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August 28, 2023

**RE: REQUEST FOR PROPOSAL  
ELECTRICAL EQUIPMENT AND ENCLOSURE FOR CITY OF WEST  
COLUMBIA RIVERSIDE WATER TREATMENT PLANT HIGH SERVICE  
PUMP STATION**

To whom it may concern:

Goodwyn Mills Cawood (GMC) invites you, on behalf of the City of West Columbia, to respond to the attached Request for Proposal (RFP) for electrical equipment and enclosure for the Riverside Water Treatment Plant.

Attached herein you will find the RFP along with technical requirements. Instructions for submittal registration, submittal preparation, delivery of submittal, and all necessary information for the RFP submittal package are in the attached document. Any questions that arise shall be addressed to Jeremy Doll via email only at [Jeremy.doll@gmcnetwork.com](mailto:Jeremy.doll@gmcnetwork.com).

Each submittal package will be scored based on the following categories:

- Experience with similar projects
- Proposed cost
- Proposed schedule
- Consistency with RFP requirements

Please submit your equipment package proposal by Friday, September 27<sup>th</sup>, 2023 @ 2:00 pm EST by email to [Jeremy.Doll@gmcnetwork.com](mailto:Jeremy.Doll@gmcnetwork.com). The City of West Columbia is prepared to award within 60 days of receipt of proposals. Further, the City of West Columbia is prepared to advertise the construction portion of the project during Q1 of 2024. It is their intention that this supply contract be assigned to the successful bidder for the construction project.

We look forward to reviewing the submittals and beginning the construction process for a successful project vital to the growth of the City of West Columbia's water supply infrastructure.

Sincerely,  
GMC

Jeremy Doll, PE  
Project Engineer, Electrical

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REQUEST FOR PROPOSALS

# **ELECTRICAL EQUIPMENT AND ENCLOSURE AT THE RIVERSIDE WATER TREATMENT PLANT HIGH SERVICE PUMP STATION**

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WEST COLUMBIA, SOUTH CAROLINA

for

**CITY OF WEST COLUMBIA**

*August 2023*



Prepared By

# **GMC**

Goodwyn Mills Cawood, LLC  
117 Welborn Street  
Greenville, SC 29601  
T 864.527.0460  
[www.gmcnetwork.com](http://www.gmcnetwork.com)

**GMC PROJECT NUMBER: VGRE220006**

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# 1 INTRODUCTION

The City of West Columbia is issuing this request for proposal (RFP) to solicit proposals from suppliers for an electrical equipment package at the Riverside Water Treatment Plant High Service Pump Station. The equipment will be purchased ahead of the construction project advertisement. The successful supplier will be expected to coordinate delivery, installation and startup with the site contractor. The equipment will be delivered to 406 Sunset Boulevard, West Columbia, South Carolina, 29169.

It is the intention of The City of West Columbia to award and order the proposed equipment package within 60 Days of receipt of proposals and subsequently advertise the construction project for bid in Q1 of 2024. This equipment package will be assigned to the successful bidder for the construction project.

## 1.1 Submittal Registration

Proposers must register via email with the Engineer, Goodwyn Mills Cawood, to ensure that any addenda are received. Proposal submittals received from unregistered suppliers will not be considered. To register, please send contact information to Jeremy Doll at [Jeremy.doll@gmcnetwork.com](mailto:Jeremy.doll@gmcnetwork.com) with the subject line, "RFP for Riverside WTP". The email shall provide the following information in its body:

1. Contact Name
2. Phone (Office/Cell)
3. E-mail Address
4. Physical Address
5. Supplier Name

## 1.2 Questions

All questions will be accepted via email only and shall be addressed to Jeremy Doll, PE at [Jeremy.doll@gmcnetwork.com](mailto:Jeremy.doll@gmcnetwork.com). Appropriate responses will be issued only on those items considered necessary by the Engineer via addendum. Questions must be received no later than the following: **Friday, September 13<sup>th</sup>, 2023 @ 5 p.m. EST.**

## 1.3 Preparation of Proposal

Each Proposal shall be assembled in one (1) document with a Title Page, Table of Contents, and Section Dividers. The proposal information shall be presented in the order requested under Section 4: Proposal Information. Oversized drawings (larger than 11 inches by 17 inches), if provided, shall be folded and inserted in plastic carriers. One (1) original copy and one (1) Digital (PDF) copy on a thumb drive of the proposal shall be delivered.



In the case of Suppliers who choose to furnish separately bound “confidential information”, this information shall be clearly identified as the confidential portion of the Supplier’s proposal and shall be assembled in the same manner as described above. Suppliers shall furnish one (1) original copy. A digital copy of “confidential information” is not required.

#### **1.4 Delivery of Proposal**

Sealed Bids for **Electrical Equipment and Enclosure at the Riverside Water Treatment Plant High Service Pump Station** will be received, by the City of West Columbia, at 200 N. 12<sup>th</sup> Street, West Columbia, SC 29169, until **2:00 PM** local time on **Friday, September 27<sup>th</sup>, 2023**, at which time the Bids received will be publicly opened and read.

The proposal shall be enclosed in a sealed package. The proposal shall be mailed or delivered to the following location:

The City of West Columbia  
C/O Andy Zaengle, Director of Engineering and Water Plants  
200 N. 12<sup>th</sup> Street  
West Columbia, SC 29169

The outside of the package shall plainly identify the subject of the submittal (Supplier Proposal); the project title “**Modifications to Riverside WTP High Service Pump Station**” and the name, address, phone number, and e-mail address of the Supplier.



## 2 TECHNICAL REQUIREMENTS

The Modifications to Riverside WTP High Service Pump Station proposal shall meet the following requirements:

### 2.1 General Requirements

- 1) The Supplier shall fabricate and deliver one package electrical building with all related equipment including panelboards, transformers, variable frequency drives, HVAC, lights, receptacles, conduit/cable tray, conductors, etc. pre-installed and connected as required by the attached specifications. The supplier shall note that there shall be open mounting space for other equipment provided by others in the construction project.
- 2) Please refer to the attached drawings and technical specifications for all technical and operating requirements. Note that the electrical drawings attached are a part of the future construction project documents. Where equipment is labeled “by others” or “by owner”, suppliers shall be aware that those notes apply from the construction contractor’s perspective, not the supplier’s perspective. The specifications attached should be the ultimate determinate for the scope of supply of this contract.
  - a. Drawing E-101
  - b. Drawing E-961
  - c. Specification Section 26 05 19
  - d. Specification Section 26 05 23
  - e. Specification Section 26 05 33
  - f. Specification Section 26 05 53
  - g. Specification Section 26 22 00
  - h. Specification Section 26 24 16
  - i. Specification Section 26 29 23
  - j. Specification Section 26 43 13
  - k. Specification Section 26 47 00

### 2.2 Contract Requirements

- 1) An unexecuted copy of the supply contract has been attached for review.

### 2.3 Exceptions

- 1) If the equipment submitted does not meet the requirements in the attached specification, please provide an “Exceptions” letter that outlines each exception taken.

- 2) **Note:** Any information that is determined by The City of West Columbia, or its Engineer, Goodwyn Mills Cawood, to be substantially inaccurate, misleading, exaggerated, or incorrect may be disqualified from consideration.

### 3 SELECTION PROCESS

The City of West Columbia and its Engineer reserve the right to change, suspend, or rescind the award rating and/or selection based on subsequently ascertained information.

The proposals will be evaluated according to the requirements below:

- Vendor Experience with Similar Scope and Complexity (15 points)
- Cost (60 points)
- Production Schedule (15 points)
- Consistency of the submittal with the requirements of the RFP (10 points)

### 4 REQUIRED PROPOSAL INFORMATION

#### 4.1 General

- 1) Provide an acknowledgment of all addenda.
- 2) Provide the following Contact information:
  - a. Sales Representative company name (if applicable), project contact, address, phone number, web address and email
  - b. Supplier company name, project contact, address, phone number, web address and email

#### 4.2 Vendor Experience:

- 1) Installation list showing packaged, pre-engineered electrical buildings of the type and generally with the components described above.
- 2) Location(s) of manufacturing/assembly.
- 3) Shipping/freight capabilities, in the event that shipping of the packaged building involves an oversized load.
- 4) Description of QA/QC procedures during manufacturing/assembly and immediately prior to shipping to the job site.
- 5) Description of typical and available field services during installation and start-up.
- 6) Capabilities for witnessed performance and/or field testing.
- 7) Information on warranties/guarantees/bonds typically provided and available to the Owner.

- 8) Preferred/available Suppliers of electrical equipment and variable frequency drives.
- 9) Provide a reference list with at least 3 references for packaged electrical buildings as similar as possible to the type and size/capacity indicated in the attached specifications. Information for each reference shall include the following at a minimum:
  - a. Location.
  - b. Installation/in service date.
  - c. Owner, installing contractor, design engineer, and contact name and number for each party.
  - d. Equipment manufacturers and models installed.
  - e. Total building dimensions and number of modular enclosure pieces in which building was shipped for field installation/connection.
  - f. Several photos of electrical buildings, inside and out, if available.
- 10) State the location and qualifications of service personnel closest to the station
- 11) Provide a copy of the product warranty
- 12) Provide a description of service and support capabilities including costs.

#### **4.3 Cost**

Provide a not to exceed cost for electrical building & equipment including, but not limited to; materials, manufacturing, testing, freight, delivery, startup, and incidentals required to produce a fully functioning system.

#### **4.4 Production Schedule**

State how long, in calendar days, from time of submittal approval to delivery of the station.

#### **4.5 Consistency of the submittal with the requirements of the RFP**

Submit with the proposal a copy of the Supplier's submittal for approval documents properly dated, sectioned, titled, with a detailed table of contents for the entire submittal at the beginning of the submittal and for each tab at the beginning of the tab, and including no less than the following:

- 1) Full set of shop drawings including dimensioning and equipment layout, all to scale.
- 2) Properly marked cut sheets and accessory selections for each major component of the system.
- 3) Complete description of the system including:

- a. Submittal Schedule
- b. Specification section number relevant to the submittal
- c. Technical information
- d. Mechanical major component properly marked cut sheets
- e. Electrical major component properly marked cut sheets
- f. Supplier recommended spare parts list
- g. SCADA interface, whether via Ethernet or discrete components
- h. Post production features
- i. Owner's manual description
- j. Shipment method and carrier type
- k. Notes clarification and exceptions
- l. Receiving instructions
- m. Storage instructions
- n. Warranty statement
- o. Refer to attached specifications for all other submittal requirements

#### 4) Owner's Manuals

- a. Operation and maintenance manual shall be prepared for this specific project, based on the approved submittal, and shall not be a general manual applicable to many systems.
- b. Operation and maintenance manual shall be provided as an electronic file and two printed and bound copies to the Owner. The electronic file shall be suitable for printing as many copies as are necessary.
- c. Manuals shall be provided at time of delivery of the package electrical building and shall be produced in the same format as the submittal, bound in a three-ring binder, with tabbed sections, including as built drawings, schematics and PLC & OIT programs.
- d. Suppliers' technical manuals shall be included with the submittal for each piece of equipment that is field serviceable.
  - i. Supplier's manuals shall be included as an appendix to the submittal after the submittal pages for each field serviceable device.
  - ii. Supplier's manuals shall include a comprehensive troubleshooting guide applicable to the specific system.

