adhesive in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.

3. Include sets of polymer-overlay Samples in the form of treated cementitious tiles at least 4 inches long by 4 inches wide representative of the range of required colors and textures.

4. Include sets of polymer-sealer Samples in the form of treated cementitious tiles at least 4 inches long by 4 inches wide representative of the range of required colors and textures.

5. Have each set of Samples contain a close color range of at least 3 Samples of different mixes of materials that match the variations in existing, adjacent concrete when cured and dry.

D. Samples for Verification: Cured Samples for each exposed product and for each color and texture specified.

1. Include Samples of each required type, color, and texture of patching material in the form of patches in drilled holes or sawed joints in sample concrete representative of the range of concrete colors on the building.

2. Include Samples of epoxy crack-injection in the form of injection-treated, whole, dense concrete block or brick units representative of the range of required adhesive colors.

3. Include Samples of each required type, color, and texture of polymer-overlay material in the form of cementitious tiles at least 8 inches long by 8 inches wide.

4. Include Samples of each required type, color, and texture of polymer-sealer material in the form of cementitious tiles at least 8 inches long by 8 inches wide.

## 1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For concrete-maintenance specialist and manufacturers.

B. Material Certificates: For each type of portland cement, aggregate supplied for mixing or adding to products at Project site.

C. Product Test Reports: For each manufactured bonding agent, cementitious patching mortar, joint-filler, crack-injection adhesive, polymer overlay, polymer sealer, and composite structural reinforcement, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Quality-Control Program: Submit before work begins.

## 1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: Each manufactured bonding-agent, packaged patching-mortar, joint-filler, crack-injection-adhesive, corrosion-inhibiting-treatment, polymer-overlay, polymer-sealer, composite-structural-reinforcement, and embedded anode manufacturer shall employ factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

B. Concrete-Maintenance Specialist Qualifications: Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply packaged patching-mortar, crack-injection adhesive, corrosion-inhibiting treatments, polymer overlays, polymer sealers, embedded anodes, and composite structural reinforcement to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing or patching new concrete is insufficient experience for concrete-maintenance work.

1. Field Supervision: Concrete-maintenance specialist firm shall maintain experienced full-time supervisors on Project site during times that concrete-maintenance work is in progress.

C. Quality-Control Program: Prepare a written plan for concrete maintenance to systematically demonstrate the ability of personnel to properly perform maintenance work, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.

## 1.10 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.

B. Store cementitious materials off the ground, under cover, and in a dry location.

C. Store aggregates covered and in a dry location; maintain grading and other required characteristics and prevent contamination.

## 1.11 FIELD CONDITIONS

A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

1. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40 deg F (5 deg C) within eight hours.

2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F (16 deg C) within eight hours.

3. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F (16 deg C) for eight hours.

B. Cold-Weather Requirements for Cementitious Materials: Do not apply unless concrete-surface and air temperatures are above 40 deg F (5 deg C) and will remain so for at least 48 hours after completion of Work.

C. Cold-Weather Requirements for Cementitious Materials: Comply with the following procedures:

D. When air temperature is below 40 deg F (5 deg C), heat patching-material ingredients and existing concrete to produce temperatures between 40 and 90 deg F (5 and 32 deg C).

E. When mean daily air temperature is between 25 and 40 deg F (minus 4 and plus 5 deg C), cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.

F. When mean daily air temperature is below 25 deg F (minus 4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.

G. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F (32 deg C) and above.

H. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below 55 deg F (13 deg C) or above 75 deg F (24 deg C). Apply only to dry substrates that have been dry for at least 72 hours.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Source Limitations: For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

### 2.2 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Manufactured product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

B. Epoxy Bonding Agent: ASTM C881/C881M, bonding system Type II and free of VOCs.

C. Latex Bonding Agent, Redispersible: ASTM C1059/C1059M, Type I for use at nonstructural and interior locations unless otherwise indicated.

D. Latex Bonding Agent, Non-Redispersible: ASTM C1059/C1059M, Type II for use at structural and exterior locations and where indicated.

E. Mortar Scrub Coat: Mix consisting of 1-part portland cement and 1 part fine aggregate complying with ASTM C144 except 100 percent passing a No. 16 (1.18-mm) sieve.

### 2.3 PATCHING MORTAR

A. Patching Mortar Requirements:

1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar that matches existing, adjacent, exposed concrete. Blend several aggregates if necessary to achieve suitable matches.
3. Coarse Aggregate for Patching Mortar: ASTM C33/C33M, washed aggregate, Size No. 8, Class 5S. Add to patching-mortar mix only as permitted by patching-mortar manufacturer.

B. Job-Mixed Patching Mortar: 1-part portland cement and 2-1/2 parts fine aggregate complying with ASTM C144, except 100 percent passing a No. 16 (1.18-mm) sieve.

C. Cementitious Patching Mortar: Packaged, dry mix for repair of concrete.

1. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C109/C109M.

D. Rapid-Strengthening, Cementitious Patching Mortar: Packaged, dry mix, ASTM C928/C928M for repair of concrete.

1. Compressive Strength: Not less than 2000 psi within 3 hours when tested according to ASTM C109/C109M.

E. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix for repair of concrete and that contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C109/C109M.

F. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix for repair of concrete and that contains silica fume complying with ASTM C1240 and a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

1. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C109/C109M.

## 2.4 PREPLACED CONCRETE MATERIALS

A. Preplaced Aggregate: Washed aggregate, ASTM C33/C33M, Class 5S, with 95 to 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, zero to 10 percent passing a 1/2-inch (12.5-mm) sieve, and zero to 2 percent passing a 3/8-inch (9.5-mm) sieve.

B. Fine Aggregate for Grout: Fine aggregate according to ASTM C33/C33M, but with 100 percent passing a No. 8 (2.36-mm) sieve, 95 to 100 percent passing a No. 16 (1.18-mm) sieve, 55 to 80 percent passing a No. 30 (0.6-mm) sieve, 30 to 55 percent passing a No. 50 (0.3-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, zero to 10 percent passing a No. 200 (0.075-mm) sieve, and having a fineness modulus of 1.30 to 2.10.

C. Grout Fluidifier for Grout: ASTM C937.

D. Pozzolans for Grout: ASTM C618.

## 2.5 JOINT FILLER

A. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of at least 80 according to ASTM D2240.

B. Polyurea Joint Filler: Two-component, semirigid, 100 percent solids, polyurea resin with a Type A Shore durometer hardness of at least 80 according to ASTM D2240.

C. Color: As selected by Architect from full range of industry colors.

## 2.6 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C881/C881M, bonding system Type IV at structural locations and where indicated, Type I at other locations; free of VOCs.

1. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.

2. Color: Provide epoxy crack-injection adhesive and capping adhesive as indicated by manufacturer's designations that blend with existing, adjacent concrete and do not stain concrete surface.

## 2.7 CORROSION-INHIBITING MATERIALS

A. Corrosion-Inhibiting Treatment: Waterborne solution of alkaline corrosion-inhibiting chemicals for concrete-surface application that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

## 2.8 POLYMER-OVERLAY MATERIALS

A. Polymer Overlay: Epoxy adhesive complying with ASTM C881/C881M, bonding system Type III, with surface-applied aggregate for skid resistance; free of VOCs.

1. Aggregate: ACI 503.3, oven-dried, washed silica sand.

2. Color and Texture: As selected by Architect from full range of industry colors.

## 2.9 POLYMER-SEALER MATERIALS

A. Epoxy Polymer Sealer: Low-viscosity epoxy, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; VOC content 100 g/L or less.

1. Color: As selected by Architect from full range of industry colors.

B. Methacrylate Polymer Sealer: Low-viscosity, high-molecular-weight methacrylate, penetrating sealer, and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; VOC content 100 g/L or less.

1. Color: As selected by Architect from full range of industry colors.

## 2.10 COMPOSITE REINFORCEMENT MATERIALS

A. Composite Structural Reinforcement: Manufacturer's system consisting of carbon-fiber reinforcement in the form of tow sheet with field-applied saturant and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as externally bonded structural reinforcement for concrete.

## 2.11 MISCELLANEOUS MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I, II, or III unless otherwise indicated.

B. Water: Potable.

## 2.12 MIXES

A. General: Mix products, in clean containers, according to manufacturer's written instructions.

1. Do not add water, thinners, or additives unless recommended by manufacturer.
2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
3. Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.

B. Mortar Scrub Coat: Mix dry ingredients with enough water to provide consistency of thick cream.

C. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

D. Concrete

E. Comply with Section 03 30 00 "Cast-in-Place Concrete."

F. Grout for Use with Preplaced Aggregate: Proportion according to ASTM C938. Add grout fluidifier to mixing water followed by portland cement, pozzolan, and fine aggregate.

# PART 3 - EXECUTION

## 3.1 CONCRETE MAINTENANCE

A. Have concrete-maintenance work performed only by qualified concrete-maintenance specialist.

B. Comply with manufacturers' written instructions for surface preparation and product application.

## 3.2 EXAMINATION

A. Notify Architect seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb unless otherwise indicated.

C. Pachometer Testing: Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer using depth of cover measurements and verify depth of cover in removal areas using pachometer.

D. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

## 3.3 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete maintenance work begins and during its progress.

B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete maintenance work.

1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
2. Use only proven protection methods appropriate to each area and surface being protected.
3. Provide temporary barricades, barriers, and directional signage to exclude public from areas where concrete maintenance work is being performed.
4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of concrete maintenance work.
5. Contain dust and debris generated by concrete maintenance work and prevent it from reaching the public or adjacent surfaces.
6. Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment that ensure that such water will not create a hazard or adversely affect other building areas or materials.
7. Protect floors and other surfaces along haul routes from damage, wear, and staining.
8. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
9. Protect adjacent surfaces and equipment by covering them with heavy polyethylene film and waterproof masking tape or a liquid strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
10. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
11. Dispose of debris and runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is in working order.

1. Prevent solids such as aggregate or mortar residue from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete maintenance work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

D. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.

1. Verify that affected utilities have been disconnected and capped.
2. Inventory and record the condition of items to be removed for reinstallation or salvage.
3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.

E. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by abrasive blast cleaning or wire brushing until only tightly adhered light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.
2. Remove additional concrete as necessary to provide at least 3/4-inch (19-mm) clearance at existing and replacement bars.
3. Splice replacement bars to existing bars according to ACI 318 (ACI 318M) by lapping, welding, or using mechanical couplings.
4. Install embedded anodes as per drawings and Section 03 70 00 “Embedded Galvanic Anodes”.

F. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 2 inches deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.

G. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete to remove dirt, oils, films, and other materials detrimental to treatment application.

1. Use sand blasting.
2. Allow surface to dry before applying corrosion-inhibiting treatment.

H. Surface Preparation for Overlays:

1. Remove delaminated material and deteriorated concrete surface material.

2. Roughen surface of concrete to produce a surface profile matching CSP 5 according to ICRI 310.2.
3. Use shot blasting.
4. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.

I. Acidic Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 according to ICRI 310.2. Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration**.**

1. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
2. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
3. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable according to sealer manufacturer's written instructions.
4. When pH is acceptable according to sealer manufacturer's written instructions and surface is clean, vacuum dry.

J. Nonacidic Surface Preparation for Sealers: Clean concrete to remove dirt, oils, films, and other materials detrimental to sealer application.

1. Use shot blasting.

K. Surface Preparation for Composite Structural Reinforcement: Clean concrete where reinforcement and epoxy patching mortar is to be placed by detergent scrubbing to remove dirt, oils, films, and other materials detrimental to epoxy patching mortar.

1. Roughen surface of concrete by sand blasting.
2. Remove delaminated material and deteriorated concrete surface material.
3. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.

## 3.4 REMOVAL OF CONCRETE

A. Do not overload structural elements with debris.

B. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch (13 mm). Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.

D. Remove additional concrete if necessary to provide a depth of removal of at least 1/2 inch (13 mm) over entire removal area.

E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least 3/4-inch (19-mm) clearance around bar.

F. Test areas where concrete has been removed by tapping with hammer and remove additional concrete until unsound and disbonded concrete is completely removed.

G. Provide surfaces with a fractured profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.

H. Thoroughly clean removal areas of loose concrete, dust, and debris.

## 3.5 APPLICATION OF BONDING AGENT

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.

B. Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Place patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.

C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.

D. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. Place patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.

E. Mortar Scrub Coat for Job-Mixed Patching Mortar and Concrete: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub coat dries, recoat before placing patching mortar or concrete.

F. Slurry Coat for Cementitious Patching Mortar: Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent] into substrate, filling pores and voids.

## 3.6 INSTALLATION OF PATCHING MORTAR

A. Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer or where dry-pack mortar is indicated.

1. Provide forms where necessary to confine patch to required shape.

2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified bonding agent.

C. General Placement: Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.

D. Vertical Patching: Place material in lifts of not more than 1 inch (25 mm) or less than 1/4 inch (6 mm). Do not feather edge.

E. Overhead Patching: Place material in lifts of not more than 1 inch (25 mm) or less than 1/4 inch (6 mm). Do not feather edge.

F. Consolidation: After each lift is placed, consolidate material and screed surface.

G. Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

H. Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a surface matching adjacent concrete.

I. Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

## 3.7 INSTALLATION OF DRY-PACK-MORTAR

A. Use dry-pack mortar for deep cavities and where indicated. Place as specified in this article unless otherwise recommended in writing by manufacturer.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified bonding agent.

C. Place dry-pack mortar into cavity by hand and compact tightly into place. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.

D. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.

E. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

## 3.8 CONCRETE PLACEMENT

A. Place concrete according to Section 03 30 00 "Cast-in-Place Concrete" and as specified in this article.

B. Pretreatment: Apply epoxy bonding agent to reinforcement and concrete substrate.

C. Pretreatment: Apply Type I latex bonding agent to concrete substrate.

D. Standard Placement: Place concrete by form-and-pump method unless otherwise indicated.

1. Use vibrators to consolidate concrete as it is placed.
2. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.

E. Form-and-Pump Placement: Place concrete by form-and-pump method where indicated.

1. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and where forms abut existing concrete.
2. Pump concrete into place from bottom to top, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi (96 kPa).

F. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

G. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

## 3.9 GROUTING PREPLACED AGGREGATE CONCRETE

A. Use grouted preplaced aggregate concrete where indicated for column and wall repairs. Place as specified in this article.

B. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and where forms abut existing concrete.

C. Apply epoxy bonding agent to reinforcement and concrete substrate.

D. Place aggregate in forms, consolidating aggregate in lifts as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.

E. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.

F. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi (96 kPa).

G. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

H. Repair voids with patching mortar and finish to match surrounding concrete.

## 3.10 FLOOR-JOINT REPAIR

A. Cut out deteriorated concrete and reconstruct sides of joint with patching mortar as indicated on Drawings. Install joint filler in nonmoving floor joints where indicated and as specified in this article.

B. Depth: Install joint filler to a depth of at least 1 inch (25 mm). Use fine silica sand no more than 1/4 inch (6 mm) deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.

C. Top Surface: Install joint filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.

## 3.11 EPOXY CRACK INJECTION

A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.

B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.

D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch (6 mm) thick by 1 inch (25 mm) wider than crack.

E. Inject cracks wider than 0.003 inch (0.075 mm) to a depth of 8 inches (200 mm).

F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.

G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

## 3.12 APPLICATION OF CORROSION-INHIBITING-TREATMENT

A. Apply corrosion-inhibiting treatment to surfaces indicated on Drawings.

B. Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete or applying a sealer or overlay.

## 3.13 APPLICATION OF POLYMER OVERLAY

A. Apply polymer overlay according to ACI 503.3.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

## 3.14 APPLICATION OF POLYMER SEALER

A. Apply polymer sealer by brush, roller, or airless spray at manufacturer's recommended application rate.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

## 3.15 INSTALLATION OF COMPOSITE STRUCTURAL REINFORCEMENT

A. Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, install as follows:

1. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.

2. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.

3. Apply epoxy saturant to fiber tow sheet using roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy to fully saturate tow sheet.

4. Apply additional layers using same procedure, fully saturating each layer with epoxy.

5. After saturant has cured, apply protective topcoat by roller or spray.

B. Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, install as follows:

1. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.

2. Apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm) to prepared concrete surfaces.

3. Clean fiber sheet with acetone or other suitable solvent, and apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm).

4. Apply adhesive-coated fiber sheet to adhesive-coated concrete and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.

5. Apply additional layers using same procedure.

## 3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Packaged, Cementitious Patching Mortar: Five randomly selected sets of samples for each type of mortar required, tested according to ASTM C928/C928M.

2. Job-Mixed Patching Mortar: Five randomly selected sets of samples for each type of mortar required, tested for compressive strength according to ASTM C109/C109M.

3. Concrete: As specified in Section 03 30 00 "Cast-in-Place Concrete."

4. Grout for Preplaced Aggregate: Tested for compressive strength according to ASTM C942.

    a. Testing Frequency: One sample for each 25 cu. yd. (19 cu. m) of grout or fraction thereof, but not less than one sample for each day's work.

5. Joint Filler: Core-drilled samples to verify proper installation.

    a. Testing Frequency: One sample for each 100 feet (30 m) of joint filled.

    b. Where samples are taken, refill holes with joint filler.

6. Epoxy Crack Injection: Core-drilled samples to verify proper installation.

    a. Testing Frequency: one sample for each 100 feet of crack injected.

    b. Where samples are taken, refill holes with epoxy mortar.

C. Product will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.

1. Have manufacturers' factory-authorized service representatives perform the following number of Project-site inspections to observe progress and quality of the Work, distributed over the period of product installation, regardless of on-site assistance requested by Architect:

    a. Bonding-Agent and Packaged Patching-Mortar Installation: Three inspections.

    b. Joint-Filler Installation: Two inspections.

    c. Crack-Injection-Adhesive Preparation and Installation: Four inspections.

d. Corrosion-Inhibiting Treatment: Two inspections.

e. Polymer Overlay: Two inspections.

f. Polymer Sealer: Two inspections.

g. Composite-Structural-Reinforcement: Three inspections.

## 3.17 CONCRETE MAINTENANCE SCHEDULE

A. Perform the following as required in field or where repair or patch work is required:

1. Removal of deteriorated concrete and subsequent replacement and patching.
2. Floor joint repair.
3. Epoxy crack injection.
4. Corrosion-inhibiting treatment.
5. Polymer overlays.
6. Polymer sealers.
7. Composite structural reinforcement on underside of slab.

**END OF SECTION**

# SECTION 03 30 00

CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

### 1.3 INFORMATIONAL SUBMITTALS

A. Material certificates.

B. Material test reports.

C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

### 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

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

## 1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

## 1.6 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1.

1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301.

# PART 2 - PRODUCTS

## 2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 117.

## 2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

## 2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, deformed.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

## 2.4 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I/II gray.
2. Fly Ash: ASTM C 618, Class F or C.
3. Slag Cement: ASTM C 989/C 989M, Grade 100.
4. Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, portland blast-furnace slag Type IP, portland-pozzolan or Type IT, ternary blended cement.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.

1. Maximum Coarse-Aggregate Size: ¾" inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: ASTM C 94/C 94M and potable.

## 2.5 WATERSTOPS

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

## 2.6 VAPOR RETARDERS

A. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

## 2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9oz/square yard when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating**,** certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating**,** certified by curing compound manufacturer to not interfere with bonding of floor covering.

H. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

I. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

## 2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

## 2.9 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

## 2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Normal-Weight Concrete:

1. Minimum Compressive Strength: 3000 psi and 4000psi as indicated at 28 days.
2. Maximum W/C Ratio: 0.50 .
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1 inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

## 2.11 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 degrees F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 degrees F, reduce mixing and delivery time to 60 minutes.

# PART 3 - EXECUTION

## 3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

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

## 3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

## 3.3 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

## 3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

## 3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8 inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

## 3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

## 3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

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

## 3.8 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo .

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated, exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system .
2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10 foot long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4” .

D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

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

## 3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

## 3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

## 3.11 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

**END OF SECTION**

# SECTION 03 70 00

EMBEDDED GALVANIC ANODES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. SECTION 03 01 30 MAINTENANCE OF CAST-IN-PLACE CONCRETE

### 1.2 SUMMARY

A. This Section includes furnishing all labor, tools, materials, equipment, and services necessary to properly install embedded galvanic anodes.

B. Embedded galvanic anodes are designed to provide localized corrosion protection. When placed at the appropriate spacing along the perimeter of concrete repairs or along the interface between new/existing concrete, the anodes mitigate corrosion and the formation of new corrosion sites in the adjacent existing concrete.

### 1.3 REFERENCES

A. ACI Repair Application Procedure (RAP) Bulletin 8 – Installation of Embedded Galvanic Anodes

B. ACI Guideline No. 222 – Corrosion of Metals in Concrete

C. ACI 562 - Code Requirements for Evaluation, Repair and Rehabilitation of Concrete Buildings

D. ASTM B418– Standard Specification for Cast and Wrought Galvanic Zinc Anodes

E. ICRI Guideline 310.1R - Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion

F. ISO 12696 – Cathodic Protection of Steel in Concrete

### 1.4 MANUFACTURER EXTENDED LIMITED WARRANTY

A. Contractor shall provide a Limited Warranty with a notarized signature from a corporate officer of the anode manufacturer.

B. The Limited Warranty shall state the following:

1. The published anode spacing guidelines for anode size and spacing are based on an estimated minimum 20-year anode service life in the environment it is installed.

2. The galvanic anodes will remain electrochemically active and produce galvanic current in relation to the environment in which it is installed for a minimum of 5 years from the date of anode installation.

3. The anode unit, including its constituents, does not include intentionally added substances that may cause corrosion to reinforcing steel over the life of the structure.

4. The galvanic anodes meet all building and repair code requirements.

## 1.5. ANODE MANUFACTURER CORROSION TECHNICIAN

A. The contractor will enlist and pay for a technical representative employed by the galvanic anode manufacturer to provide training and on-site technical assistance during the initial installation of the galvanic anodes. The technical representative shall be a NACE-qualified corrosion technician (NACE CP2 Cathodic Protection Technician or higher).

B. The qualified corrosion technician shall have verifiable experience in the installation and testing of embedded galvanic protection systems for reinforced concrete structures.

C. The contractor shall coordinate its work with the designated corrosion technician to allow for site support during project startup and initial anode installation. The corrosion technician shall provide contractor training and support for development of application procedures, verification of electrical continuity, and project documentation.

# PART 2 - PRODUCTS

## 2.1 EMBEDDED GALVANIC ANODES

Embedded galvanic anodes shall be Anode Type 1A with the following nominal dimensions: 25 x 31 x 64 mm (1 x 1.25 x 2.5 in.). The anodes shall be pre-manufactured with zinc in compliance with ASTM B418 Type II cast around an integral, unspliced, uncoated, non-galvanized double loop steel tie wire and encased in a highly alkaline cementitious shell with a pH of 14 or greater.

The galvanic anodes shall be alkali-activated and shall contain no intentionally added chloride, bromide or other constituents that are corrosive to reinforcing steel as per ACI 562. The anode size and spacing shall deliver a minimum current density to the steel adjacent to the repair of 4.3mA/ft2 for the 20-year design life taking into account an anode aging factor calculated from previous field installations and the in-service environment.

Embedded galvanic anodes shall be Galvashield® XP Compact available from Vector Corrosion Technologies (www.vector-corrosion.com) USA (813) 830-7566, Canada (204) 489-9611, UK +44 (0) 1384 671414 or approved equal.

Application for approved equals shall be requested in writing two weeks before submission of project bids. Application for galvanic anode approved equals shall include verification of the following information:

1. The zinc anode is alkali-activated with an alkaline cementitious shell with a pH of 14 or greater.
2. The galvanic anode shall contain no intentionally added constituents which are corrosive to reinforcing steel, e.g. chloride, bromide, etc.
3. The anode manufacturer shall provide documented performance data from field installations showing that the anodes have remained active for a minimum of 20 years in service and meet the ISO 12696 Cathodic Prevention Standard.
4. Project design calculations showing that the minimum specified current density to reinforcing steel adjacent to the repair will be achieved 20 years after installation. The design calculations shall take into consideration expected in-service temperature and humidity conditions in the environment in which the anodes are to be placed in service and use a galvanic anode aging factor derived from field monitoring for at least one anode aging step. The aging factor for Galvashield is 12.5 years at average annual temperature of 10-15oC (50-60oF)
5. The galvanic anode shall have been used in a minimum of ten projects of similar size and application.
6. The galvanic anode units shall be supplied with solid zinc core (ASTM B418) cast around an uncoated, non-galvanized, non-spliced steel tie wire for wrapping around the reinforcing steel and twisting to provide a durable steel-to-steel connection between the tie wire and the reinforcing steel.
7. The anode manufacturer shall provide third party product evaluation, such as from Concrete Innovations Appraisal Service, BBA, etc.

## 2.2 REPAIR MATERIALS

A. Use an ionically conductive, cement-based repair mortar or concrete. Non-conductive repair materials such as epoxy, urethane, or magnesium phosphate shall not be permitted. Insulating materials such as epoxy bonding agents shall not be used unless otherwise called for in the design.

B. If repair materials have a saturated bulk resistivity of 50,000 ohm-cm or greater, pack Galvashield® Embedding Mortar or another repair mortar with a resistivity of 15,000 ohm-cm or less between the anode and the substrate to provide an ionically conductive path to the substrate.

## 2.3 STORAGE

Deliver, store, and handle all materials in accordance with manufacturer's instructions. Anode units shall be stored in dry conditions in the original unopened containers in a manner to avoid exposure to extremes of temperature and humidity.

## PART 3 - EXECUTION

### 3.1 CONCRETE REMOVAL

A. Remove loose or delaminated concrete.

B. Undercut all exposed reinforcing steel by removing concrete from the full circumference of the steel as per ICRI R310.1R. The minimum clearance between the concrete substrate and reinforcing steel shall be ¾ inch (19 mm) or ¼ inch (6 mm) larger than the top size aggregate in the repair material, whichever is greater.