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# BID FORM

## ARTICLE 1 - BID RECIPIENT

1.01 This Bid is submitted to:

*The City of West Columbia  
ATTN: Andy Zaengle, Director of Engineering and Water Plants  
200 N. 12<sup>th</sup> Street  
West Columbia, SC 29169*

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into a Contract with Buyer in the form included in the Bidding Documents to furnish the Goods and Special Services as specified or indicated in the Bidding Documents, for the prices and within the times indicated in this Bid, and in accordance with the other terms and conditions of the Bidding Documents.

## ARTICLE 2 - BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the Request for Proposals. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Buyer.

## ARTICLE 3 - BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, the related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date
_____	_____
_____	_____
_____	_____

B. Bidder is familiar with and is satisfied as to all Laws and Regulations in effect as of the date of the Bid that may affect cost, progress, and the furnishing of Goods and Special Services.

C. Bidder has carefully studied, considered, and correlated the information known to Bidder; information commonly known to sellers of similar goods doing business in the locality of the Point of Destination and the site where the Goods will be installed or where Special Services will be provided; information and observations obtained from Bidder's visits, if any, to the Point of Destination and the site where the Goods will be installed or Special Services will be provided; and any reports and drawings identified in the Bidding Documents regarding the Point of Destination and the site where the

Goods will be installed or where Special Services will be provided, with respect to the effect of such information, observations, and documents on the cost, progress, and performance of Seller's obligations under the Bidding Documents.

- D. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution (if any) thereof by Engineer is acceptable to Bidder.
- E. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for furnishing the Goods and Special Services for which this Bid is submitted.

#### **ARTICLE 4 - BIDDER'S CERTIFICATIONS**

4.01 Bidder certifies that:

- A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;
- B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;
- C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and
- D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:
  - 1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;
  - 2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Buyer, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;
  - 3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish bid prices at artificial, non-competitive levels; and
  - 4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process.



**ARTICLE 5 - BASIS OF BID**

5.01 Bidder will furnish the Goods and Special Services in accordance with the Contract Documents for the following price(s):

Lump Sum Bid Price \$ \_\_\_\_\_

**ARTICLE 6 - TIME OF COMPLETION**

6.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedule set forth in Article 5 of the Agreement.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

**ARTICLE 7 - ATTACHMENTS TO THIS BID**

7.01 The following documents are attached to and made a condition of this Bid:

- A. List of Proposed Major Suppliers;
- B. and Proposal for **Electrical Equipment and Enclosure at the Riverside Water Treatment Plant High Service Pump Station**

**ARTICLE 8 - DEFINED TERMS (NOT USED)**

**ARTICLE 9 - BID SUBMITTAL**

9.01 This Bid submitted by:

If Bidder is:

An Individual

Name (typed or printed): \_\_\_\_\_

By: \_\_\_\_\_  
*(Individual's signature)*

Doing business as: \_\_\_\_\_

Business address: \_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

E-mail address: \_\_\_\_\_

A Partnership

Partnership Name: \_\_\_\_\_  
(SEAL)

By: \_\_\_\_\_  
*(Signature of general partner - attach evidence of authority to sign)*

Name (typed or printed): \_\_\_\_\_

Business address: \_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

E-mail address: \_\_\_\_\_

A Corporation

Corporation Name: \_\_\_\_\_

State of Incorporation: \_\_\_\_\_

Type (General Business, Professional, Service, other): \_\_\_\_\_

By: \_\_\_\_\_  
*(Signature - attach evidence of authority to sign)*

Name (typed or printed): \_\_\_\_\_

Title: \_\_\_\_\_

(CORPORATE SEAL)

Attest \_\_\_\_\_  
*(Signature of Corporate Secretary)*

Business address: \_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

E-mail address: \_\_\_\_\_

A Limited Liability Company (LLC)

LLC Name: \_\_\_\_\_

State in which organized: \_\_\_\_\_

By: \_\_\_\_\_  
*(Signature - attach evidence of authority to sign)*

Name (typed or printed): \_\_\_\_\_

Title: \_\_\_\_\_

Business address: \_\_\_\_\_

\_\_\_\_\_

**CONTRACT  
FOR PURCHASE OF ELECTRICAL ENCLOSURE & EQUIPMENT  
  
FOR THE CITY OF WEST COLUMBIA MODIFICATIONS TO  
RIVERSIDE WATER TREATMENT PLANT HIGH SERVICE  
PUMPS**

This Contract, dated \_\_\_\_\_ is between the City of West Columbia (Owner) and *to be determined* (Seller).

**RECITALS**

1. Seller has submitted a bid to Owner for the sale of certain goods and services for the City of West Columbia Modifications to Riverside Water Treatment Plant High Service Pumps Project.
2. Owner wishes to purchase the goods and services from Seller.

**TERMS AND CONDITIONS**

1. Description

A. Owner shall purchase the goods (Goods) and services (Services) described in Exhibit A, attached hereto and incorporated herein. Seller's goods and services shall meet the highest standards prevalent in the industry or business most closely involved in providing the goods Owner is purchasing.

B. Owner may propose changes to the specifications at any time prior to shipment. Seller shall promptly respond by stating in writing what effect, if any, the changes would have on the purchase price and delivery date. No changes shall be effective unless approved as an amendment to this Contract as provided in Paragraph 23.

C. Seller shall promptly advise Owner of all reasonably available technological advances that are known or become known to Seller while this Contract is in effect which may result in the goods having added value when used for Owner's purposes. No changes incorporating the advances shall be effective unless approved as an amendment to this Contract as provided in Paragraph 23.

D. Goodwyn Mills Cawood, LLC. (Engineer) will be Owner's representative for the Project.

## 2. Contract Documents

A. The Contract Documents which comprise the entire agreement between Owner and Seller consist of the following:

1. Bid Form;
2. Contract;
3. Exhibit A – Description of Goods and Services;
4. Exhibit B – Drawings E-101, E-961 & Specifications 260519, 260523, 260533, 260553, 262200, 262416, 262923, 264313, 264700
5. Exhibit C – Sample Lien Waiver

B. There are no Contract Documents other than those listed in this article. The Contract Documents may only be amended, modified, or supplemented as provided herein.

C. The parties agree that Owner has the right to assign the Contract Documents to the general contractor awarded the contract to construct the Project (Contractor). If the Contract Documents are assigned to Contractor, Seller agrees that Contractor shall be substituted for Owner and the line of communication or instruction shall be construed to run between Seller and Contractor and from Contractor to Owner, unless otherwise indicated.

## 3. Price/Payment

A. Owner shall pay a total purchase price of \$(*to be determined*) for the Goods and Services (Contract Price), delivered free on board (F.O.B.), City of West Columbia Riverside Water Treatment Plant located at 406 Sunset Boulevard, West Columbia, SC 29169. Contract Price includes all sales tax, shipping fees, licenses, permits, and any other items for Goods and Services to be completely free of all other financial obligations.

B. Owner shall pay Seller progress payments to which Seller is entitled reflecting the percentage of Goods delivered to the Site less retainages described herein. Payments to Seller shall in no way imply acceptance of Goods or relieve Seller from the warranties specified herein and by the Contract Documents.

C. Owner shall retain ten (10) percent of the actual invoice amounts until all Goods and Services have been delivered, including startup, field testing, and installation check.

D. An executed lien waiver, as attached in Exhibit C, must accompany any invoice for payment.

E. The Owner shall have no less than thirty (30) days after the receipt of Seller's invoice in which to make payment.

#### 4. Submittals

A. Seller is responsible for providing Owner with complete submittal packages in accordance with the Specifications in addition to the following:

- Clearly identified performance characteristics and selected components
- Proposed cost as specified herein. The seller shall guarantee the proposed cost of goods & services for a minimum of 30 business days from the date of submittal.
- Proposed delivery schedule.

B. Owner will be allowed 15 business days for the review of submittal packages prior executing this contract with the selected equipment supplier.

#### 5. Delivery

A. Seller shall provide the Goods and Services to the site in accordance with their proposed delivery schedule. The proposed delivery schedule shall commence to run upon execution of this contract.

B. Seller shall give Owner at least seven days' prior written notice of the date when the Goods will be ready for shipment and the manner of shipment. The notice will include instructions concerning any special equipment or Services required at the Site to unload and care for the Goods. Seller also shall require the carrier to give Owner not less than 24 hours' notice by telephone of the anticipated hour of delivery.

C. Owner shall inspect the Goods upon delivery for purposes of identifying the Goods and general verification of quantities and observation of apparent condition to provide a basis for payment as set forth in Paragraph 3. Owner may refuse to accept delivery of any Goods that are apparently defective. If no apparent defects are discovered, Owner shall accept delivery.

D. Notice of Owner's receipt of delivery will be provided to Seller by a copy of the shipping documents.

#### 6. Liquidated Damages

A. Owner and Seller recognize that time is of the essence of this Project and that Owner will suffer loss if the Goods are not delivered within the times specified in the Contract, plus any extensions thereof allowed. They also recognize the delays, expense and difficulties in proving the actual loss suffered by Owner if the delivery is not completed on time. Accordingly, instead of requiring any such proof, Owner and Seller agree that as liquidated damages for delay (but not as a penalty) Seller shall pay Owner Three Hundred

Dollars (\$300.00) for each day that expires after the time specified in the Contract until the delivery is complete, excluding delays under Paragraph 7 herein.

B. Liquidated damages will be deducted from the invoice for Goods and Services from the Seller prior to remission of payment.

#### 7. Excusable Delays

Neither Owner nor Seller shall be responsible for or liable for damages resulting from delays due to causes beyond their reasonable control, including, but not limited to, acts of God, acts or omissions of governmental authorities, strikes, lockouts, acts of the public enemy, wars, blockades or civil disturbances. In the event of such a delay, the completion date for Seller's services shall be extended for a period equal to the length of the delay. Seller shall notify Owner in writing not more than ten days after the occurrence of any event that Seller believes will result in such a delay. The failure of Seller to provide such notice shall result in a waiver of Seller's right to claim that the delay is excusable.