C. Concrete removal shall continue along the reinforcing steel until no further delamination, cracking, or significant rebar corrosion exists and the reinforcing steel is well bonded to the surrounding concrete as per ICRI R310.1R.

### 3.2 CLEANING AND REPAIR OF REINFORCING STEEL

A. Clean exposed reinforcing steel of rust, mortar, etc. to provide sufficient electrical connection and mechanical bond.

B. If significant reduction in the cross section of the reinforcing steel has occurred, replace or install supplemental reinforcement as directed by the engineer of record.

C. Secure loose reinforcing steel by tying tightly to other bars with steel tie wire.

D. Verify electrical continuity of all exposed reinforcing steel, including supplemental steel, as per Section 3.4.E.

E. If the reinforcing steel is to receive a barrier coating, do not coat the reinforcing steel within 1 in. (25mm) of the anode and do not apply coating to any surface of the anode or the steel tie wires.

### 3.3 EDGE AND SURFACE CONDITIONING OF CONCRETE

A. Concrete repairs shall be square or rectangular in shape with squared corners per ICRI Guideline 310.1R.

B. Saw cut the repair boundary ½ inch (13 mm) deep or less if required to avoid cutting reinforcing steel.

C. Create a clean, sound substrate by removing bond-inhibiting materials from the concrete substrate by high pressure water blasting or abrasive blasting.

### 3.4 GALVANIC ANODE INSTALLATION

A. Install anode units and repair material immediately following preparation and cleaning of the steel reinforcement.

B. Galvanic anodes shall be installed along the interface between new and old concrete at rebar spacing.

C. Place the galvanic anodes as close as possible to the interface with the parent concrete maximum 4 in. while still providing sufficient clearance between anodes and substrate to allow the repair material to fully encase the anode.

1. Place the anode such that the preformed BarFit™ groove fits along a single bar or at the intersection between two bars and secure to each clean bar.

2. If less than 1 in. (25 mm) of concrete cover is expected, place anode beneath the bar and secure to clean reinforcing steel or increase the size of the repair cavity to accommodate the anodes.

D. Wrap the tie wires around the clean reinforcing steel at least one full turn in opposite directions and bring the two free ends together and twist tight to create a secure electrical connection that will not allow anode movement during concrete placement.

E. Electrical Continuity

1. Confirm electrical connection between anode tie wire and reinforcing steel by measuring DC resistance (ohm Ω) or DC potential (mV) with a multi-meter. Electrical connection is acceptable if the DC resistance measured with the multi-meter is 1 Ω or less or the DC potential is 1 mV or less.

2. Confirm electrical continuity of the exposed reinforcing steel within the repair area. Electrical continuity shall be established by tying discontinuous steel to continuous steel using steel tie wire when necessary. Electrical continuity within the repair area is acceptable if the DC resistance measured with multi-meter is 1 Ω or less or the potential is 1 mV or less.

## 3.5 CONCRETE OR MORTAR REPLACEMENT

A. If the repair procedures require the concrete surface to be saturated with water, do not damage the anode nor allow the anode units to be soaked for greater than 20 minutes.

B. Complete the repair with the repair material, taking care not to damage, loosen or leave voids around the anode.

**END OF SECTION**

# SECTION 05 12 00

STRUCTURAL STEEL FRAMING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

### 1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator, and testing agency.

B. Welding certificates.

C. Mill test reports for structural steel, including chemical and physical properties.

D. Source quality-control reports.

E. Field quality-control and special inspection reports.

### 1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using AISC 360.
2. Use Allowable Stress Design; data are given at service-load level.

B. Construction: Braced frame.

### 2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M.

B. Channels, Angles: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

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

E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

### 2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

C. Unheaded Anchor Rods: ASTM F 1554, Grade 36.

1. Configuration: Straight.

2. Finish: Plain.

D. Threaded Rods: ASTM A 36/A 36M .

1. Finish: Plain.

## 2.4 PRIMER

A. Primer: Comply with Section 09 96 00 "High-Performance Coatings."

B. Primer: SSPC-Paint 25, Type I , zinc oxide, alkyd, linseed oil primer.

C. Primer: Fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

## 2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

## 2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

## 2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.

3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.
6. Surfaces enclosed in interior construction.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

## 2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

D. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

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

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

## 3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

## 3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

## 3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials.
2. Verify weld materials and inspect welds.
3. Verify connection materials.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

**END OF SECTION**

# SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Fire-alarm wire and cable.
4. Connectors, splices, and terminations rated 600 V and less.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable

C. Product Schedule: Indicate type, use, location, and termination locations.

### 1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 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. Alpha Wire; brand of Belden, Inc.
2. Belden Inc.
3. Encore Wire Corporation.
4. Okonite Company (The).
5. Southwire Company, LLC.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. 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 B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:
1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

## 2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

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

1. Okonite Company (The).
2. Service Wire Co.
3. Southwire Company, LLC.
4. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel, interlocked.

I. Jacket: PVC applied over armor.

## 2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs 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. ABB, Electrification Business.
3. Hubbell Utility Solutions; Hubbell Incorporated.
4. ILSCO.
5. Ideal Industries, Inc.
6. NSi Industries LLC.
7. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.

C. Jacketed Cable Connectors: For steeljacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: Two hole with long barrels.
3. Termination: Compression.

# PART 3 - EXECUTION

## 3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper, Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

## 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 Crawlspaces: 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. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: 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 33.13 "Conduit 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."

## 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.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.

## 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. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## 3.7 FIRESTOPPING

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

**END OF SECTION**

# SECTION 26 05 23

CONTROL-VOLTAGE ELECTRICAL POWER CABLES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Balanced twisted pair cabling hardware.
4. RS-485 cabling.
5. Control cabling.
6. Control-circuit conductors.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

## 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 inch 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.

## 2.2 CATEGORY 5e BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden Inc.
3. CommScope, Inc.
4. General Cable; Prysmian Group North America.
5. Mohawk; a division of Belden Networking, Inc.
6. West Penn Wire; brand of Belden, Inc.

C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

D. Conductors: 100 ohm, No. 24 AWG solid copper.

E. Shielding/Screening: Shielded twisted pairs (FTP).

F. Cable Rating: Riser.

G. Jacket: Gray thermoplastic.

## 2.3 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

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

1. 3M.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Berk-Tek, a Leviton Company.
5. CommScope, Inc.
6. General Cable; Prysmian Group North America.
7. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
8. Mohawk; a division of Belden Networking, Inc.

C. General Requirements for Balanced 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 must be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source.

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. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19 inch equipment racks.
3. Number of Jacks per Field: One for each four-pair.

H. Patch Cords: Factory-made, four-pair cables in 36 inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords must have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords must have latch guards to protect against snagging.
2. Patch cords must have color-coded boots for circuit identification.

I. 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 balanced 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.

J. 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 balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards.

a. Category 5e, unshielded balanced twisted pair cable must comply with IEC 60603-7-2.

b. Category 5e, shielded balanced twisted pair cable must comply with IEC 60603-7-3.
c. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.
d. Category 6, shielded balanced twisted pair cable must comply with IEC 60603-7.5.
e. Category 6a, unshielded balanced twisted pair cable must comply with IEC 60603-7-41.

4. Marked to indicate transmission performance.

K. Faceplate:

1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Retain "Plastic Faceplate" or "Metal Faceplate" Subparagraph below, or retain both as required to match Section 26 27 26 "Wiring Devices."
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
4. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

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

L. Legend:

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

## 2.4 CONTROL CABLE

A. 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.

## 2.5 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Encore Wire Corporation.
2. General Cable; Prysmian Group North America.
3. Service Wire Co.
4. Southwire Company, LLC.

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

## 2.6 SOURCE QUALITY CONTROL

A. Factory test balanced twisted pair cables according to TIA-568-C.2.

B. Cable will be considered defective if it does not pass tests and inspections.

C. 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 33.13 "Conduit for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes must be no smaller than 2 inch wide, 3 inch high, and 2-1/2 inch deep.
2. Flexible metal conduit must 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 if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on Unistrut if a single piece of unistrut is installed, or in the corner of the room if multiple unistruts are installed around perimeter walls of the room.
2. Secure conduits to unistrut if entering the room from overhead.
3. Extend conduits 3 inch above finished floor.
4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96 inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

## 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; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. 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.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de reeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lay on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.

2. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 26 05 33.13 "Conduit for Electrical Systems."

## 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 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

## 3.6 FIRESTOPPING

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping" Chapter.

## 3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For control-voltage wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

## 3.8 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 must use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

## 3.9 FIELD QUALITY CONTROL

A. 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.

B. End-to-end cabling will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

**END OF SECTION**

# SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

### 1.2 Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connector.
7. Grounding and bonding busbars.
8. Grounding (earthing) electrodes.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product indicated.

B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control" Article, including the following:

1. Test wells.
2. Rod electrodes.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color, in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. ASTM - Bare Copper Grounding and Bonding Conductor:

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

a. ERICO; brand of nVent Electrical plc.
b. Harger Lightning & Grounding; business of Harger, Inc.

2. Referenced Standards: Complying with one or more of the following:

a. Soft or Annealed Copper Wire: ASTM B3
b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

## 2.2 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

C. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:

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

a. ABB, Electrification Business.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Crouse-Hinds; brand of Eaton, Electrical Sector.
d. ERICO; brand of nVent Electrical plc.
e. ILSCO.
f. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
g. Panduit Corp.

2. General Characteristics:

a. Two pieces with zinc-plated bolts.

b. Clamp Material: Die-cast zinc alloy.
c. Listed for outdoor use.

D. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:

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

a. ABB, Electrification Business.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Crouse-Hinds; brand of Eaton, Electrical Sector.
d. ERICO; brand of nVent Electrical plc.
e. Harger Lightning & Grounding; business of Harger, Inc.
f. ILSCO.
g. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
h. Panduit Corp.

2. General Characteristics:

a. Clamp Material: Aluminum.
b. Listed for outdoor use.

E. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:

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

a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
b. Crouse-Hinds; brand of Eaton, Electrical Sector.
c. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
d. Panduit Corp.

F. UL KDER - Beam Grounding and Bonding Clamp:

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

a. ABB, Electrification Business.
b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Panduit Corp.
d. Penn-Union Corp.; subsidiary of Nesco, Inc.

2. General Characteristics: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.

G. UL KDER - Exothermically Welded Connection:

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

a. ABB, Electrification Business.

b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
d. Crouse-Hinds; brand of Eaton, Electrical Sector.
e. ERICO; brand of nVent Electrical plc.
f. Harger Lightning & Grounding; business of Harger, Inc.

2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.3 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Bonding Bushing

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

a. ABB, Electrification Business.
b. Crouse-Hinds; brand of Eaton, Electrical Sector.
c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics: Threaded bushing with insulated throat.

D. UL KDER - Grounding Bushing

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

a. ABB, Electrification Business.
b. Crouse-Hinds; brand of Eaton, Electrical Sector.
c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

## 2.4 GROUNDING AND BONDING HUBS

A. Description: Hubs with certified grounding or bonding locknut.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Grounding and Bonding Hub:

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

a. ABB, Electrification Business.
b. Arlington Industries, Inc.
c. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
d. Crouse-Hinds; brand of Eaton, Electrical Sector.
e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
f. Penn-Union Corp.; subsidiary of Nesco, Inc.

2. General Characteristics: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

## 2.5 GROUNDING AND BONDING CONNECTORS

A. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

B. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector:

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

a. ABB, Electrification Business.
b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.

C. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal:

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

a. ABB, Electrification Business.
b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Chatsworth Products, Inc.
d. Greaves Corp.; Essex Products Group, Inc.
e. ILSCO.

2. General Characteristics: Mechanical-type, copper rated for direct burial terminal with set screw.

D. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal:

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

a. ABB, Electrification Business.
b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Harger Lightning & Grounding; business of Harger, Inc.
d. ILSCO.

2. General Characteristics: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on 5/8 or 1 inch centers for two-bolt connection to busbar.

E. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector:

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

a. ABB, Electrification Business.
b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. ILSCO.
d. allG Fabrication (formerly ALT).

2. General Characteristics: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.

a. Tinned copper, C and H shaped.

## 2.6 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding device that serves as common connection for multiple grounding and bonding conductors.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Equipment Room Grounding and Bonding Busbar:

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

a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
b. Chatsworth Products, Inc.
c. Cooper B-line; brand of Eaton, Electrical Sector.
d. ERICO; brand of nVent Electrical plc.
e. Harger Lightning & Grounding; business of Harger, Inc.
f. Hoffman; brand of nVent Electrical plc.
g. ILSCO.
h. Panduit Corp.

2. General Characteristics:

a. Bus: Rectangular bar of annealed copper.
b. Mounting Stand-Off Insulators: Lexan or PVC.

1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

3. Options:

a. Dimensions: 1/4 by 4 inch in cross section; length as indicated on Drawings.required.
b. Mounting Hardware: Stand-off brackets that provide 4 inch clearance to access rear of bus. Brackets and bolts must be stainless steel.

D. UL KDER - Rack and Cabinet Bonding Busbar:

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

a. Chatsworth Products, Inc.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Harger Lightning & Grounding; business of Harger, Inc.
d. Hoffman; brand of nVent Electrical plc.
e. Panduit Corp.

2. General Characteristics:

a. Bus: Rectangular bar of hard-drawn solid copper.
b. Horizontal Mounting Dimensions: Designed for mounting in 19 inch wide equipment racks or cabinets.
c. Vertical Mounting Dimensions: Designed for mounting in 72 inch high equipment racks or cabinets.
d. Predrilled Hole Pattern: Accepts connectors for grounding and bonding conductor sizes 14 AWG to 2/0 AWG.
e. Mounting Hardware: Stainless steel or copper-plated, for attachment to rack.

## 2.7 GROUNDING (EARTHING) ELECTRODES

A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe and plate electrodes.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Rod Electrode:

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

a. ABB, Electrification Business.
b. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
c. ERICO; brand of nVent Electrical plc.
d. Galvan Industries, Inc.; Electrical Products Division, LLC.
e. Harger Lightning & Grounding; business of Harger, Inc.

2. General Characteristics: Copper-clad steel;.

D. UL KDER - Plate Electrode:

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

a. ALLTEC LLC.
b. Galvan Industries, Inc.; Electrical Products Division, LLC.

2. General Characteristics: 1/4 inch thick, hot-dip galvanized.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

### 3.2 SELECTION OF BUSBARS

A. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inch minimum from wall, 6 inch 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.

### 3.3 SELECTION OF GROUNDING AND BONDING CONDUCTORS

A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.

B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.

C. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.

D. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.

E. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

F. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

G. Underground Grounding Conductors: Install bare tinned-copper conductor, 2/0 AWG minimum.

1. Bury at least 30 inch below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.

## 3.4 SELECTION OF CONNECTORS

A. 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.

## 3.5 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. 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.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Conductors:

a. 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.

2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. 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 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 disconnect-type connection is required, use bolted clamp.

g. 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 bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where 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 bolted connector.
3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.

3. Electrodes:

a. Ground Rods: Drive rods until tops are 2 inch 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) Use exothermic welds for below-grade connections.

b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.

4. Grounding at Service:

a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.

5. Grounding Underground Distribution System Components:

   a. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
   b. Comply with IEEE C2 grounding requirements.

6. Equipment Grounding:

   a. Install insulated equipment grounding conductors with 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.

   c. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
   d. Metallic Fences: Comply with requirements of IEEE C2.

      1) Grounding Conductor: Bare, tinned copper, not less than 8 AWG.
      2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.
      3) Barbed Wire: Strands must be bonded to grounding conductor.

7. Fence Grounding: Install at maximum intervals of 1500 ft except as follows:

   a. Fences within 100 ft of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 ft.

      1) Gates and Other Fence Openings: Ground fence on each side of opening.

         a) Bond metal gates to gate posts.
         b) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use 2 AWG wire and bury it at least 18 inch below finished grade.

   b. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at maximum distance of 150 ft on each side of crossing.
   c. Grounding Method: At each grounding location, drive grounding rod vertically until top is 6 inch below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.

d. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
e. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground fence and bond fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

## 3.6 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect.

B. 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 calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by 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 in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

C. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

D. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω.

## 3.7 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

**END OF SECTION**

# SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

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

### 1.2 INFORMATIONAL SUBMITTALS

A. Welding certificates.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS304 Stainless Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.

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

    a. ABB, Electrification Business.
    b. Allied Tube & Conduit; Atkore International.
    c. CADDY; brand of nVent Electrical plc.
    d. Cooper B-line; brand of Eaton, Electrical Sector.
    e. Flex-Strut Inc.
    f. Haydon Corporation.
    g. Unistrut; Atkore International.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: 304 stainless steel.
4. Channel Width: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: 304 Stainless Steel hangers, clamps, 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 electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: 304 stainless steel 3Coordinate "Mounting, Anchoring, and Attachment Components" Paragraph below with Part 3 installation requirements.

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. All materials to be 304 stainless steel.

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

        1) Hilti, Inc.
        2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.

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) Cooper B-line; brand of Eaton, Electrical Sector.
        2) Empire Industries, Inc.
        3) Hilti, Inc.
        4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

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 F3125/F3125M, Grade A325.
6. Toggle Bolts: Stainless steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted 304 stainless steel structural-steel shapes, shop fabricated to fit dimensions of supported equipment.

# PART 3 - EXECUTION

## 3.1 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA NEIS 102.

B. Comply with requirements for raceways and boxes specified in Section 26 05 33.13 "Conduit for Electrical Systems."

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch in diameter.

## 3.2 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

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 must be weight of supported components plus 200 lb.

C. 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. To Light Steel: Sheet metal screws.
   6. 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. 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. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

**END OF SECTION**

# SECTION 26 05 33.13

CONDUITS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Type HDPE and Type EPEC duct raceways and fittings.
2. Type FMC-S and Type FMC-A duct raceways.
3. Type LFMC duct raceways.
4. Type LFNC duct raceways.
5. Rigid Aluminum Conduit.
6. Type PVC duct raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Electrically conductive corrosion-resistant compounds for threaded conduit.
9. Solvent cements.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 26 05 53 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:
1. Section 26 05 19 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

### 1.2 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Raceway: A single enclosed raceway for conductors or cable.

### 1.3 ACTION SUBMITTALS

A. Product Data:
1. Type HDPE and Type EPEC duct raceways and fittings.
2. Type FMC-S and Type FMC-A duct raceways.
3. Type LFMC duct raceways.
4. Type LFNC duct raceways.
5. Rigid Aluminum Conduit.
6. Type PVC duct raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Electrically conductive corrosion-resistant compounds for threaded conduit.
9. Solvent cements.

10. Provide conduit routing schedules and schematic diagrams for various electrical and low voltage systems for review and approval prior to roughing.

## 1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:
   1. Type HDPE and Type EPEC duct raceways and fittings.
   2. Type FMC-S and Type FMC-A duct raceways.
   3. Type LFMC duct raceways.
   4. Type LFNC duct raceways.
   5. Rigid Aluminum Conduit.
   6. Type PVC duct raceways and fittings.
   7. Fittings for conduit, tubing, and cable.
   8. Electrically conductive corrosion-resistant compounds for threaded conduit.
   9. Solvent cements.

# PART 2 - PRODUCTS

## 2.1 TYPE HDPE AND TYPE EPEC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN EAZX; including UL 651A.

B. Source Quality Control:

   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
   2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL EAZX - Schedule 40 Electrical HDPE Underground Conduit (HDPE-40):

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

      a. Blue Diamond Industries, LLC.
      b. JM Eagle.
      c. Petroflex North America.
      d. Prysmian Cables and Systems; Prysmian Group North America.
      e. Southwire Company, LLC.
   2. Dimensional Specifications: Schedule 40.
   3. Options:

      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

D. UL EAZX - Schedule 80 Electrical HDPE Underground Conduit (HDPE-80):

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

a. Blue Diamond Industries, LLC.
b. JM Eagle.
c. Petroflex North America.
d. Prysmian Cables and Systems; Prysmian Group North America.
e. Southwire Company, LLC.

2. Dimensional Specifications: Schedule 80.
3. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

E. UL EAZX - Type A Electrical HDPE Underground Conduit (EPEC-A):
1. Dimensional Specifications: Type A.
2. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

F. UL EAZX - Type B Electrical HDPE Underground Conduit (EPEC-B):
1. Dimensional Specifications: Type B.
2. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

## 2.2 TYPE FMC-S DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DXUZ; including UL 1.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):

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

a. ABB, Electrification Business.
b. Anaconda Sealtite; Anamet Electrical, Inc.
c. Electri-Flex Company.

d. International Metal Hose Co.
e. Topaz Lighting & Electric.

2. Material: Steel.
3. Options:

a. Minimum Trade Size: Metric designator 16 (trade size 1/2).

## 2.3 TYPE IMC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DYBY; including UL 1242.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DYBY - Steel Intermediate Metal Conduit (IMC):

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

a. ABB, Electrification Business.
b. Allied Tube & Conduit; Atkore International.
c. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
d. Western Tube; Zekelman Industries.
e. Wheatland Tube; Zekelman Industries.

2. Options:

a. Exterior Coating: Zinc, PVC coated.Interior Coating: Zinc with organic top coating.
b. Minimum Trade Size: Metric designator 16 (trade size 1/2).

## 2.4 TYPE LFMC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DXHR; including UL 360.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

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

   a. ABB, Electrification Business.
   b. Anaconda Sealtite; Anamet Electrical, Inc.
   c. Electri-Flex Company.
   d. International Metal Hose Co.
2. Material: Steel.
3. Options:

   a. Minimum Trade Size: Metric designator 16 (trade size 1/2).

## 2.5 TYPE LFNC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DXOQ; including UL 1660.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXOQ - Layered (Type A) Liquidtight Flexible Nonmetallic Conduit (LFNC-A):

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

   a. AFC Cable Systems; Atkore International.
   b. Electri-Flex Company.
   c. Topaz Lighting & Electric.
2. Additional Criteria: Type A conduit with smooth seamless inner core and cover bonded together with one or more reinforcement layers between core and cover.
3. Options:

   a. Minimum Trade Size: Metric designator 16 (trade size 1/2).

D. UL DXOQ - Integral (Type B) Liquidtight Flexible Nonmetallic Conduit (LFNC-B):

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

    a. Cambridge Resources.
    b. Electri-Flex Company.
    c. Superflex Ltd.
    d. Topaz Lighting & Electric.
2. Additional Criteria: Type B conduit with smooth inner surface with integral reinforcement within conduit wall.
3. Options:

    a. Minimum Trade Size: Metric designator 16 (trade size 1/2).

## 2.6 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DZYR; including UL 651.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

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

    a. ABB, Electrification Business.
    b. Calconduit; Atkore International.
    c. Champion Fiberglass, Inc.
    d. NAPCO; Westlake Chemical Corp.
    e. Opti-Com Manufacturing Network, Inc (OMNI).
    f. Topaz Lighting & Electric.
2. Dimensional Specifications: Schedule 40.
3. Options:

    a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
    b. Markings: For directional boring applications.

D. UL DZYR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

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

a. ABB, Electrification Business.
b. Calconduit; Atkore International.
c. JM Eagle.
d. Opti-Com Manufacturing Network, Inc (OMNI).
e. Topaz Lighting & Electric.

2. Dimensional Specifications: Schedule 80.
3. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
b. Markings: For directional boring applications.

E. UL DZYR - Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Southern Pipe, Inc.

2. Dimensional Specifications: Type A.
3. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

## 2.7 ALUMINUM CONDUIT

A. Performance Criteria:

1 Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product operating instructions for product.
2. Manufacturer's published instructions: Prepare and submit installation, testing, and operating instructions for product.
3. Rigid aluminum conduit shall conform to UL 6A and NEMA C80.5.
4. Rigid Aluminum Conduit Fittings: Standard threaded coupling, locknuts, bushings, conduit bodies, and elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.40% copper are not acceptable. Locknuts and bushings shall be as specified for rigid steel and IMC conduit. Set screw fittings not permitted for use with aluminum conduit.

## 2.8 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DWTT - Fittings for Type ERMC, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:

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

    a. ABB, Electrification Business.
    b. Appleton; Emerson Electric Co., Automation Solutions.
    c. Crouse-Hinds; brand of Eaton, Electrical Sector.
    d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
    e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    f. Southwire Company, LLC.
2. Listing Criteria: UL CCN DWTT; including UL 514B.
3. Options:

    a. Material: Steel.
    b. Coupling Method: Raintight compression coupling with distinctive color gland nut.
    c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

D. UL ILNR - Fittings for Type FMC Duct Raceways:

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

    a. American Fittings Corp. (AMFICO).
    b. Liquid Tight Connector Co.
    c. Southwire Company, LLC.
2. Listing Criteria: UL CCN ILNR; including UL 514B.

E. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Liquid Tight Connector Co.
2. Listing Criteria: UL CCN DXAS; including UL 514B.

## 2.9 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. ABB, Electrification Business.

## 2.10 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DWTT; including UL 514B.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation:

3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DWTT - Solvent Cements for Type PVC Duct Raceways and Fittings:

## PART 3 - EXECUTION

### 3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE and EPEC underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE underground conduits are not permitted to be used aboveground on Project.

C. Outdoors:

1. Exposed and Subject to Severe Physical Damage: . Aluminum threaded pipe RMC
2. Exposed and Subject to Physical Damage: . Aluminum threaded pipe RMC

    a. Locations less than 2.5 m (8 ft) above finished floor.

3. Exposed and Not Subject to Physical Damage: Aluminum threaded pipe RMC
4. Concealed Aboveground: Aluminum threaded pipe RMC
5. Direct Buried: PVC-80.
6. Concrete Encased Not in Trench: PVC-40.
7. Concrete Encased in Trench: PVC-40.
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

### 3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
1. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
2. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
3. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
4. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
5. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
6. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
7. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
8. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
9. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
10. Expansion Fittings: NEMA FB 2.40.
11. Type Aluminum RMC: Article 344 of NFPA 70 and NECA.
12. Consult Engineer for resolution of conflicting requirements.