#### 8. Transportation Insurance

A. Transportation insurance shall be of the "all risks" type and shall protect Seller and Owner from all insurable risks of physical loss or damage to equipment and materials in transit to the designated location. The coverage amount shall be not less than the full value of items exposed to risk in transit at any one time.

B. Transportation insurance shall provide for losses to be payable to Seller and Owner as their interests may appear and shall contain a waiver of subrogation rights against the insured parties. For insurance purposes, the risk of loss to equipment and materials shall remain with Seller until the equipment and materials are accepted by the assignee general construction contractor at the designated location.

C. Seller shall submit a copy of the transportation insurance policy to Owner at least 30 days before the scheduled shipping date. The policy shall quote the insuring agreement, shall list all exclusions, and shall state that 30 days' written notice will be given Owner before the policy is changed or canceled.

#### 9. Testing

Seller shall test the goods following installation in accordance with the Specifications.

#### 10. Repair of Damage

Seller shall promptly repair all damage to Owner's premises caused by Seller. Seller shall repair the premises to its original condition and in a manner that does not result in the cancellation or impairment of warranties issued by third parties concerning any portion of the premises.

11. Training

Seller shall provide the training as referenced in the Specifications.

12. Operations Manuals

Seller shall deliver operation and maintenance manuals to the Owner as required in the Specifications.

13. Acceptance

Owner shall not be deemed to have accepted the goods until after Seller has performed all of Seller's delivery, installation, testing and training obligations, as defined herein.

14. Risk of Loss

Seller shall bear the risk of loss to the goods until Owner has accepted delivery of the goods at the Site.

15. Warranty Against Defects

Seller shall provide a warranty for the Goods in accordance with the Contract Documents.

16. Maintenance Services

Seller shall provide maintenance services as defined the specifications.

17. Indemnity/Hold Harmless

To the fullest extent permitted by law, Seller shall indemnify, hold harmless, reimburse and defend Owner and/or Engineer, their officers, employees, agents and representatives from and against all claims, demands, penalties, and causes of action of any kind or character, including the cost of defense thereof, including attorney fees at trial and on appeal, arising out of, or resulting from Seller's performance of this Contract, but only to the extent caused by the breach of this Contract or the negligent acts or omissions of Seller, any lower-tier seller, or any individual or entity directly or indirectly employed by any of them to perform under this Contract, or anyone for whose acts any of them may be liable.

18. Patents and Licenses

Seller agrees that all equipment and materials furnished as described herein are in

compliance with governing patent regulations, royalties and license agreements. Seller further holds Owner harmless from any damages, including attorney's fees, incurred as a result of any action for infringement of patent rights or for any royalties due on patents used by the Seller.

19. Bid Research/Inspection

Seller represents that Seller has knowledge of the circumstances and conditions of the use of the product sold under this Contract, and further represents that Seller has correlated the observations or knowledge with the requirements of the Contract Documents. Failure to make such observations or to possess such knowledge shall not release Seller from any obligations herein.

20. Termination

A. Owner may terminate this Contract without cause at any time prior to the completion of delivery. In the event of such termination, Owner's liability to Seller shall be limited to the reasonable value of work performed by Seller and the reimbursement of reasonable expenses incurred by Seller prior to the time Seller received Owner's notice of termination. In no event shall Owner's liability exceed the purchase price of the Goods. In the event of such termination, Owner shall be entitled to all materials, work in progress and completed work included in computing the value of work performed and reasonable expenses.

B. Owner may terminate this Contract for cause, at no expense to the Owner, at any time prior to Owner's acceptance if Seller has breached this Contract and has not cured the breach within five (5) days after receiving Owner's written notice of breach. If the unpaid balance of the Contract Price exceeds all claims, costs, losses and damages sustained by Owner arising out of or resulting from the completion of delivery for Goods and Services, such excess will be paid to Seller. If such claims, costs, losses and damages exceed such unpaid balance, Seller shall pay the difference to Owner. Such claims, costs, losses and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and when so approved by Engineer incorporated as a revision in Contract Price, provided that when exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price to complete the delivery of Goods and Services.

21. Compliance with State and Federal Laws/Rule

Seller shall comply with all applicable federal, state and local laws, rules and regulations-

22. No Contingent Fees

Seller warrants that Seller has not employed or retained any company or person, other than a bona fide employee working solely for Seller, to solicit or secure this Contract, and



that Seller has not paid or agreed to pay any company or person, other than a bona fide employee working solely for Seller any fee or consideration of any kind, contingent upon or resulting from the award or making of this Contract. In the event Seller breaches the warranty contained in this paragraph, Owner shall have the right to deduct from the Contract price or otherwise recover the full amount of such fee or consideration.

23. Amendments/Waivers

No waiver of any portion of this Contract and no amendment, modification or alteration of this Contract shall be effective unless in writing and signed by Seller's authorized representative and the Owner.

24. Third Party Beneficiaries

No provision of this Contract shall in any way inure to the benefit of any third person so as to constitute any such person a third-party beneficiary of this Contract or of any one or more of the terms of this Contract, or otherwise give rise to any cause of action in any person not a party to this Contract.

25. Arbitration

If, at any time, any controversy should arise between Seller and Owner with respect to any matter or thing involved in, arising out of, or related to this Contract then the controversy may, at Owner's option, be decided by mediation in accordance with the Construction Industry Mediation Procedures in effect on the date of the Contract. The American Arbitration Association shall administer the mediation. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. No claim, dispute or other matter in controversy shall interfere with the delivery of the equipment and materials and Seller shall proceed

with shipments, at Owner's option, despite the existence of and without awaiting the resolution of any such dispute.

26. Waiver of Claims

The making and acceptance of final payment will constitute:

- 1) a waiver of all claims by Owner against Seller, except claims arising from unsettled Liens, from defective Goods and Services appearing after final inspection, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Seller's continuing obligations under the Contract Documents;
- 2) and a waiver of all claims by Seller against Owner.

27. Interpretation of Contract

A. This Contract shall not be construed for or against any party by reason of the authorship or alleged authorship of any provision.

B. The paragraph headings contained in this Contract are for ease of reference only and shall not be used in constructing or interpreting this Contract.

28. Severability/Survival

If any of the provisions contained in this Contract are held illegal, invalid or unenforceable, the enforceability of the remaining provisions shall not be impaired. All provisions concerning the limitation of liability, indemnity and conflicts of interest shall survive the termination of this Contract for any cause.

29. Choice of Law/Venue

This Contract and all rights, obligations and disputes arising out of the Contract shall be governed by South Carolina law. All disputes and litigation arising out of this Contract shall be decided by the state courts in Lexington County, South Carolina.

30. Integration

This Contract constitutes the entire Contract between the parties on the subject matter hereof and supersedes all prior or contemporaneous written or oral understandings, representations or communications of every kind on the subject. No course of dealing between the parties and no usage of trade shall be relevant to supplement any term used in this Contract. Acceptance or acquiescence in a course of performance rendered under this Contract shall not be relevant to determine the meaning of this Contract and no waiver by a party of any right under this Contract shall prejudice the waiving party's exercise of the right in the future.

31. Contract Assignment

Owner may assign this Contract to its Contractor, and Seller will accept this assignment pursuant to the Contract Documents. After the Contract has been assigned, Seller shall function as a subcontractor to the Contractor, and all obligations of Seller to Owner shall become obligations of Seller to the Contractor. Notwithstanding this assignment, the guarantees and warranties specified in the Contract Documents are intended for the benefit of Owner and Contractor, and may be enforced by either party.

32. Miscellaneous and/or Special Provisions

This Contract including the documents incorporated herein by reference embodies the

entire agreement of the parties and supersedes all prior negotiations, agreements, and understandings relating to the subject matter hereof.

The provisions of the Contract and the Specifications are intended to supplement and complement each other. If, however, any provision of the Contract irreconcilably conflicts with the provisions of the Specifications, the provision imposing the greater duty on Seller shall govern, unless otherwise agreed to by Owner.

## **Exhibit A – Description of Goods and Services**

### 1. GOODS AND SERVICES

A. Seller shall furnish the following Goods and Services as specified or indicated in the Contract Documents.

B. Goods and Services shall include fabrication and delivery of:

- 1) One package electrical building with all related equipment including panelboards, transformers, variable frequency drives, HVAC, lights, receptacles, conduit/cable tray, conductors, etc. pre-installed and connected as required by the attached specifications.
- 2) The supplier shall note that there shall be open mounting space for other equipment provided by others in the construction project.