## 3.3 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Section 26 05 29 "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Secure rigid conduit to sheet metal enclosures with two (2) locknuts and insulated bushing.

I. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on steel. Nails are not acceptable.

J. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry is complete. Protect conduit stub-ups during construction from damage; any damaged conduits shall not be used.

K. Provide expansion fitting in all conduits where length of run exceeds 200 feet or where conduits pass building expansion joints.

L. Where transition is made from raceway in or under slab on grade to any type of raceway out of slab, make transition with rigid galvanized elbow and riser below grade. For corrosion protection, where elbow penetrates surface, wrap with vinyl all-weather electrical tape or coat with bituminous asphaltic compound, for 6” above and below concrete surface.

M. Use flexible conduit for connections to motors, dry type transformers, electrical duct heaters, unit heaters, and flush mounted lighting fixtures.

N. Flexible conduit used for connection of motors, dry type transformers, and electric duct heaters and unit heaters shall not exceed 18” in length.

O. Flexible conduit from outlet box to flush mounted lighting fixture shall not exceed 6-ft in length.

P. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit metal covering for ground continuity.

Q. Liquid tight conduit shall be used to connect equipment in mechanical equipment, and exterior installation.

R. Conduits shall be installed parallel or at right angles to building walls, ceilings or structural members. Run exposed conduits close to ceilings to cross over the rooms or open spaces. Do not install conduits with low head-rooms. Install and group power, control and low voltage conduits separate from each other throughout. Do not mix or cross over conduits for various systems. Keep Parallel conduit runs in the same plan throughout the installation.

S. Support branch circuit conduits at intervals not exceeding 10 ft., within 2 feet from conduit bend, and termination at each outlet, junction box, cabinet or fitting. Attach individual branch circuit conduits to structural steel members with spring steel type or beam conduit clamps and to non-metallic structural members with one-hole conduit straps. For exposed conduits and where conduits must be suspended below structure, hanger rod and conduit clamp assembly shall support single conduit runs from structure at a minimum of 6’ on centers and on each side of bend. Two hole straps shall be used on flat surface for conduit 1” and larger. Multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.

T. Attach feeder conduits larger than 1” trade diameter to or from structure on intervals not exceeding 12 ft. with conduit beam clamps, two hole conduit straps or trapeze type support in accordance with support systems described for branch circuit conduits.

U. Where conduits must pass through structural members, obtain approval of Architect with respect to location and size of hole prior to drilling.

V. Install conduit sleeves in slabs where conduits 2.0” and larger pass through. Sleeves shall extend 1” minimum above finished slab. Seal all spare sleeves and between conduits and sleeves to maintain fire rating and to make watertight and smoke tight.

W. Conduits rigidly secured to building construction on opposite sides of a building expansion joint shall be provided with an expansion and deflection coupling. In lieu of an expansion coupling, conduits 2-1/2” and smaller may be provided with junction boxes on both sides of the expansion joint connected by 15” of slack flexible conduit with bonding jumper.

1. Types of Raceways:

    a. Complete duct raceway installation before starting conductor installation.
    b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
    c. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inches of changes in direction.
    d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
    e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
    f. Support conduit within 12 inches of enclosures to which attached.

g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.

h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct 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 duct raceway enters a building or structure.
3) Conduit extending from interior to exterior of building.
4) Conduit extending into pressurized duct raceway and equipment.
5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6) Where otherwise required by NFPA 70.
7) Provide vapor tight conduit seal at the wet well and control boxes to prevent corrosion of electrical and instrumentation devices.

i. Do not install duct raceways or electrical items on “explosion-relief” walls or rotating equipment.

j. Do not install conduits within 2 inches of the bottom side of a metal deck roof.

k. Keep duct raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.

l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.

m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.

n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts..

2. Types Aluminum RMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

3. Type ERMC-S-PVC:

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

4. Types FMC, LFMC, and LFNC:

a. Provide a maximum of 72 inch of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

5. Types PVC, HDPE, and EPEC:

a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
b. Comply with manufacturer's published instructions for solvent welding and fittings.

6. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.

7. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
b. EMT: Provide setscrew, fittings. Comply with NEMA FB 2.10.
c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

8. Expansion-Joint Fittings:

a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
4) Attics: 135 deg F temperature change.

c. 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.
d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

9. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
10. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

a. Provide warning signs.

X. Interfaces with Other Work:
1. Coordinate with Section 26 05 29 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

## 3.4 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**

# SECTION 26 05 44

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Pourable sealants.
6. Foam sealants.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Advance Products & Systems, LLC.
    b. CCI Piping Systems.
    c. Flexicraft Industries.
    d. GPT; an EnPro Industries company.
2. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. PVC Pipe Sleeves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. CCI Piping Systems.
    b. GPT; an EnPro Industries company.

c. Metraflex Company (The).

2. General Characteristics: ASTM D1785, Schedule 40.

## 2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Advance Products & Systems, LLC.
2. BWM Company.
3. Flexicraft Industries.
4. Proco Products, Inc.

B. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

C. Options:

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.3 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Holdrite; a division of Reliance Worldwide Corporation.

B. General Characteristics: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber water stop collar with center opening to match piping OD.

## 2.4 GROUT

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. W. R. Meadows, Inc.

B. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000 psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

## 2.5 POURABLE SEALANTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Carlisle Syntec Systems.
2. GAF.
3. Johns Manville; a Berkshire Hathaway company.

B. Performance Criteria:

1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.

a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

## 2.6 FOAM SEALANTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Innovative Chemical Products (Building Solutions Group).
2. The Dow Chemical Company.

B. Performance Criteria:

1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam. Foam expansion must not damage cables or crack penetrated structure.

# PART 3 - EXECUTION

## 3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

## 3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

## 3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical

sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

**END OF SECTION**

# SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

B. Related Requirements:

### 1.2 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.

## 2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 1000 V or Less:

1. Black letters on orange field.
2. Legend: Indicate voltage.

B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service conductors.

1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
2. Colors for 208Y/120 V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Color for Neutral: White.
4. Color for Equipment Grounds: Green.

C. Warning Label Colors:

1. Identify system voltage with black letters on orange background.

D. Warning labels and signs must include, but are not limited to, the following legends:
1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

E. Equipment Identification Labels:

1. Black letters on white field.

## 2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

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

    a. Brady Corporation.
    b. Champion America.
    c. HellermannTyton.
    d. Marking Services Inc.
    e. Panduit Corp.
    f. emedco.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

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

    a. Brady Corporation.
    b. HellermannTyton.
    c. Marking Services Inc.
    d. Panduit Corp.
    e. Seton Identification Products; a Brady Corporation company.

C. 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. Grafoplast Wire Markers.
    c. Ideal Industries, Inc.
    d. LEM Products Inc.
    e. Marking Services Inc.
    f. Panduit Corp.
    g. emedco.
2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.
3. Marker for Labels:
    a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

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

    a. Brady Corporation.
    b. Grafoplast Wire Markers.
    c. HellermannTyton.
    d. Ideal Industries, Inc.
    e. LEM Products Inc.
    f. Marking Services Inc.
    g. Panduit Corp.
    h. emedco.
2. Minimum Nominal Size:

    a. 1-1/2 by 6 inch for raceway and conductors.
    b. 3-1/2 by 5 inch for equipment.
    c. As required by authorities having jurisdiction.

## 2.4 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch long, with diameters sized to suit diameters and that stay in place by gripping action.

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

a. Brady Corporation.
b. HellermannTyton.
c. Marking Services Inc.
d. Panduit Corp.

B. 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 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.

## 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. Champion America.
c. HellermannTyton.
d. Ideal Industries, Inc.
e. Marking Services Inc.
f. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil thick by 1 to 2 inch wide; compounded for outdoor use.

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

a. Brady Corporation.
b. Carlton Industries, LP.
c. Marking Services Inc.
d. emedco.

C. Tape and Stencil: 4 inch wide black stripes on 10 inch centers placed diagonally over orange background and are 12 inch wide. Stop stripes at legends.

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

a. HellermannTyton.
b. LEM Products Inc.
c. Marking Services Inc.
d. Pipemarker.com; Brimar Industries, Inc.
e. Seton Identification Products; a Brady Corporation company.

D. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

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

a. Carlton Industries, LP.
b. Seton Identification Products; a Brady Corporation company.

E. Underground-Line Warning Tape:

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

a. Brady Corporation.
b. Ideal Industries, Inc.
c. Marking Services Inc.
d. Pipemarker.com; Brimar Industries, Inc.
e. Seton Identification Products; a Brady Corporation company.

2. Tape:

a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape must be permanent and may not be damaged by burial operations.
c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:

a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".
c. Inscriptions for Orange Tapes: "CAUTION BURIED COMMUNICATION LINE BELOW".

4. Tape Type IDE-601:

a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of

continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.

b. Width: 3 inch.
c. Overall Thickness: 5 mil.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 28 lb/1000 sq. ft.
f. Tensile in accordance with ASTM D882: 70 lbf and 4600 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 1 inch.

## 2.6 TAGS

A. Write-on Tags:

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

   a. Carlton Industries, LP.
   b. LEM Products Inc.
   c. Pipemarker.com; Brimar Industries, Inc.
   d. Seton Identification Products; a Brady Corporation company.
2. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
3. Marker for Tags:
   a. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.7 SIGNS

A. Baked-Enamel Signs:

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

   a. Carlton Industries, LP.
   b. Champion America.
   c. Marking Services Inc.
   d. emedco.
2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4 inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inch.

B. Metal-Backed Butyrate Signs:

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

a. Brady Corporation.
b. Champion America.
c. Marking Services Inc.
d. emedco.

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 inch.

C. Laminated Acrylic or Melamine Plastic Signs:

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

a. Brady Corporation.
b. Carlton Industries, LP.
c. Marking Services Inc.
d. Seton Identification Products; a Brady Corporation company.
e. emedco.

2. Engraved legend.
3. Thickness:

a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
b. For signs larger than 20 sq. inch, 1/8 inch thick.
c. Engraved legend with black letters on white face.
d. Self-adhesive.
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.8 CABLE TIES

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

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services Inc.
4. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

C. 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 in accordance with ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. 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 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 1000 V: Identification must 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. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

I. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

K. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "TELECOM"
4. ”FIRE ALARM
5. “SECURITY”.

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Self-Adhesive Labels:

1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide 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 2 inch high.

P. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

Q. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

R. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

S. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

V. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in common trench exceeds 16 inch overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

W. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using plenum-rated cable ties.

X. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide 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 2 inch high.

Y. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide 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 2 inch high.

Z. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide 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 2 inch high.

AA. 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. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. ".FIRE ALARM"
4. ”SECURITY”
5. “TELECOM”

D. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.

F. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with conductor designation.

G. Conductors to Be Extended in Future: Attach marker tape to conductors.

H. 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.

I. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

J. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in direction of access to live parts. Workspace must 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.

K. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel 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.

M. Operating Instruction Signs: Baked-enamel warning signs.

N. Emergency Operating Instruction Signs: Baked-enamel warning signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

O. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Outdoor Equipment: Laminated acrylic or melamine sign.

**END OF SECTION**

# SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Products Furnished, but Not Installed, under This Section:

### 1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

### 1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Transformer working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. ABB, Electrification Business.
2. Eaton.
3. Federal Pacific.
4. Hammond Power Solutions Inc.

### 2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

### 2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Bolted.

D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound using vacuum-pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.

4. Environmental Protection:

    a. Indoor: UL 50E, Type 4X, Stainless Steel.

F. Taps for Transformers 3 kVA and Smaller: None.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

K. Wall Brackets: Manufacturer's standard brackets.

## 2.4 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."
2. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 26 05 53 "Identification for Electrical Systems."

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

## 3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Secure transformer to concrete base in accordance with manufacturer's published instructions.

D. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

E. Remove shipping bolts, blocking, and wedges.

## 3.3 CONNECTIONS

A. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

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

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

## 3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.

3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

B. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

C. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Assemble and submit test and inspection reports.

## 3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

**END OF SECTION**

# SECTION 26 24 16

PANELBOARDS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.

### 1.2 DEFINITIONS

A. GFEP: Ground-fault equipment protection.

B. VPR: Voltage protection rating.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.
4. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

## 1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

## 1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

# PART 2 - PRODUCTS

## 2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

D. Enclosures: Surface-mounted, dead-front cabinets with exterior cover/door in addition to dead-front .

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: UL 50E, Type 1.

2. Outdoor Locations: UL 50E, Type 4X stainless steel. Other Wet or Damp Indoor Locations: UL 50E, Type 4X stainless steel Height: 7 ft maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.

E. Incoming Mains:

1. Location: Top.

F. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.

H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices.

I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

J. Panelboard Short-Circuit Current Rating:
   1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

## 2.2 POWER PANELBOARDS

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

   1. ABB, Electrification Business.
   2. Eaton.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; Schneider Electric USA.

B. Listing Criteria: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

   1. For doors more than 36 inch high, provide two latches, keyed alike.

D. Mains: Circuit breaker Or Main Lugs Only (MLO).Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

   1. ABB, Electrification Business.
   2. Eaton.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; Schneider Electric USA.

B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Door-in-door construction with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

    a. RMS sensing.
    b. Field-replaceable rating plug or electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.
    e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
    f. Integral test jack for connection to portable test set or laptop computer.
    g. Field-Adjustable Settings:

        1) Instantaneous trip.
        2) Long- and short-time pickup levels.
        3) Long and short time adjustments.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
6. Subfeed Circuit Breakers: Vertically mounted.
7. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

d. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
2. Consult Engineer for resolution of conflicting requirements.

C. Special Techniques:
1. Mount top of trim 7.5 ft above finished floor or operating handle of top-most switch or circuit breaker, in on position, is not higher than 79 inches above finished floor unless otherwise indicated.
2. Mount panelboard cabinet plumb and rigid without distortion of box.
3. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
4. Install overcurrent protective devices and controllers not already factory installed.

5. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
6. Install filler plates in unused spaces.

### 3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

C. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

## 3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**END OF SECTION**

# SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

B. Related Requirements:

### 1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches .

1. Include plans, elevations, sections, details, and attachments to other work.

## 1.4 CLOSEOUT SUBMITTALS

# PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

## 2.2 FUSIBLE SWITCHES

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 480 V(ac).
4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Service-Rated Switches: Labeled for use as service equipment.

## 2.3 NONFUSIBLE SWITCHES

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

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty, Three Pole, Single Throw 480, or 240 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

## 2.4 ENCLOSURES

A. Enclosed Switches: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be stainless steel(UL 50E Type4x).

C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.

# PART 3 - Operating Mechanism: EXECUTION

## 3.1 SELECTION OF ENCLOSURES

A. “”Indoor, Dry and Clean Locations: UL 50E, Type 4X, stainless steel

B. Outdoor Locations: UL 50E, Type 4X, stainless steel.

C. Wash-Down Areas: UL 50E, Type 4X, stainless steel.

## 3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. 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.
2. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.

3. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
4. Install fuses in fusible devices.

## 3.3 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.

## 3.4 FIELD QUALITY CONTROL

A. Testing Preparation:

B. 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 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 following methods:

1) Use 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 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 must be in accordance with manufacturer's published data. In 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 Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

C. Nonconforming Work:

1. Enclosed switches will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

## 3.5 ADJUSTING

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

**END OF SECTION**

# SECTION 26 29 23

VARIABLE-FREQUENCY MOTOR CONTROLLERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors. VFC cable to be used from VFC to local disconnect.

### 1.2 DEFINITIONS

A. CPT: Control power transformer.

B. DDC: Direct digital control.

C. EMI: Electromagnetic interference.

D. OCPD: Overcurrent protective device.

E. PID: Control action, proportional plus integral plus derivative.

F. RFI: Radio-frequency interference.

G. VFC: Variable-frequency motor controller.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

B. Shop Drawings: For each VFC indicated.

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

## 1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Ten years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Danfoss, Inc.
2. Or approved equal

## 2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1 motors.
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 22 kA.
7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
11. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
12. Speed Regulation: Plus or minus 5 percent.
13. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
14. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.
6. .

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.

## 2.3 PERFORMANCE REQUIREMENTS (NOT USED)

## 2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display (VFC-HMI) to be remotely mounted inside the RTU cabinet on dead-front. Parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: 0- to 10-V dc.
b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

a. 0- to 10-V dc.
b. 4- to 20-mA dc.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc), which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

## 2.5 OPTIONAL FEATURES

1. Forces VFC to transfer to bypass mode and operate motor at full speed.
2. Causes display of override mode on the VFC display.
3. Reset VFC to normal operation on removal of override signal manually.

B. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer.

## 2.6 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 4X stainless steel.
2. Outdoor Locations: Type 4X stainless steel.

## 2.7 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Covered.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, NEMA TYPE 4X; UL 508 component recognized: Supply fan, with stainless-steel intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in each fusible-switch VFC.

D. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

### 3.2 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

### 3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

## 3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable pressure switches.

## 3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

**END OF SECTION**

# SECTION 26 36 00

TRANSFER SWITCHES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes automatic transfer switches rated 600 V and less.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

### 1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

## 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. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Short-time withstand capability for 30 cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Service-Rated Transfer Switch:

   1. Comply with UL 869A and UL 489.
   2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
   3. In systems with a neutral, the bonding connection shall be on the neutral bus.
   4. Provide removable link for temporary separation of the service and load grounded conductors.
   5. Surge Protective Device: Service rated.
   6. Service Disconnecting Means: Externally operated, manual mechanically actuated.

K. Neutral Terminal: Solid and fully rated unless otherwise indicated.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 26 05 53 "Identification for Electrical Systems."

   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   4. Accessible via frontaccess.

M. Enclosures: General-purpose NEMA 250, Type 4X, stainless steel, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. ABB, Electrification Business (ABB True One-Mode 4 controller Cam Loc connectors, separate enclosure).
2. Caterpillar, Inc.; Electric Power Division.
3. Cummins Power Generation.
4. Eaton.
5. Generac.
6. Russelectric, Inc.

B. Comply with Level 2 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.
6. Main and Neutral Lugs: Mechanical type.
7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position. Neutral or open position from remote input is required.

F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

G. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

## 2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for legally required systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.
g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.
m. Receptacle withstand capability.
n. Insulating base and supports damage.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.
1. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 26 05 53 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

## 3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 26 05 33.13 "Conduit for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect twisted pair cable according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

F. Route and brace conductors according to manufacturer's written instructions and Section 26 05 29 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

G. Final connections to equipment shall be made with liquid-tight, flexible metallic conduit no more than 18 inches in length.

## 3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and required clearances.
d. Verify that the unit is clean.
e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.
h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

2. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.

## 3.4 DEMONSTRATION

A. Training shall be provided by manufacturer certified product rep. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

B. Coordinate this training with that for generator equipment.

**END OF SECTION**

# SECTION 26 43 13

SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:

1. Type 1 surge protective devices.
2. Type 2 surge protective devices.
3. Enclosures.

B. Related Requirements:
1. Section 26 24 16 "Panelboards" for integral SPDs installed by panelboard manufacturer.

### 1.2 DEFINITIONS

A. $I_n$: Nominal discharge current.

B. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.
b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.
2) $I_n$ ratings.
3) MCOV, type designations.
4) OCPD requirements.
5) Manufacturer's model number.
6) System voltage.
7) Modes of protection.

B. Field quality-control reports.

## 1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

## 1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: 10 year(s) from date of Substantial Completion, for materials only, f.o.b. the nearest shipping point to Project site.

# PART 2 - PRODUCTS

## 2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. ABB, Electrification Business.
2. Advanced Protection Technologies Inc. (APT).
3. Eaton.
4. Schneider Electric USA, Inc.
5. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics:

1. Reference Standards: UL 1449, Type 1.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 160 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
    b. Line to Line: 2000 V for 480Y/277 V 1200 V for 208Y/120 V.

5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.

b. Line to Line: 1200 V.

6. SCCR: Not less than 100 kA.
7. $I_n$ Rating: 20 kA.

D. Options:

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
6. Include surge counter.

## 2.2 ENCLOSURES

A. Indoor Enclosures: Type 1.

B. Outdoor Enclosures: Type 4X.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

## 3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

B. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

## 3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

**END OF SECTION**

# SECTION 31 10 00

SITE CLEARING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Preparation of right-of-way and other designated areas for construction operations by removing and disposing of all obstructions including clearing and grubbing when removal of such obstructions is not specifically shown on the Drawings to be paid by other Sections.

B. Related Specification Sections include but are not necessarily limited to

1. Division 1 – General Requirements
2. Section 02 41 13 – Selective Site Demolition

### 1.2 REFERENCES [NOT USED]

### 1.3 ADMINSTRATIVE REQUIREMENTS

A. Preinstallation Meetings

1. Hold a preliminary site clearing meeting and include the CONTRACTOR, OWNER, and ENGINEER for the purpose of reviewing the CONTRACTOR's site clearing.

### 1.4 SUBMITTALS

A. Site Clearing Plan: The CONTRACTOR shall prepare and submit a Site Clearing Plan detailing site clearing activities and schedule.

### 1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

### 1.6 CLOSEOUT SUBMITTALS [NOT USED]

### 1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

### 1.8 QUALITY ASSURANCE

A. Conform to applicable federal, state, and local regulations for environmental requirements and disposal of debris.

### 1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

### 1.10 FIELD CONDITIONS [NOT USED]

### 1.11 WARRANTY [NOT USED]

## PART 2 - PRODUCTS [NOT USED]

## PART 3 - EXECUTION

### 3.1 INSTALLERS [NOT USED]

### 3.2 EXAMINATION [NOT USED]

### 3.3 PREPARATION [NOT USED]

### 3.4 EXECUTION

A. Protection of Trees

1. Protect all trees and shrubs as shown on the Drawings.
2. Do not park equipment, service equipment, store materials, or disturb the root area under the branches of trees designated for preservation.

B. Hazardous Materials

1. The CONTRACTOR will notify the ENGINEER immediately if any hazardous or questionable materials not shown on the Drawings are encountered.
2. The testing, removal, and disposal of hazardous materials will be in accordance with Division 1.

C. Site Clearing

1. Clear areas shown on the Drawings of all obstructions. Such obstructions include, but are not limited to:

    a. Remains of buildings and other structures
    b. Foundations
    c. Floor slabs
    d. Concrete
    e. Brick
    f. Lumber
    g. Abandoned utility pipes or conduits
    h. Equipment
    i. Fences (if required)
    j. Retaining walls
    k. Other items as specified on the Drawings

2. Remove vegetation and other landscape features not designated for preservation, whether above or below ground.
3. In areas to be excavated, remove obstructions to 2 feet below the excavation level.
4. In all other areas, remove obstructions to 1 foot below natural ground.

D. Disposal

1. All materials and debris removed becomes the property of the CONTRACTOR, unless otherwise stated on the Drawings.
2. The CONTRACTOR will dispose of material and debris off-site in accordance with local, state, and federal laws and regulations.

E. Topsoil Stripping and Stockpiling

1. Existing topsoil to be removed to a depth of at least four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material.
2. Stripping:

    a. Strip topsoil to depths encountered, in manner that prevents intermingling of topsoil with underlying subsoil or other objectionable material. Remove heavy growths of grass and vegetation from areas before stripping.

3. Stockpile topsoil in storage stockpiles in areas shown, or where otherwise accepted by ENGINEER. Construct storage piles so that surface water drains freely. Stabilize large topsoil piles with a cover crop and mulch and provide silt fencing around perimeter of pile to prevent topsoil erosion and sedimentation; silt fencing shall be in accordance with Section 31 25 00 – Erosion and Sediment Control. Cover smaller topsoil stockpiles, when used, with reinforced fabric to prevent windblown dust.

**3.5 REPAIR [NOT USED]**
**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD QUALITY CONTROL [NOT USED]**
**3.8 SYSTEM STARTUP [NOT USED]**
**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING [NOT USED]**
**3.11 CLOSEOUT ACTIVITIES [NOT USED]**
**3.12 PROTECTION [NOT USED]**
**3.13 MAINTENANCE [NOT USED]**
**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

# SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Implementation of the project's Storm Water Pollution Prevention Plan (SWPPP) and installation, maintenance and removal of erosion and sediment control devices

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. ASTM Standard:

   a. ASTM D3786, Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
   b. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
   c. ASTM D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
   d. ASTM D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

3. Georgia Environmental Protection Division (GEPD)

### 1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]
### 1.4 SUBMITTALS

A. Storm Water Pollution Prevention Plan (SWPPP)
B. Notice of Change (if applicable)

### 1.5 ACTION SUBMITTALS/INFORMATION SUBMITTALS [NOT USED]
### 1.6 CLSEOUT SUBMITTALS [NOT USED]
### 1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
### 1.8 QUALITY ASSURANCE [NOT USED]
### 1.9 DELIVERY, STORAGE AND HANDLING [NOT USED]
### 1.10 FIELD [SITE] CONDITIONS [NOT USED]
### 1.11 WARRANTY [NOT USED]

## PART 2 - PRODUCTS

## 2.1 OWNER-FURNISHED [NOT USED]

## 2.2 PRODUCT TYPES AND MATERIALS

A. Rock Filter Dams

1. Aggregate

a. Furnish aggregate with hardness, durability, cleanliness and resistance to crumbling, flaking and eroding acceptable to the ENGINEER.
b. Provide the following:

1) Types 1, 2 and 4 Rock Filter Dams

a) Use 3-to-6-inch aggregate.

2) Type 3 Rock Filter Dams

a) Use 4-to-8-inch aggregate.