## Exhibit B – Drawings and Specifications

### 2. Drawings:

E-101 – E-HOUSE ELECTRICAL PLAN

E-961 – RISER DIAGRAM AND PANEL SCHEDULES

### 3. Specifications

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

26 05 23 ..... CONTROL-VOLTAGE ELECTRICAL POWER CABLES

26 05 33 .....RACEWAYS & BOXES FOR ELECTRICAL SYSTEMS

26 05 53 ..... IDENTIFICATION FOR ELECTRICAL SYSTEMS

26 22 00 ..... LOW-VOLTAGE TRANSFORMERS

26 24 16 .....PANELBOARDS

26 29 23 ..... VARIABLE-FREQUENCY MOTOR CONTROLLERS

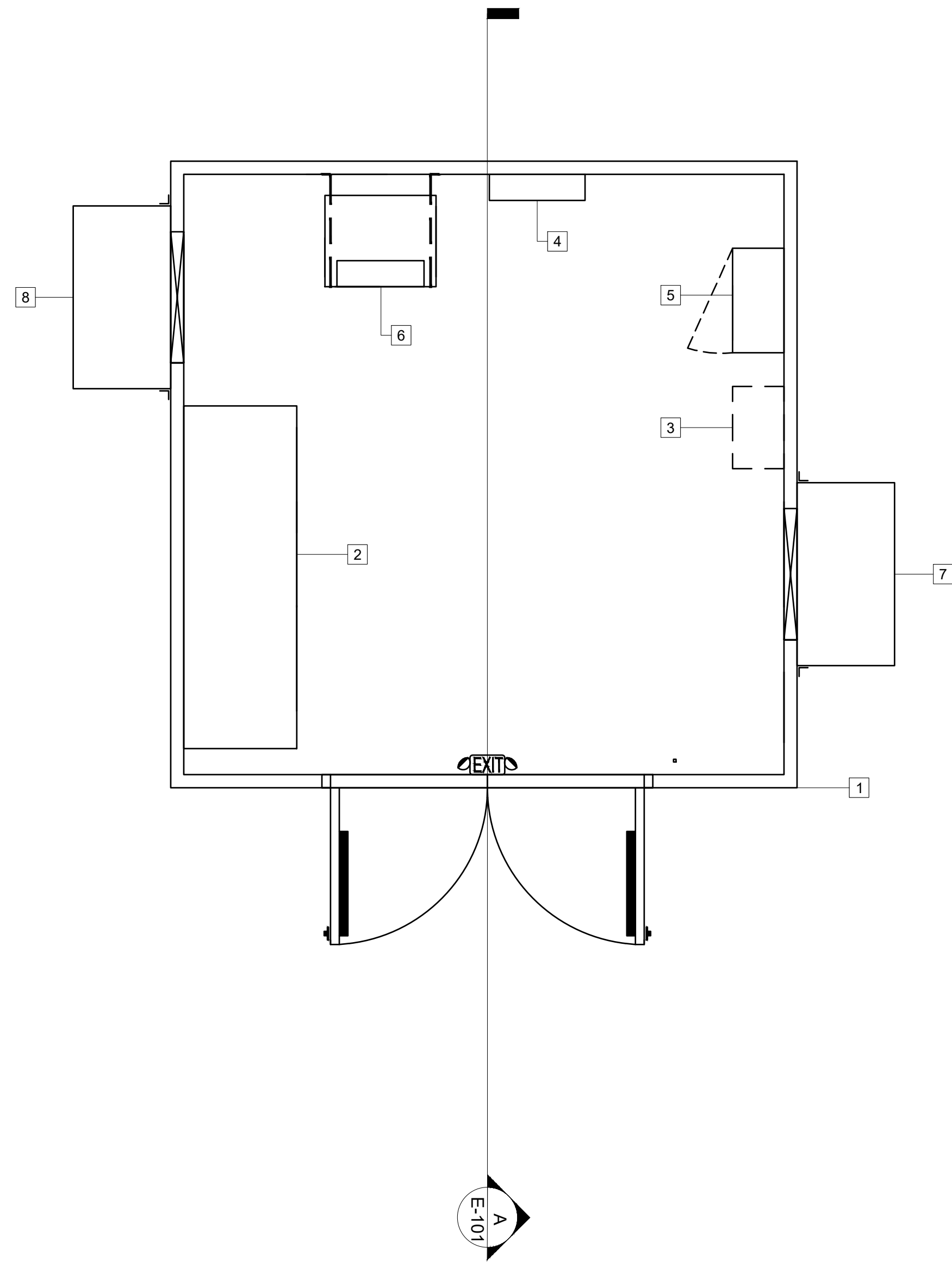
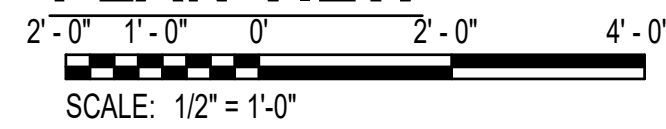
26 43 13 .....SURGE PROTECTION FOR LOW-VOLTAGE CIRCUITS

26 47 00 ..... ELECTRICAL EQUIPMENT CENTERS

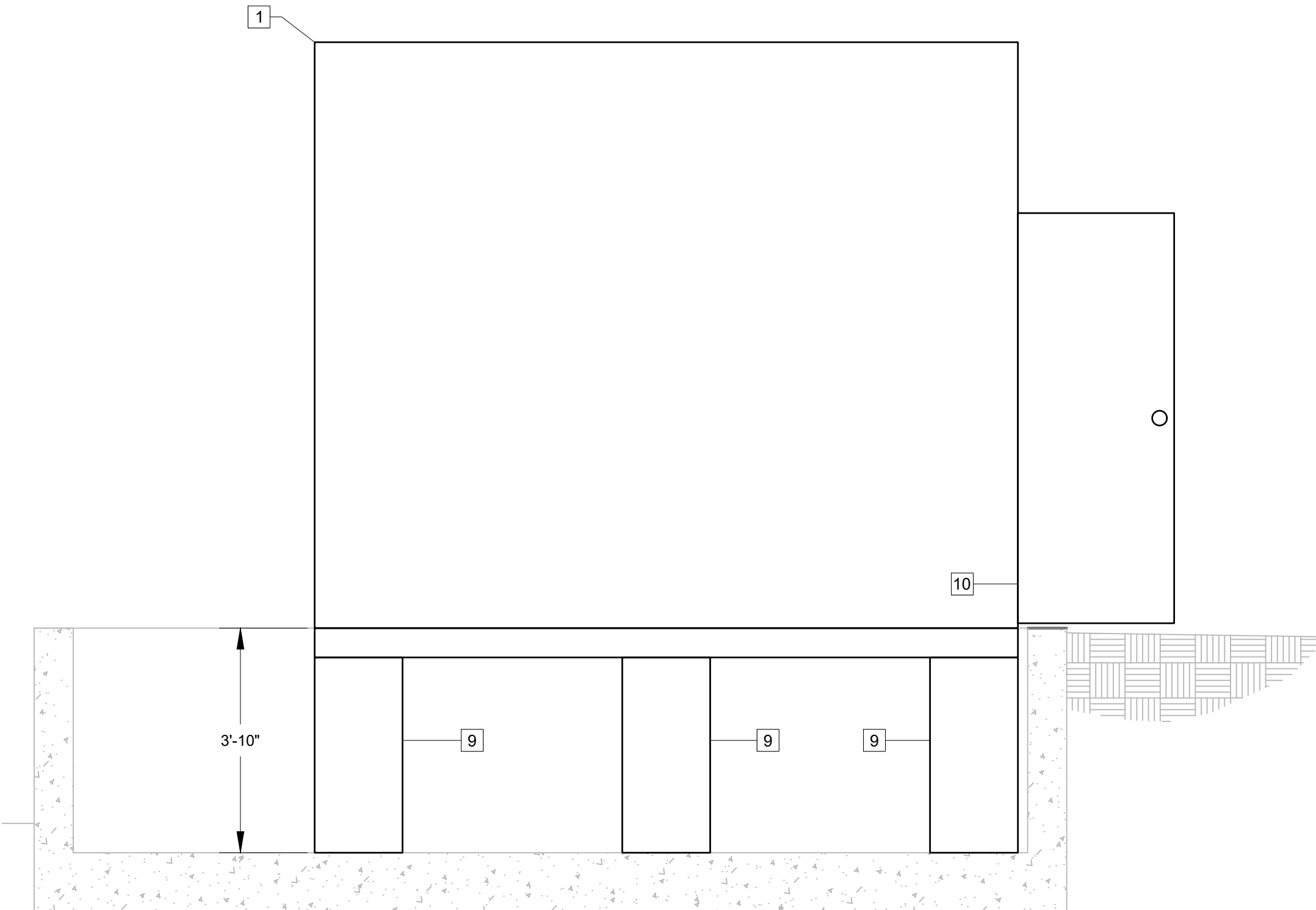
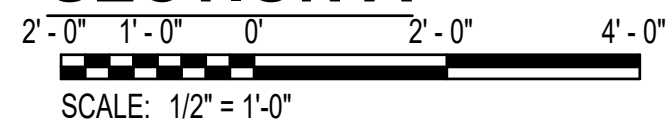
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 PLOTTED: Aug 21, 2023 3:58pm

**PLAN VIEW**



**SECTION A**

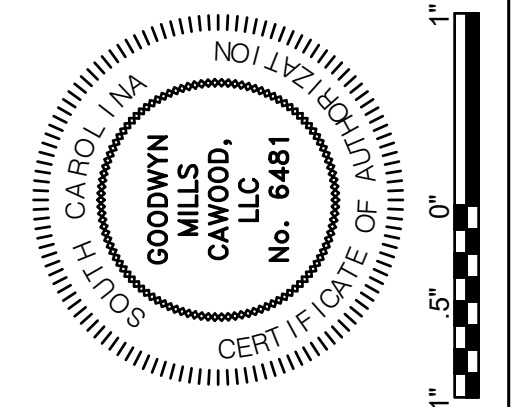


**GENERAL NOTES:**

1. NOT ALL ELECTRICAL COMPONENTS TO BE SUPPLIED AND PREINSTALLED ARE SHOWN ON THIS DRAWING. SEE SPECIFICATIONS FOR MORE DETAILS.

**KEY NOTES:** #

1. NEW E-HOUSE SUPPLIED BY OTHERS. INSTALLED BY CONTRACTOR. ALL EQUIPMENT INSIDE AND ATTACHED TO E-HOUSE INCLUDING PANELS, TRANSFORMERS, VFD'S, HVAC, CONDUIT/WIRE, ETC. SHALL BE INSTALLED BY E-HOUSE SUPPLIER.
2. NEW 480V, 3Φ, 400HP VFD.
3. EXISTING, RELOCATED, 200HP VFD.
4. NEW 120/208V LOAD CENTER 'B'.
5. NEW REMOTE SCADA PANEL BY SYSTEMS INTEGRATOR.
6. NEW 30kVA 480V-120/208V TRANSFORMER.
7. NEW HVAC UNIT #1.
8. NEW HVAC UNIT #2.
9. STRUCTURAL SUPPORT FOR E-HOUSE. SEE CIVIL SHEETS FOR ADDITIONAL INFORMATION FOR STRUCTURAL SUPPORT. E-HOUSE SHALL BE PROPERLY SUPPORTED AND FASTENED TO STRUCTURAL SUPPORT MEMBERS.
10. LOCATE E-HOUSE SO THAT EDGE OF BUILDING WITH DOOR OPENING IS MAXIMUM 2" FROM EDGE OF RETAINING WALL.