2. Wire

a. Provide minimum 20-gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams
b. Type 4 dams require:

1) Double-twisted, hexagonal weave with a nominal mesh opening of 2½ inches x 3 ¼ inches
2) Minimum 0.0866-inch steel wire for netting
3) Minimum 0.1063-inch steel wire for selvages and corners
4) Minimum 0.0866 inch for binding or tie wire

B. Geotextile Fabric

1. Place the aggregate over geotextile fabric meeting the following criteria:

a. Tensile Strength of 250 pounds, per ASTM D4632
b. Puncture Strength of 135 pounds, per ASTM D4833
c. Mullen Burst Rate of 420 psi, per ASTM D3786
d. Apparent Opening Size of No. 20 (max), per ASTM D4751

C. Sandbag Material

1. Furnish sandbags meeting Section 2.5 except that any gradation of aggregate may be used to fill the sandbags.

D. Stabilized Construction Entrances

1. Provide materials that meet the details shown on the Drawings and this Section.

a. Provide crushed aggregate for long and short-term construction exits.
b. Furnish aggregates that are clean, hard, durable and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft or flaky materials and organic and injurious matter.
c. Use 3-to-5-inch coarse aggregate with a minimum thickness of 12 inches.

d. The aggregate shall be placed over a geotextile fabric meeting the following criteria:

1) Tensile Strength of 300 pounds, per ASTM D4632
2) Puncture Strength of 120 pounds, per ASTM D4833
3) Mullen Burst Rate of 600 psi, per ASTM D3786
4) Apparent Opening Size of No. 40 (max), per ASTM D4751

E. Embankment for Erosion Control

1. Provide rock, loam, clay, topsoil, or other earth materials that will form a stable embankment to meet the intended use.

F. Sandbags

1. Provide sandbag material of polypropylene, polyethylene or polyamide woven fabric with a minimum unit weight of 4 ounces per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70 percent.
2. Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags.
3. Filled sandbags must be 24 to 30 inches long, 16 to 18 inches wide, and 6 to 8 inches thick.

**Table 1**
**Sand Gradation**

| **Sieve #** | **Maximum Retained (% by Weight)** |
|---|---|
| 4 | 3 percent |
| 100 | 80 percent |
| 200 | 95 percent |

G. Temporary Sediment Control Fence

1. Provide a net-reinforced fence using woven geo-textile fabric.
2. Logos visible to the traveling public will not be allowed.

a. Fabric

1) Provide fabric materials in accordance with DMS-6230, “Temporary Sediment Control Fence Fabric.”

b. Posts

1) Provide essentially straight wood or steel posts with a minimum length of 48 inches, unless otherwise shown on the Drawings.
2) Soft wood posts must be at least 3 inches in diameter or nominal 2 x 4 inch
3) Hardwood posts must have a minimum cross-section of 1-1/2 x 1-1/2 inch
4) T- or L-shaped steel posts must have a minimum weight of 1.3 pounds per foot.

c. Net Reinforcement

1) Provide net reinforcement of at least 12-1/2 gauge galvanized welded wire mesh, with a maximum opening size of 2 x 4 inch, at least 24 inches wide, unless otherwise shown on the Drawings.

d. Staples

1) Provide staples with a crown at least 3/4 inch wide and legs 1/2 inch long.

**2.3 ACCESSORIES [NOT USED]**
**2.4 SOURCE QUALITY CONTROL [NOT USED]**

**PART 3 - EXECUTION**

**3.1 INSTALLERS [NOT USED]**
**3.2 EXAMINATION [NOT USED]**
**3.3 PREPARATION [NOT USED]**
**3.4 INSTALLATION**

A. Storm Water Pollution Prevention Plan

1. Develop and implement the project's Storm Water Pollution Prevention Plan (SWPPP) in accordance with the GEPD requirements. Prevent water pollution from stormwater runoff by using and maintaining appropriate structural and nonstructural BMPs to reduce pollutants discharges from the Site.

B. Control Measures

1. Implement control measures in the area to be disturbed before beginning construction, or as directed. Limit the disturbance to the area shown on the Drawings or as directed.
2. Control site waste such as discarded building materials, concrete truck washout water, chemicals, litter and sanitary waste at the construction site.
3. Minimize disturbance to vegetation.
4. Immediately correct ineffective control measures. Implement additional controls as directed. Remove excavated material within the time requirements specified in the applicable stormwater permit.
5. Upon acceptance of vegetative cover by the ENGINEER, remove and dispose of all temporary control measures, temporary embankments, bridges, matting, falsework, piling, debris, or other obstructions placed during construction that are not a part of the finished work, or as directed.

C. Do not locate disposal areas, stockpiles, or haul roads in any wetland, water body, or streambed.
D. Do not install temporary construction crossings in or across any water body without the prior approval of the appropriate resource agency and the ENGINEER.
E. Provide protected storage area for paints, chemicals, solvents, and fertilizers at an approved location. Keep paints, chemicals, solvents, and fertilizers off bare ground and provide shelter for stored chemicals.
F. Installation and Maintenance

1. Perform work in accordance with GEPD regulations.

2. When approved, sediments may be disposed of within embankments, or in areas where the material will not contribute to further siltation.
3. Dispose of removed material in accordance with federal, state, and local regulations.
4. Remove devices upon approval or when directed.

    a. Upon removal, finish-grade and dress the area.
    b. Stabilize disturbed areas in accordance with the permit, and as shown on the Drawings or directed.

5. The CONTRACTOR retains ownership of stockpiled material and must remove it from the project when new installations or replacements are no longer required.

G. Rock Filter Dams for Erosion Control

1. Remove trees, brush, stumps and other objectionable material that may interfere with the construction of rock filter dams.
2. Place sandbags as a foundation when required or at the CONTRACTOR's option.
3. For Types 1, 2, 3, and 5, place the aggregate to the lines, height, and slopes specified, without undue voids.
4. For Types 2 and 3, place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings, or as directed.
5. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed.
6. Construct filter dams according to the following criteria, unless otherwise shown on the Drawings:

    a. Type 1 (Non-reinforced)

        1) Height - At least 18 inches measured vertically from existing ground to top of filter dam
        2) Top Width - At least 2 feet
        3) Slopes - At most 2:1

    b. Type 2 (Reinforced)

        1) Height - At least 18 inches measured vertically from existing ground to top of filter dam
        2) Top Width - At least 2 feet
        3) Slopes - At most 2:1

    c. Type 3 (Reinforced)

        1) Height - At least 36 inches measured vertically from existing ground to top of filter dam
        2) Top Width - At least 2 feet
        3) Slopes - At most 2:1

    d. Type 4 (Sack Gabions)

        1) Unfold sack gabions and smooth out kinks and bends.

2) For vertical filling, connect the sides by lacing in a single loop–double loop pattern on 4- to 5-inches spacing. At 1 end, pull the end lacing rod until tight, wrap around the end, and twist 4 times. At the filling end, fill with stone, pull the rod tight, cut the wire with approximately 6 inches remaining, and twist wires 4 times.
3) For horizontal filling, place sack flat in a filling trough, fill with stone, and connect sides and secure ends as described above.
4) Lift and place without damaging the gabion.
5) Shape sack gabions to existing contours.

e. Type 5

1) Provide rock filter dams as shown on the Drawings.

H. Construction Entrances

1. When tracking conditions exist, prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction entrances.
2. Place the exit over a foundation course, if necessary.

a. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the Drawings or as directed.

3. At drive approaches, make sure the construction entrance is the full width of the drive and meets the length shown on the Drawings.

a. The width shall be at least 14 feet for 1-way and 24 feet for 2-way traffic for all other points of ingress or egress or as directed by the ENGINEER.

I. Earthwork for Erosion Control

1. Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.

a. Excavation and Embankment for Erosion Control Measures

1) Place earth dikes, swales or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover.
2) Place swales and dikes at other locations as shown on the Drawings or as directed to prevent runoff spillover or to divert runoff.
3) Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides.
4) Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the Drawings or as directed.
5) Where required, create a sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at 1 time, not including offsite areas.

b. Excavation of Sediment and Debris

1) Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.

J. Sandbags for Erosion Control

1. Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment and release water in sheet flow.
2. Fill each bag with sand so that at least the top 6 inches of the bag is unfilled to allow for proper tying of the open end.
3. Place the sandbags with their tied ends in the same direction.
4. Offset subsequent rows of sandbags 1/2 the length of the preceding row.
5. Place a single layer of sandbags downstream as a secondary debris trap.
6. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.

K. Temporary Sediment-Control Fence

1. Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
2. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the Drawings, as specified in this Section, or as directed.

a. Post Installation

1) Embed posts at least 18 inches deep, or adequately anchor, if in rock, with a spacing of 6 to 8 feet and install on a slight angle toward the run-off source.

b. Fabric Anchoring

1) Dig trenches along the uphill side of the fence to anchor 6 to 8 inches of fabric.
2) Provide a minimum trench cross-section of 6 x 6 inches
3) Place the fabric against the side of the trench and align approximately 2 inches of fabric along the bottom in the upstream direction.
4) Backfill the trench, then hand-tamp.

c. Fabric and Net Reinforcement Attachment

1) Unless otherwise shown under the Drawings, attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced.
2) Sewn vertical pockets may be used to attach reinforcement to end posts.
3) Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 inches or less.

d. Fabric and Net Splices

1) Locate splices at a fence post with a minimum lap of 6 inches attached in at least 6 places equally spaced, unless otherwise shown under the Drawings.

a) Do not locate splices in concentrated flow areas.

2) Requirements for installation of used temporary sediment-control fence include the following:

a) Fabric with minimal or no visible signs of biodegradation (weak fibers)
b) Fabric without excessive patching (more than 1 patch every 15 to 20 feet)
c) Posts without bends
d) Backing without holes

**3.5 REPAIR/RESTORATION [NOT USED]**
**3.6 RE-INSTALLATION [NOT USED]**
**3.7 FIELD [OR] SITE QUALITY CONTROL [NOT USED]**
**3.8 SYSTEM STARTUP [NOT USED]**
**3.9 ADJUSTING [NOT USED]**
**3.10 CLEANING**

A. Waste Management

1. Remove sediment, debris and litter as needed.

**3.11 CLOSEOUT ACTIVITIES**

A. Erosion control measures remain in place and are maintained until all soil disturbing activities at the project site have been completed.
B. Establish a uniform vegetative cover with a density of 70 percent on all unpaved areas, on areas not covered by permanent structures, or in areas where permanent erosion control measures (i.e., riprap, gabions, or geotextiles) have been employed.
C. Temporary erosion and sediment control measures shall be removed upon completion of permanent erosion control measures or vegetative cover as specified.

**3.12 PROTECTION [NOT USED]**
**3.13 MAINTENANCE**

A. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until earthwork construction and permanent erosion control features are in place or the disturbed area has been adequately stabilized as determined by the ENGINEER.
B. If a device ceases to function as intended, repair or replace the device or portions thereof as necessary.
C. Perform inspections of the construction site as prescribed in the applicable stormwater permit.
D. Records of inspections and modifications based on the results of inspections must be maintained and available in accordance with the permit.

**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

# SECTION 33 03 10

BYPASS PUMPING OF EXISTING SEWER SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Bypass pumping of the existing sewer system.

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. Occupational Safety and Health Organization (OSHA).

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Schedule meeting with OWNER and ENGINEER to review sewer shutdown one week prior to replacing or rehabilitating any facilities.
2. The OWNER shall be notified 24 hours prior to any interruptions or connections being made.
3. No bypassing operations shall begin prior to securing OWNER approval of respective connection plan and work schedule.
4. OWNER reserves the right to delay schedule due to weather conditions, or other unexpected emergency within the sewer system.
5. Review bypass pumping arrangement or layout in the field with OWNER and ENGINEER prior to beginning operations. Facilitate preliminary bypass pumping run with OWNER staff present to affirm the operation is satisfactory.
6. After replacement or rehabilitation of facilities, coordinate the reestablishment of sewer flow with OWNER staff.
7. Provide onsite continuous monitoring during all bypass pumping operations using one of the following methods:

    a. Personnel on site.
    b. Portable SCADA equipment.

### 1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. For each pump station, submit a detailed Bypass Systems Plan and description outlining all provisions and precautions that will be taken with regard to the handling of sewer flows. Submit the plan to the ENGINEER a minimum of 7 days prior to commencing Work. Include the following details:

1. Detailed drawings showing all required equipment, staging areas, and piping
2. Schedule for installation and maintenance of the bypass pumping system.
3. Number, size, material, location, and method of installation of suctioning piping.
4. Pump sizes, capacity, number of each size, and power requirements.
5. Calculations for static lift, friction losses, and velocity.
6. Pump curves showing operating range and system head curves.
7. Sewer plugging methods and types of plugs
8. Number, size, length, material, joint type, and method for installation of suction and discharge piping.
9. Fuel storage information and take size.
10. Thrust and restraint block sizes and locations as necessary in accordance with manufacturer/supplier of LineStops, Insert Valves, and other equipment to be installed within piping.
11. Sections showing suction and discharge piping depth, embedment, select fill and backfill, and any equipment necessary to maintain vehicular and construction equipment in driveways and parking areas; modification of existing structures to allow for efficient installation of bypass pumping equipment and operation.
12. Any temporary pipe supports, and anchoring required.
13. Design for access to bypass system operation locations.
14. Calculations and selection of bypass pump pipe size(s).
15. Method of noise control for each pump and/or generator, if required.
16. Method for maintaining minimum levels in force main to reduce debris collection.
17. Standby power generator size and location.
18. Suction and discharge piping plan.
19. Emergency action plan identifying the measures taken in the event of a pump failure or sewer spill.
20. Continuous monitoring plan including qualifications of any monitoring persons and specifications of any electronic monitoring operations.
21. Staffing plan for responding to alarm conditions identifying multiple contacts by name and phone numbers.
22. A contingency plan to implement in the event the replacement or rehabilitation has unexpected delays or problems.
23. Necessary restoration including repairs to existing structures which were modified to install and operate bypass pumping equipment

C. Sequence of Bypass System Operations

D. The Contractor shall develop a Sequence of Bypass System Operations regarding staging of piping connections and equipment. Under no circumstances shall the proposed Sequence of Bypass System Operations lead to an interruption of the pump stations or sewer collection system directly upstream of the bypass location or of the downstream operations during the project.

E. Contractor shall submit the proposed Sequence of Bypass System Operations to the JWSC and Engineer for review and approval in conjunction with the Bypass Systems Plan. The Sequence of Bypass Systems Operations shall define work to be performed, including the following items:

1. Definition of the start date, duration and end date for each of the segments of the work at each bypass location.
2. For each segment of work, define activities to be performed by or witnessed by JWSC and date on which these activities are to be performed.
3. Scheduling/timing of manufacturer's field services, as specified.

**1.5 CLOSEOUT SUBMITTALS [NOT USED]**

**1.6 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**

**1.7 QUALITY ASSURANCE [NOT USED]**

**1.8 DELIVERY, STORAGE, AND HANDLING [NOT USED]**

**1.9 FIELD [SITE] CONDITIONS [NOT USED]**

**1.10 WARRANTY [NOT USED]**

**PART 2 - PRODUCTS**

**2.1 OWNER-FURNISHED PRODUCTS [NOT USED]**

**2.2 EQUIPMENT**

A. CONTRACTOR shall furnish, install, and maintain all temporary utilities during the contract period including removal upon completion of the project work.

B. Pumping

1. Provide equipment that will convey 100 percent of wet weather peak flow conditions.
2. Provide fully automatic self-priming pumps. Foot-valves or vacuum pumps are not permitted for priming the system.
3. Pumps shall be diesel/fuel powered, unless otherwise approved.
4. All pumps shall be sound attenuated and equipped with quiet packs.
5. Pumps must be constructed to allow dry running for periods of time to account for the cyclical nature of sewer flow.
6. All pumps shall be High Pressure Solids Handling Sel-Priming Pumps as manufactured by Thompson Pump & Manufacturing Co., Inc. in the state of Georgia, Godwin Pumps by Xylem, Gorman-Rupp, Patterson Pump Co., BBA Pumps Inc., or an approved equal.
7. Provide 1 stand-by pump for each size to be maintained on Site. Place backup pumps online with isolation valve, check valve, and float switch.
8. If multiple pumps are required to meet the flow requirements, provide the necessary fittings and connections to incorporate multiple discharges.

C. Piping

1. Install pipes with joints which prevent the incident of flow spillage.

D. Plugs or Stop Logs

1. Plugs

a. Select a plug that is made for the size and potential pressure head that will be experienced.
b. Provide an additional anchor, support or bracing to secure plug when back pressure is present.
c. Use accurately calibrated air pressure gauges for monitoring the inflation pressure.
d. Place inflation gauge at location outside of confined space area. Keep the inflation gauge and valve a safe distance from the plugs.
e. Never over inflate the plug beyond its pressure rating.

## 2.3 ACCESSORIES [NOT USED]

## 2.4 SOURCE QUALITY CONTROL [NOT USED]

# PART 3 - EXECUTION

## 3.1 INSTALLERS [NOT USED]

## 3.2 EXAMINATION [NOT USED]

## 3.3 PREPARATION

A. Locate the bypass pipelines in area to minimize disturbance to existing utilities and obtain approval of those locations from the OWNER and authority having jurisdiction.
B. All costs associated with relocating utilities and obtaining all approvals shall be paid by the CONTRACTOR.
C. Driveway access and parking areas shall not be impeded by bypass piping.
D. The CONTRACTOR shall be responsible for all physical damage to existing infrastructure caused by human or mechanical failure.
E. CONTRACTOR shall not allow sewage to be leaked, dumped, or spilled in or onto any area outside of the existing sanitary sewer system.
F. In the event of accidental spill or overflow, the CONTRACTOR shall immediately stop the discharge and take action to clean up and disinfect the spill. A notification must be made to the OWNER.
G. The CONTRACTOR is responsible for any damages that may have occurred to public or private property in the event of an accidental spill or overflow.
H. Make preparations to comply with OSHA requirements when working in the presence of sewer gases, oxygen-deficient atmospheres, and confined spaces.

## 3.4 INSTALLATION

A. Install and make connections to the existing suction and discharge structures and construct temporary bypass pumping structures only at the access locations indicated on approved Bypass Systems Plan Drawings.
B. Sewer flow stoppage

1. Plugging or blocking

a. Utilize existing slide gates, plugs, and/or LineStops.
b. Use confined space procedures and equipment during installation when necessary.
c. Thoroughly clean the pipe before insertion of the plug.

d. Insert the plug seal surface completely so it is fully supported by the pipe.
e. Position the plug where there are no sharp edges or protrusions that may damage the plug.
f. Use pressure gauges for measuring inflation pressures.

C. Minimize upstream pressure head before deflating and removing Sewer flow control and monitoring

1. Take sufficient precautions to ensure sewer flow operations do not cause flooding or damage to public or private property. The CONTRACTOR is responsible for any damage resulting from bypass pumping operations.
2. Begin continual monitoring of the sewer system as soon as the sewer is plugged or blocked. Be prepared to immediately start bypass pumping if needed due to surcharge conditions.
3. Sewer discharge may be into another sewer manhole or appropriate vehicle or container only. Do not discharge sewer into an open environment such as an open channel or earthen holding facility.

## 3.5 BYPASS PIPELINES THAT CROSS DRIVEWAYS OR LOCAL STREETS SHALL BE INSTALLED IN TRENCHED AND COVERED WITH TRAFFIC RATED PLATES OR TEMPORARY PAVEMENT. REPAIR / RESTORATION [NOT USED]

## 3.6 RE-INSTALLATION [NOT USED]

## 3.7 FIELD QUALITY CONTROL

A. Field Tests and Inspections

1. Perform leakage and pressure tests of the bypass pumping pipe and equipment before actual operation begins. OWNER staff shall be present during testing unless otherwise directed.

## 3.8 SYSTEM STARTUP

A. Prior to startup of bypass system, CONTRACTOR shall develop and submit a bypass startup plan for approval.

B. Prior to startup of bypass system, CONTRACTOR shall pump discharge main for three cycles to remove debris from the discharge force main.

## 3.9 ADJUSTING [NOT USED]

## 3.10 CLEANING

A. CONTRACTOR is responsible for cleaning of lines and removal of accumulated debris from bypassing activities in order to prevent damage to new pumps.

## 3.11 CLOSEOUT ACTIVITIES

A. Once plugging or blocking is no longer necessary, remove in such a way that permits the sewer flow to slowly return to normal – preventing surge, surcharging and major downstream disturbance.
B. At the conclusion of the bypass system operations the new system shall be demonstrated in automatic mode for 72 hours.

1. CONTRACTOR shall drain / flush bypass pumping system prior to removal of equipment.
2. All piping and bypass pumping equipment shall be removed after the demonstration period and receiving written approval from the OWNER.
3. All property shall be restored to pre-construction condition, including pavement.

**3.12 PROTECTION [NOT USED]**

**3.13 MAINTENANCE [NOT USED]**

**3.14 ATTACHMENTS [NOT USED]**

**END OF SECTION**

# SECTION 34 71 13

TRAFFIC CONTROL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Installation of Traffic Control Devices and preparation of Traffic Control Plans

B. Related Specification Sections include, but are not necessarily limited to:

1. Division 1 – General Requirements

### 1.2 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. Manual on Uniform Traffic Control Devices (MUTCD).

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Contact the agency having jurisdiction a minimum of 48 hours prior to implementing Traffic Control.

B. Sequencing

1. Any deviations to the Traffic Control must be first approved by the ENGINEER and agency having jurisdiction before implementation.

### 1.4 SUBMITTALS

A. Provide the ENGINEER with a current list of qualified flaggers before beginning flagging activities. Use only flaggers on the qualified list.
B. Provide copies of permits required from agencies having jurisdiction.
C. CONTRACTOR shall prepare and submit Traffic Control Plan.
D. Lane closures 24 hours or longer shall require a site-specific traffic control plan.

### 1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]
### 1.6 CLOSEOUT SUBMITTALS [NOT USED]
### 1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]
### 1.8 QUALITY ASSURANCE [NOT USED]
### 1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]
### 1.10 FIELD CONDITIONS [NOT USED]
### 1.11 WARRANTY [NOT USED]

## PART 2 - PRODUCTS

### 2.1 OWNER-FURNISHED PRODUCTS [NOT USED]
### 2.2 ASSEMBLIES AND MATERIALS

A. Description

1. Regulatory Requirements

a. Provide Traffic Control Devices that conform to MUTCD and Georgia Department of Transportation Standards.

2. Materials

a. Traffic Control Devices must meet all reflectivity requirements included in the MUTCD.
b. Electronic message boards shall be provided in accordance with the MUTCD.

### 2.3 ACCESSORIES [NOT USED]
### 2.4 SOURCE QUALITY CONTROL [NOT USED]

## PART 3 - EXECUTION

### 3.1 EXAMINATION [NOT USED]
### 3.2 PREPARATION

A. Protection of In-Place Conditions

1. Protect existing traffic signal equipment.

B. CONTRACTOR shall coordinate with emergency services, schools, United States Post Office, and other affected agencies to minimize impacts of lane closures or restrictions.

### 3.3 INSTALLATION

A. Follow the Traffic Control Plan (TCP) and install Traffic Control Devices as shown on the Drawings and as directed.
B. Install Traffic Control Devices straight and plumb.
C. Maintain Traffic Control Devices by taking corrective action as soon as possible.

1. Corrective action includes but is not limited to cleaning, replacing, straightening, covering, or removing Devices.
2. Maintain the Devices such that they are properly positioned, spaced, and legible, and that retroreflective characteristics meet requirements during darkness and rain.

D. If the CONTRACTOR fails to comply with applicable federal, state, or local laws (by failing to furnish the necessary flagmen, warning devices, barricades, lights, signs, or other precautionary measures for the protection of persons or property), the OWNER may order such additional precautionary measures be taken to protect persons and property.
E. Subject to the approval of the OWNER, portions of this Project, which are not affected by or in conflict with the proposed method of handling traffic or utility adjustments, can be constructed during any phase.

F. Barricades and signs shall be placed in such a manner as to not interfere with the sight distance of drivers entering the highway from driveways or side streets.
G. To facilitate shifting, barricades and signs used in lane closures or traffic staging may be erected and mounted on portable supports.

    1. The support design is subject to the approval of the ENGINEER.

H. Lane closures shall be in accordance with the approved Traffic Control Plans.
I. If at any time the existing traffic signals become inoperable as a result of construction operations, the CONTRACTOR shall provide portable stop signs with 2 orange flags to be used for Traffic Control.
J. CONTRACTOR shall make arrangements for police assistance to direct traffic if lane closures must occur at peak travel times on heavily traveled roadways.
K. Flaggers

    1. Provide a CONTRACTOR representative who has been certified as a flagging instructor through courses offered by the Georgia Department of Transportation, the American Traffic Safety Services Association, the National Safety Council, or other approved organizations.

        a. Provide the certificate indicating course completion when requested.
        b. This representative is responsible for training and assuring that all flaggers are qualified to perform flagging duties.

    2. A qualified flagger must be independently certified by 1 of the organizations listed above or trained by the CONTRACTOR's certified flagging instructor.
    3. Flaggers must be courteous and able to effectively communicate with the public.
    4. When directing traffic, flaggers must use standard attire, flags, signs, and signals and follow the flagging procedures set forth in the MUTCD.
    5. Provide and maintain flaggers at such points and for such periods of time as may be required to provide for the safety and convenience of public travel and CONTRACTOR's personnel.

        a. These flaggers shall be located at each end of the lane closure.

L. Removal

    1. Upon completion of Work, remove from the Site all barricades, signs, cones, lights, and other Traffic Control Devices used for work-zone traffic handling in a timely manner, unless otherwise shown on the Drawings.

**3.4 REPAIR / RESTORATION [NOT USED]**
**3.5 RE-INSTALLATION [NOT USED]**
**3.6 FIELD QUALITY CONTROL [NOT USED]**
**3.7 SYSTEM STARTUP [NOT USED]**
**3.8 ADJUSTING [NOT USED]**
**3.9 CLEANING [NOT USED]**
**3.10 CLOSEOUT ACTIVITIES [NOT USED]**
**3.11 PROTECTION [NOT USED]**
**3.12 MAINTENANCE [NOT USED]**
**3.13 ATTACHMENTS [NOT USED]**

**END OF SECTION**