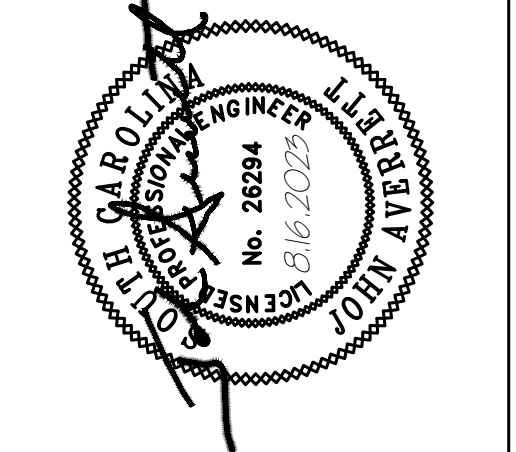
ISSUE	DATE
30% SUBMITTAL	11.18.2022
60% SUBMITTAL	1.13.2023
90% SUBMITTAL	03.21.2023
FINAL	08.16.2023

PROJECT MANAGER:	JRD
ENGINEER:	JEA
DESIGNER:	JRD
DRAWN BY:	MBH

MODIFICATIONS TO  
 RIVERSIDE WTP  
 HIGH SERVICE PUMPS  
 WEST COLUMBIA, SC

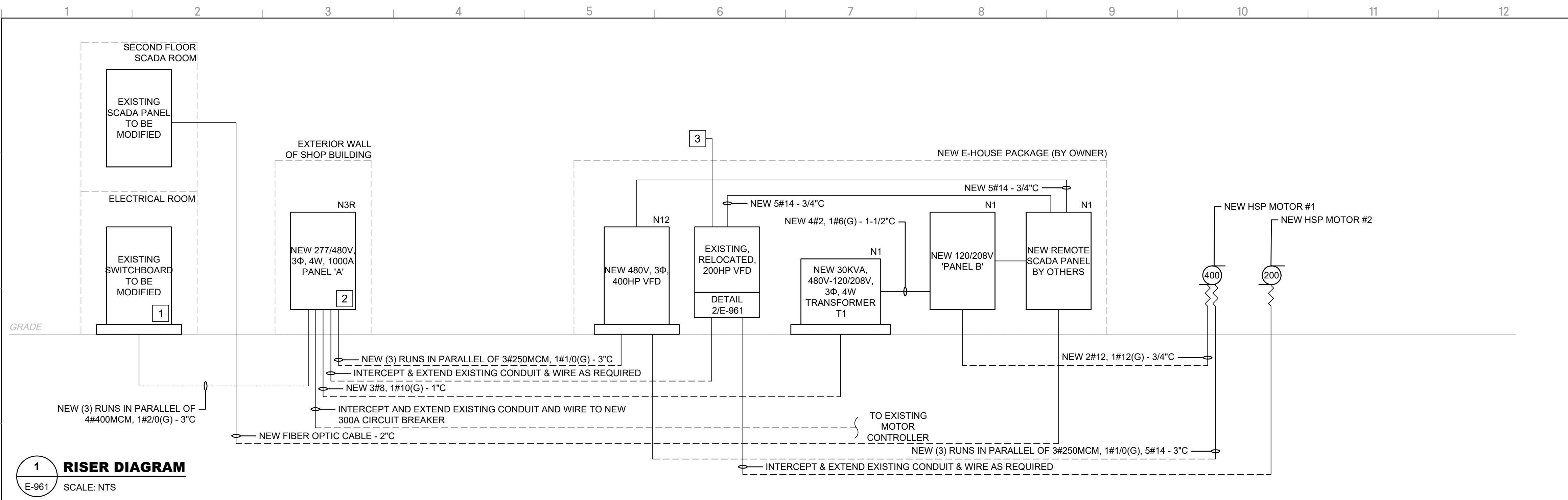
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**E-HOUSE ELECTRICAL  
 PLAN**

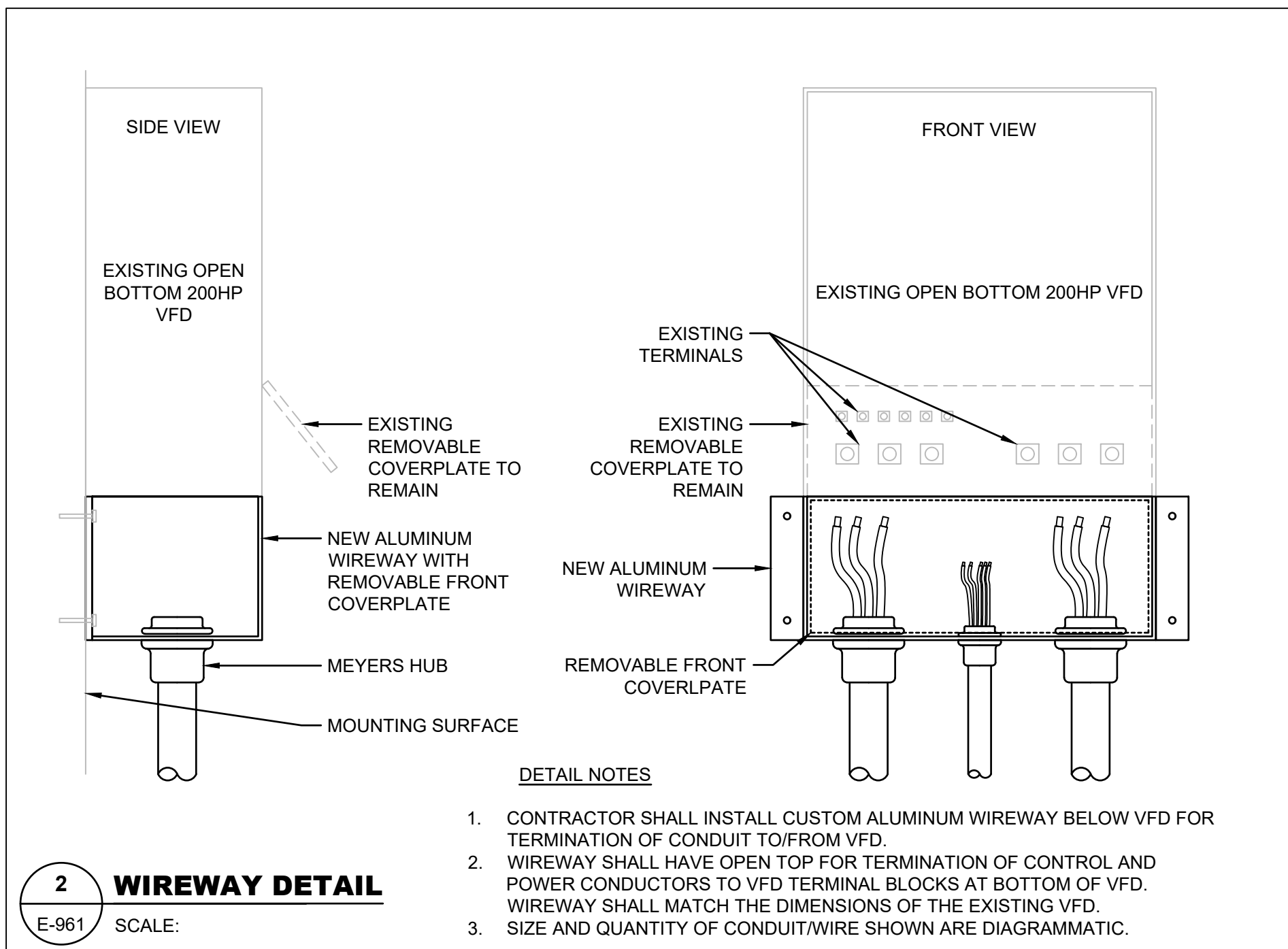
**E-101**





**1 RISER DIAGRAM**  
E-961 SCALE: NTS

- KEY NOTES: #**
- EXISTING EATON SWITCHBOARD 'MDP' THAT FEEDS HIGH SERVICE PUMP #2 & EXISTING EXTERIOR PANELBOARD. CONTRACTOR SHALL VERIFY EXACT LOCATION ON SITE. CONTRACTOR SHALL REPLACE EXISTING CIRCUIT BREAKER FEEDING EXTERIOR 800A PANEL SHOWN ON E-002 WITH A NEW 1000A, 3P, CIRCUIT BREAKER TO MATCH EXISTING TYPE & INTERRUPTING RATING. CONTRACTOR SHALL DISCONNECT EXISTING CIRCUIT BREAKER FOR EXISTING HIGH SERVICE PUMP #2 AND LABEL AS 'SPARE'. CONTRACTOR SHALL VERIFY LOCATION AND CIRCUIT BREAKERS ON SITE PRIOR TO BID.
  - ALL MAIN AND BRANCH CIRCUIT BREAKERS SHALL HAVE LOCKABLE HANDLES FOR MAINTENANCE & LOCKOUT-TAGOUT PURPOSES.
  - RELOCATED AND INSTALLED BY ELECTRICAL CONTRACTOR IN THE FIELD. VFD SHALL BE INSTALLED IN A VENTED, PROTECTIVE ENCLOSURE FOR PROPER TERMINATION OF POWER CONDUCTORS AND CONTROL CONDUCTORS.



**PANELBOARD SCHEDULE: A**

LOCATION	EXTERIOR WALL	MAIN: 1000A MCB	NEMA 3R							
VOLTAGE	277/480	SYSTEM: 3Φ, 4 WIRE								
TRIM	SURFACE	INTERRUPTING RATING: 65K AIC								
CKT #	LOAD DESCRIPTION	BREAKER P	TRIP	PHASE (kVA) A B C	PHASE (kVA) A B C	BREAKER TRIP P	LOAD DESCRIPTION	CKT #		
1	EXISTING LOAD, RECONNECT LOAD SIDE CONDUCTORS AS REQUIRED	3	300	62.0	62.0	62.0	800	3	HIGH SERVICE PUMP #1	2
3				10.0	10.0	10.0	400	3	HIGH SERVICE PUMP #2	4
5										6
7										8
9	PANEL B THRU TRANSFORMER T1	3	50							10
11										12
13	BUSSED SPACE									14
15	BUSSED SPACE									16
17	BUSSED SPACE									18
19	BUSSED SPACE									20
21	BUSSED SPACE									22
23	BUSSED SPACE									24
25	BUSSED SPACE									26
27	BUSSED SPACE									28
29	BUSSED SPACE									30
31	BUSSED SPACE									32
33	BUSSED SPACE									34
35	BUSSED SPACE									36
37	BUSSED SPACE									38
39	BUSSED SPACE									40
41	BUSSED SPACE									42

**PANELBOARD SCHEDULE: B**

LOCATION	E-HOUSE	MAIN: 100A MCB	NEMA 1							
VOLTAGE	120/208V	SYSTEM: 3Φ, 4 WIRE								
TRIM	SURFACE	INTERRUPTING RATING: 65K AIC								
CKT #	LOAD DESCRIPTION	BREAKER P	TRIP	PHASE (kVA) A B C	PHASE (kVA) A B C	BREAKER TRIP P	LOAD DESCRIPTION	CKT #		
1				2.8	2.8	2.8	30	3	HVAC #2	2
3	HVAC #1	3	30							4
5										6
7	RECEPTACLES	1	20	0.8		0.5	20	1	SCADA PANEL	8
9	INTERIOR LIGHTS	1	20		0.1		20	1	PUMP HEATER	10
11	EXTERIOR LIGHTS	1	20			0.1	20	1	SPARE	12
13	VAULT LIGHTING	1	20	0.1			20	1	SPARE	14
15	SPARE	1	20				20	1	SPARE	16
17	SPARE	1	20				20	1	SPARE	18
19	SPARE	1	20				20	1	SPARE	20
21	SPARE	1	20				20	1	SPARE	22
23	SPARE	1	20				20	1	SPARE	24
25	SPARE	1	20				20	1	SPARE	26
27	BUSSED SPACE									28
29	BUSSED SPACE									30
31	BUSSED SPACE									32
33	BUSSED SPACE									34
35	BUSSED SPACE									36
37	BUSSED SPACE									38
39	BUSSED SPACE									40
41	BUSSED SPACE									42

**GMC**

1" = 5' 0"

ISSUE DATE

30% SUBMITTAL	11.18.2022
60% SUBMITTAL	1.13.2023
90% SUBMITTAL	03.21.2023
FINAL	08.16.2023

PROJECT MANAGER: JRD  
ENGINEER: JEA  
DESIGNER: JRD  
DRAWN BY: MBH

MODIFICATIONS TO RIVERSIDE WTP HIGH SERVICE PUMPS WEST COLUMBIA, SC

VGRE220006

**E-961**

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**SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY****A. Section Includes:**

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

**B. Related Requirements:**

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

**1.3 DEFINITIONS**

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

**1.4 ACTION SUBMITTALS**

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

**1.5 INFORMATIONAL SUBMITTALS**

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

**1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

**PART 2 - PRODUCTS****2.1 COPPER BUILDING WIRE**

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

**2.2 CONNECTORS AND SPLICES**

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

**PART 3 - EXECUTION****3.1 CONDUCTOR MATERIAL APPLICATIONS**

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

**3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS**

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

- E. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- I. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- J. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.
- L. VFC Output Circuits: Type XHHW-2 in metal conduit.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

### 3.4 CONNECTIONS

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

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

### 3.5 IDENTIFICATION

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

### 3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. 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 according to Section 07 84 13 "Penetration Firestopping."

### 3.8 FIELD QUALITY CONTROL

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

- a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
  - b. Test bolted connections for high resistance using one of the following:
    - 1) A low-resistance ohmmeter.
    - 2) Calibrated torque wrench.
    - 3) Thermographic survey.
  - c. Inspect compression-applied connectors for correct cable match and indentation.
  - d. Inspect for correct identification.
  - e. Inspect cable jacket and condition.
  - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
  - g. Continuity test on each conductor and cable.
  - h. Uniform resistance of parallel conductors.
4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:
1. Procedures used.
  2. Results that comply with requirements.
  3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

**SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

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

**1.3 DEFINITIONS**

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

**1.4 ACTION SUBMITTALS**

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

**1.5 INFORMATIONAL SUBMITTALS**

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

- C. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

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

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

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

### 2.2 BACKBOARDS

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

### 2.3 CATEGORY 6 TWISTED PAIR CABLE

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



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

**2.4 TWISTED PAIR CABLE HARDWARE**

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden CDT Networking Division/NORDX.
  2. General Cable; General Cable Corporation.
  3. Hubbell Premise Wiring.
  4. Leviton Manufacturing Co., Inc.
  5. Mohawk; a division of Belden Networking, Inc.
  6. Or Approved Equal.
- C. General Requirements for Twisted Pair Cable Hardware:
1. Comply with the performance requirements of Category 6.
  2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
  3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- E. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. 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 cable indicated.
- 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 shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
  2. Patch cords shall 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 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 twisted pair cable.
  2. Designed to snap-in to a patch panel or faceplate.
  3. Standards:
    - a. Category 5e, unshielded twisted pair cable shall comply with IEC 60603-7-2.
    - b. Category 5e, shielded twisted pair cable shall comply with IEC 60603-7-3.
    - c. Category 6, unshielded twisted pair cable shall comply with IEC 60603-7-4.
    - d. Category 6, shielded twisted pair cable shall comply with IEC 60603-7.5.
    - e. Category 6a, unshielded twisted pair cable shall comply with IEC 60603-7-41.
    - f. Category 6a, shielded twisted pair cable shall comply with IEC 60603-7.51.
  4. Marked to indicate transmission performance.
- K. Faceplate:
1. Two port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
  2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
  3. Plastic Faceplate: High-impact plastic. 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 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.

2.5 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, one pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

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

1. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

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

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

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

**2.7 CONTROL-CIRCUIT CONDUCTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. General Cable; General Cable Corporation.
  - 2. Southwire Company.
  - 3. Or Approved Equal.
- 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.

**2.8 SOURCE QUALITY CONTROL**

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

**PART 3 - EXECUTION****3.1 EXAMINATION**

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

**3.2 INSTALLATION OF RACEWAYS AND BOXES**

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
  - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2. Outlet boxes for cables shall be no smaller than 4 inches square by 1-1/2 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
  3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
  2. Install cable trays to route cables if conduits cannot be located in these positions.
  3. Secure conduits to backboard if entering the room from overhead.
  4. Extend conduits 3 inches above finished floor.
  5. 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; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  4. Cables may not be spliced.
  5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
  7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
  9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
  10. Support: Do not allow cables to lie on removable ceiling tiles.
  11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
  12. All terminations shall be made with ring or fork type terminals.

- C. Twisted Pair Cable Installation:
1. Comply with TIA-568-C.2.
  2. Install termination hardware as specified in Section 27 15 13 "Communications Copper Horizontal Cabling" unless otherwise indicated.
  3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.
- D. Installation of Control-Circuit Conductors:
1. Install wiring in raceways. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
  3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.
- F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
  2. Install cabling after the flooring system has been installed in raised floor areas.
  3. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.
- G. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
  2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
    - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
    - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
  3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
    - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

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

### 3.4 REMOVAL OF CONDUCTORS AND CABLES

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

### 3.5 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. 14 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 low-voltage control 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 shall use label stocks, laminating adhesives, and inks complying with UL 969.

### 3.9 FIELD QUALITY CONTROL

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

END OF SECTION 26 05 23



**SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY****A. Section Includes:**

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

**1.3 DEFINITIONS**

- A. GRC: Galvanized rigid steel conduit.
- B. CGRC: PVC Coated Galvanized Rigid Conduit.
- C. PVC: Schedule 40 Poly Vinyl Chloride Conduit.

**1.4 ACTION SUBMITTALS**

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

**1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  1. Structural members in paths of conduit groups with common supports.
  2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Tube & Conduit; a part of Atkore International.
  - 2. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 3. Perma-Cote.
  - 4. Plasti-Bond.
  - 5. Southwire Company.
  - 6. Thomas & Betts Corporation; A Member of the ABB Group.
  - 7. Wheatland Tube Company.
  - 8. Or Approved Equal.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch, minimum.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
  2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- H. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

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

- M. Solvents and Adhesives: As recommended by conduit manufacturer.

### 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

### 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Moulded Products, Inc.
  2. Hoffman; a brand of Pentair Equipment Protection.
  3. Or Approved Equal.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- F. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. Panduit Corp.
    - c. Wiremold / Legrand.
    - d. Or Approved Equal.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Incorporated.
    - b. Panduit Corp.
    - c. Wiremold / Legrand.
    - d. Or Approved Equal.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Crouse-Hinds, an Eaton business.
  - 2. Hoffman; a brand of Pentair Equipment Protection.
  - 3. Hubbell Incorporated; Wiring Device-Kellems.
  - 4. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 5. Plasti-Bond.
  - 6. Thomas & Betts Corporation; A Member of the ABB Group.
  - 7. Wiremold / Legrand.
  - 8. Or Approved Equal.

- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
  - 1. Material: Cast metal or sheet metal.
  - 2. Type: Fully adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
  - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- N. Gangable boxes are allowed.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Fiberglass.
  - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

## P. Cabinets:

1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

## A. General Requirements for Handholes and Boxes:

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

## B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

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

## 2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

## A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

### PART 3 - EXECUTION

#### 3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC.
3. Underground Conduit: RNC, Type EPC-40-PVC,.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R, unless otherwise noted.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: GRC.
2. Exposed, Not Subject to Severe Physical Damage: GRC.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
  - a. Loading dock.
  - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
  - c. Mechanical rooms.
  - d. Gymnasiums.
4. Concealed in Ceilings and Interior Walls and Partitions: GRC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.



3. EMT: Use setscrew, cast-metal fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
  - F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
  - G. Install surface raceways only where indicated on Drawings.
  - H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. All vertical turnups from underground raceways shall utilize GRC sweep 90-degree radius bends and GRC vertical conduit. The Vertical portion of the conduit shall be coated or wrapped in a bitumastic coating system from below grade to 6 inches above grade.
- J. Stub-ups to Above Recessed Ceilings:
  1. Use GRC for raceways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.

- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
  2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.6 PROTECTION

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

END OF SECTION 26 05 33

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**SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY****A. Section Includes:**

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

**1.3 ACTION SUBMITTALS****A. Product Data:** For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

**B. Samples:** For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.**C. Identification Schedule:** For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.**D. Delegated-Design Submittal:** For arc-flash hazard study.**PART 2 - PRODUCTS****2.1 PERFORMANCE REQUIREMENTS**

- A. Comply with ASME A13.1.

- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and Section 26 05 74 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

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



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

D. Warning Label Colors:

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

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

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

## 2.3 LABELS

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

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

## 2.4 BANDS AND TUBES

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

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

## 2.5 TAPES AND STENCILS

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

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

**2.6 TAGS**

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

**2.7 SIGNS**

- A. Metal-Backed Butyrate Signs:

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

## 2.8 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Marking Services, Inc.
  2. Panduit Corp.
  3. Or Approved Equal.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.

## 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

### 3.2 INSTALLATION

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

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

## Y. Nonmetallic Preprinted Tags:

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

## Z. Write-on Tags:

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

## AA. Baked-Enamel Signs:

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

## BB. Metal-Backed Butyrate Signs:

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

## CC. Laminated Acrylic or Melamine Plastic Signs:

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

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

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

## 3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch-high, black letters on 20-inch centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot maximum intervals.
- D. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
  2. "POWER."
  3. "UPS."
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- J. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- K. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- L. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- M. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
  2. Wall surfaces directly external to raceways concealed within wall.



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

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

END OF SECTION 26 05 53

**SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
  - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 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.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control reports.

- D. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

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

#### 1.6 QUALITY ASSURANCE

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

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity to prevent rusting of materials during storage.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

- A. Square D
- B. EATON
- C. General Electric
- D. Or Approved Equal.

- 2.2 Source Limitations: Obtain each transformer type from single source from single manufacturer.

#### 2.3 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 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
  2. Coil Material: Copper.
- F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

## 2.4 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Totally enclosed, nonventilated.
1. NEMA 250, As shown on the plans: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
  2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Gray.
- F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.
- G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  2. Indicate value of K-factor on transformer nameplate.

3. Unit shall meet requirements of NEMA TP 1 when tested according to NEMA TP 2 with a K-factor equal to one.
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  2. Include special terminal for grounding the shield.
- M. Neutral: Rated 200 percent of full load current for K-factor rated transformers.
- N. Wall Brackets: Manufacturer's standard brackets.
- O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

## 2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

## 2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
  1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
  2. Ratio tests at the rated voltage connections and at all tap connections.
  3. Phase relation and polarity tests at the rated voltage connections.
  4. No load losses, and excitation current and rated voltage at the rated voltage connections.
  5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
  6. Applied and induced tensile tests.
  7. Regulation and efficiency at rated load and voltage.
  8. Insulation Resistance Tests:
    - a. High-voltage to ground.
    - b. Low-voltage to ground.
    - c. High-voltage to low-voltage.
  9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

**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.
  - 2. Brace wall-mounted transformers as specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 03 30 00 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, 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.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

- F. Remove shipping bolts, blocking, and wedges.

### 3.3 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. 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.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- F. Remove and replace units that do not pass tests or inspections and retest as specified above.
- G. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
  - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- H. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.



**3.5 ADJUSTING**

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

**3.6 CLEANING**

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Load centers.
  - 4. Electronic-grade panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. 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. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
  1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Keys: Two spares for each type of panelboard cabinet lock.
  2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
  3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

## 1.10 FIELD CONDITIONS

- A. Environmental Limitations:

- 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
  - b. Altitude: Not exceeding 6600 feet.

- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

- 1. Ambient temperatures within limits specified.
- 2. Altitude not exceeding 6600 feet.

- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

- 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
- 2. Do not proceed with interruption of electric service without Construction Manager's written permission.
- 3. Comply with NFPA 70E.

## 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment that fails in materials or workmanship within specified warranty period.

- 1. Warranty Period: 18 months from date of Substantial Completion.

- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
  1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  2. Height: 84 inches maximum.
  3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
  4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
  5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  7. Finishes:
    - a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel.
    - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

- G. Incoming Mains:
1. Location: Convertible between top and bottom.
  2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
    - a. Plating shall run entire length of bus.
    - b. Bus shall be fully rated the entire length.
  2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
  3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
  6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
  7. Split Bus: Vertical buses divided into individual vertical sections.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Terminations shall allow use of 75 deg C rated conductors without derating.
  3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
  5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
  6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
  9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring,

connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

- K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
  - 1. Percentage of Future Space Capacity: Ten percent.
- L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
  - 1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
  - 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

**2.2 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

**2.3 POWER PANELBOARDS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. SIEMENS Industry, Inc.; Energy Management Division.
  - 2. Square D; by Schneider Electric.
  - 3. EATON.
  - 4. Or Approved Equal.

- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: As indicated on plans.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Overcurrent Protective Devices: Fused switches.
- H. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
  - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

#### 2.4 LOAD CENTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. SIEMENS Industry, Inc.; Energy Management Division.
  - 2. Square D; by Schneider Electric.
  - 3. EATON.
  - 4. Or Approved Equal.
- B. Load Centers: Comply with UL 67.
- C. Mains: Circuit breaker or lugs only, as indicated on plans.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

#### 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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



1. SIEMENS Industry, Inc.; Energy Management Division.
  2. Square D; by Schneider Electric.
  3. EATON.
  4. Or Approved Equal.
- 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 shall be recorded with type, phase, and magnitude of fault that caused the 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) Ground-fault pickup level, time delay, and I squared T response.
  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. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
  7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  8. Subfeed Circuit Breakers: Vertically mounted.
  9. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Breaker handle indicates tripped status.
    - c. UL listed for reverse connection without restrictive line or load ratings.
    - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

- g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
  - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
  - i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
  - j. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
  - k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
  - l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
  - n. Multipole units enclosed in a single housing with a single handle.
  - o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
  - p. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 26 28 13 "Fuses."
  - 2. Fused Switch Features and Accessories:
    - a. Standard ampere ratings and number of poles.
    - b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
    - c. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

**2.6 IDENTIFICATION**

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## 2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
  1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
  2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

3. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- G. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box.
- I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- J. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.
  1. Set field-adjustable, circuit-breaker trip ranges.
  2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- L. 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.
- M. Install filler plates in unused spaces.
- N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- P. Mount spare fuse cabinet in accessible location.

### 3.3 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. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. 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.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.

- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
  - 1. Measure loads during period of normal facility operations.
  - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
  - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

### 3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

**SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section includes separately enclosed, preassembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

**1.3 DEFINITIONS**

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. NC: Normally closed.
- G. NO: Normally open.
- H. OCPD: Overcurrent protective device.
- I. PID: Control action, proportional plus integral plus derivative.
- J. RFI: Radio-frequency interference.
- K. VFD: Variable-frequency Drive.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type and rating of VFD indicated.
  - 1. Include dimensions and finishes for VFDs.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For each VFD indicated.
  - 1. Include mounting and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Required working clearances and required area above and around VFDs.
  - 2. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements.
  - 3. Show support locations, type of support, and weight on each support.
  - 4. Indicate field measurements.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Certificates: For each VFD, accessories, and components, from manufacturer.
  - 1. Certificate of compliance.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.
- D. Product Certificates: For each VFD from manufacturer.
- E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:



- a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
- b. Manufacturer's written instructions for setting field-adjustable overload relays.
- c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
- d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
- e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
- f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  3. Indicating Lights: Two of each type and color installed.
  4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
  5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

### 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

**1.10 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; by Schneider Electric
  - 2. EATON
  - 3. Allen-Bradley

**2.2 SYSTEM DESCRIPTION**

- A. General Requirements for VFDs:
  - 1. VFDs 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: Constant torque and variable torque.
- C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs 6-pulse-width-modulated inverter and active front end, factory built and tested in an enclosure, with integral disconnecting means, a start-rated bypass reduced voltage-solid state starter, output motor protection filter, 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, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
  - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
  - 3. 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 15 percent of VFD input voltage rating.
  2. Input AC Voltage Unbalance: Not exceeding 5 percent.
  3. Input Frequency Tolerance: Plus or minus 3 percent of VFD 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: 65 kA.
  7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 122 deg F.
  8. Humidity Rating: Less than 95 percent (noncondensing).
  9. Altitude Rating: Not exceeding 3300 feet.
  10. Vibration Withstand: Comply with NEMA ICS 61800-2.
  11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
  13. Speed Regulation: Plus or minus 5 percent.
  14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
  15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFDs 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.
- J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFD, 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. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD 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 VFD 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: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
  2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
  3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
  4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
  5. NC alarm contact that operates only when circuit breaker has tripped.

## 2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFDs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFDs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 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 three levels 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 VFD, local automatic control at VFD, 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 mounted flush in VFD door and connected to display VFD 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: 4- to 20-mA dc.
    - b. A minimum of six multifunction programmable digital inputs.
  2. Pneumatic Input Signal Interface: 3 to 15 psig.

3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the SCADA system:
    - a. 0- to 10-V dc.
    - b. 4- to 20-mA dc.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
  4. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA 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).
  5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - a. Motor running.
    - b. Set point speed reached.
    - c. Fault and warning indication (overtemperature or overcurrent).
    - d. PID high- or low-speed limits reached.
  6. EthernetIP Communications protocol shall be utilized with an Ethernet communications port to relay all available information from the VFD to the SCADA system.
- 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 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: VFD shall be 6-pulse with Active Front End filtering, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

## 2.6 OPTIONAL FEATURES

- A. Multiple-Motor Capability: VFD suitable for variable-speed service to multiple motors. Overload protection shuts down VFD and motors served by it, and generates fault indications when overload protection activates.
  1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.

2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
  3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.
- B. Damper control circuit with end-of-travel feedback capability.
  - C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFD resumes normal operation.
  - D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
  - E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
  - F. Remote digital operator kit.
  - G. Communication Port: Ethernet port, or equivalent connection capable of connecting a printer.

## 2.7 ENCLOSURES

- A. VFD Enclosures: NEMA 1

## 2.8 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.
  1. Push Buttons: Covered.
  2. Pilot Lights: Push to test.
  3. Selector Switches: Rotary type.
  4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- C. 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.
- D. 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.

- E. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R or Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with composite intake and exhaust grills; 120-V ac; obtained from integral CPT.
- G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- H. Spare control-wiring terminal blocks; unwired.

## 2.9 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
  - 1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
  - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.
- B. VFDs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 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. Floor-Mounting Controllers: Install VFDs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible-switch VFD.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 28 13 "Fuses."
- F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Comply with NECA 1.

### 3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs 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.
- C. Connect selector switches and other automatic-control devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
  - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

**3.4 IDENTIFICATION**

- A. Identify VFDs, 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 VFD with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

**3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- E. Tests and Inspections:
  - 1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager 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. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFD. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFD 11 months after date of Substantial Completion.
  - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. VFDs will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.7 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 Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable pressure switches.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 26 29 23

## SECTION 26 43 13 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Requirements:
  - 1. Section 26 24 16 "Panelboards" for factory-installed SPDs.

## 1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

#### 1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs 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 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

#### 2.2 PANEL SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Surge Suppression Incorporated.
  2. Eaton.
  3. Schneider Electric
  4. Or Approved Equal.
- B. SPDs: Comply with UL 1449, Type 1.

1. Include LED indicator lights for power and protection status.
  2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Comply with UL 1283.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
  2. Line to Ground: 1200 V for 480Y/277 V.
  3. Neutral to Ground: 1200 V for 480Y/277 V.
  4. Line to Line: 2000 V for 480Y/277 V
- F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V.
  2. Line to Ground: 700 V.
  3. Neutral to Ground: 700 V.
  4. Line to Line: 1200 V.
- G. SCCR: Equal or exceed 200 kA.
- H. Inominal Rating: 20 kA.
- 2.3 ENCLOSURES
- A. Indoor Enclosures: NEMA 250, Type 1.
  - B. Outdoor Enclosures: NEMA 250, Type 4X.
- 2.4 CONDUCTORS AND CABLES
- A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
  - B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
  - C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install SPD's in the following locations:
  - 1. Service entrance equipment
  - 2. Motor Control Centers
  - 3. Control Panels
  - 4. Distribution Panelboards and Switchboards
  - 5. All locations indicated on the plans.
- C. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- D. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- E. Use crimped connectors and splices only. Wire nuts are unacceptable.
- F. Wiring:
  - 1. Power Wiring: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
  - 2. Controls: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

## 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

## 3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.



- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

**SECTION 26 47 00 - ELECTRICAL EQUIPMENT CENTER**

**PART 1 - GENERAL**

**1.1 RELATED SECTIONS**

- A. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- B. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

**1.2 SUMMARY**

- A. Section Includes:
  - a. Pre-fabricated, operation ready electrical equipment centers.

**1.3 SUBMITTALS**

- A. Submit under provisions of Section 01 33 00.
- B. Customer-provided information: Customer to provide the following information for the supplied electrical equipment prior to start of design.
  - a. Equipment voltage.
  - b. Equipment type.
  - c. Equipment dimensions.
  - d. Equipment weights.
  - e. Equipment heat loss.
  - f. Power cabling requirements.
  - g. Control wiring requirements.
  - h. Penetration requirements:
    - Floor.
    - Wall.
    - Roof.
  - i. Product Data: Manufacturer's data sheets on each product to be used, including:
    - Maintenance manuals and instructions.

- C. Equipment Center manufacturer-provided information:
  - a. Approval drawings: Structural, electrical and mechanical drawings shall be submitted for approval. Approval drawings shall be placed on the manufacturer's FTP site and an e-mail notification shall be sent to purchasing and approving authorities for review. Alternatively a (1) data DVD or CD with all drawing files in electronic format or two hard copies on 11 inches by 17 inches (279 mm by 432 mm) or larger medium shall be sent to the approving authorities. Complete HVAC calculations shall be submitted with approval drawings for review.
  - b. As-built drawings: Structural, electrical and mechanical drawings shall be submitted as "Certified as-built" upon completion. As built drawings shall be placed on the manufacturer's FTP site and an e-mail notification shall be sent to approving and purchasing authorities. Alternatively a (1) data DVD or CD with all drawing files in electronic format or two hard copies on 11 inches by 17 inches (279 mm by 432 mm) or larger medium shall be sent to the approving authorities.

#### 1.4 SYSTEM DESCRIPTION

- A. General:
  - a. Equipment Center shall be designed and constructed by an approved manufacturer as listed below.
  - b. Provide a NEMA 3R Equipment Center structure with exterior walls and roof fabricated from interlocking panels to house and protect the internal equipment from the elements.
  - c. Structural grid base and floor system shall be designed for applicable floor loading allowing the Equipment Center to be lifted and transported with the interior equipment installed.
- B. Design and construction shall conform to the applicable sections of the latest standards as issued by the following agencies, as a minimum:
  - a. International Building Code (IBC): Default Structural loading criteria shall be per the IBC.
  - b. American National Standards Institute (ANSI).
  - c. American Society of Civil Engineers (ASCE).
  - d. American Institute of Steel Construction (AISC).
  - e. American Iron and Steel Institute (AISI) - Specification for the Design of Cold Formed Steel Structural Members).
  - f. Metal Building Manufacturers Association (MBMA).
  - g. American Society for Testing and Material (ASTM).
  - h. American Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE).

- i. National Electric Manufacturers Association (NEMA).
  - j. National Electric Code (NEC).
  - k. National Fire Protection Association (NFPA)
  - l. Steel Door Institute (SDI).
- C. Structural Performance:
- a. The Equipment Center shall be designed and constructed to withstand external loading conditions as prescribed by the International Building Code for the specified final location.
  - b. Building components shall be designed to withstand external loading as prescribed by the applicable codes as a minimum, with co-lateral considerations as follows:

Base and floor system shall be designed to withstand all dead and live loads as applicable, or, a minimum of 250 lb/sf (1220 kg/sm) over the entire floor area, while supported at indicated minimum support locations only.

Maximum deflection of all base members shall not exceed  $L/240$  with all applicable dead and live loads applied.

Roof loading: Per International Building Code (30 lb/sf (146 kg/sm) minimum).

Wind loading: Per International Building Code - Exposure C minimum

Seismic: Per International Building Code.

Interior walls: Interior walls shall be capable of mounting and supporting 400 lb/lf (595 kg/m) and 200 ft-lbs (28 kg-meters) of moment / torque at any place along the perimeter wall space, with attachment to the interlocking ribs, or metal studs, located on 16 inches (406 mm) centers behind interior walls.

Each shipping piece shall be designed for lifting by lugs located along the base perimeter members at 15 feet (4.5 m) approximate intervals.

All lifting lugs shall be removable.

The ceiling shall be capable of withstanding a single continuous load of 100 lb/lf (149 kg/meter) located at mid span of the ceiling panels, and running the entire building length. The ceiling panels shall act alone, structurally, and not depend on the roof or the interior equipment for support.

All shipping splits and other penetrations shall have adequate structural reinforcement via rigid frames or other means to minimize distortion during handling and transportation.

- D. Certifications:

- a. The Equipment Center shall be certified by a Nationally Recognized Testing Laboratory (NRTL) as conforming to the NEC (National Electric Code), and shall bear a label from the NRTL stating compliance.
- b. If required by the owner, the Equipment Center design shall be accomplished under the auspices of a Professional Engineer and drawings and supporting calculations will bear the Professional Engineer's seal.

## 1.5 REFERENCES

- A. ANSI C80.1 – Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI/SDI 100 – Recommended Specifications for Standard Steel Doors and Frames.
- C. ASTM A 36 – Standard Specification for Carbon Structural Steel
- D. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- E. ASTM A 572/572M – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- F. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- G. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- H. ASTM A53/A53M: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- I. ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
- J. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- K. ASTM A490 Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
- L. ASTM A653 / A653M-11 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- M. ASTM A992/A992M Standard Specification for Structural Steel Shapes
- N. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
- O. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
- P. Federal Specifications (Fed. Spec.) - TT-C-520B - Coating Compounds, Bituminous, Solvent Type, Underbody.

- Q. IEEE C37.2.2 – Guide for Protective Relay Applications to Power System Buses.
- R. National Electrical Manufacturers Association (NEMA) 250 – Enclosures for Electrical Equipment (1000 V Maximum).
- S. National Fire Protection Association (NFPA) 496: Standard for Purged and Pressurized Enclosures for Electrical Equipment.
- T. NEC - National Electric Code.
- U. Steel Structure Painting Council (SSPC) SP 3 - Surface Preparation Standards and Specifications (Power Tool Cleaning).
- V. Steel Structure Painting Council (SSPC) SP 1 - Surface Preparation Standards and Specifications (Solvent Cleaning).
- W. Underwriters Laboratories Inc. (UL) 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations
- X. Underwriters Laboratories Inc. (UL) 508 - Industrial Control Equipment.

## 1.6 WARRANTY

- A. All materials and workmanship shall be guaranteed by manufacturer (parts and labor) for a period of one year following shipment of the Equipment Center.
- B. Equipment Center shall be guaranteed for coating adhesion and integrity per ASTM Standards under normal ambient and operating conditions for a period of one year following shipment.
- C. Equipment Center shall be guaranteed for leak resistance per NEMA 3R Standards for a period of one year following shipment.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Schneider Electric
- B. Lord & Company
- C. Eaton
- D. Heyward
- E. Siemens
- F. AZZ, Inc.
- G. Or Approved Equal.

## 2.2 FABRICATION

- A. All facets of construction through coating and weatherproofing shall be performed indoors, protected from outdoor weather conditions. Construction prior to this stage out-of-doors is not acceptable.
- B. At shipping splits (when required due to transportation restrictions), each open area shall be sealed with 2 inches (52 mm) thick wooden framing and a complete OSB wood cover for temporary protection during transportation and setting. Seams in OSB wood shall be liberally caulked at the exterior.
- C. All permanent coatings and finishes shall be applied inside a dedicated paint booth with ventilation and filtration provisions in compliance with the coating manufacturer's requirements. Coatings applied in outside, ambient air conditions shall not be acceptable.

## 2.3 MATERIALS AND CONSTRUCTION

- A. Base members shall be ASTM A572 wide flange, ASTM A36 channel, angle and tube shapes forming a self-supporting grid. All members shall be continuously welded to adjoining members.
- B. Floor shall be 1/4 inch (6 mm) minimum thickness flat ASTM A36 steel plate, welded to all longitudinal and transverse base members.
  - a. Floor plate seams shall be continuously welded at all joints, and ground smooth to minimize visibility of seams. Welding of floor plate shall be staggered to produce a flat and ripple free surface.
- C. Exterior walls shall be 18ga (1.214 mm) (minimum) G90 galvanized sheet steel interlocking panels formed by computer numerical controlled equipment to create a tightly interlocking panel design, nominally 3 inches (76 mm) deep. Interlocking panel ribs shall repeat at a typical maximum nominal dimension of 16 inches (406 mm).
- D. Following assembly (and coating) of all interlocking wall panels, each exterior seam shall be neatly caulked using a high-modulus, silicone base product.
- E. Roof material shall be 18ga (1.214 mm) (minimum) G90 galvanized sheet steel interlocking panels formed by computer numerical controlled equipment to create a tightly interlocking panel design with vertical standing ribs.
- F. Interior walls shall be 18ga (1.214 mm) (minimum) G90 galvanized sheet steel firmly attached to interlocking ribs of exterior wall panels utilizing ASTM shear and pull out rated self tapping screws on 24 inches (610 mm) maximum centers. Each interior wall panel shall be formed to receive adjacent panels at overlaps.
- G. Ceiling panels shall be 18ga (1.214 mm) (minimum) G90 galvanized sheet steel interlocking panels formed by computer numerical controlled equipment to create a tightly interlocking panel design with vertical standing ribs.
- H. Wall insulation shall be secured to exterior wall panels by glue pins, straps or other means prior to assembly of interior wall (liner) panels. Ceiling insulation shall be laid between interlocking ceiling panels. Floor insulation shall be sprayed urethane foam.

- I. Insulation levels:
  - a. Ceiling: Fiberglass batt (R15).
  - b. Walls: Fiberglass batt (R15).
  - c. Floor: 1 inch (25 mm) Spray Applied Polyurethane insulation (R6).
  - d. Equipment Access Doors: 1 inch (25 mm) urethane board (R 7.2) with welded metal cover.
  - e. Personnel Doors: (R2.4).
- J. The entire roof perimeter shall be trimmed with a fascia that aesthetically hides the standing rib roof edges, prevents high velocity rainwater run-off, and prevents built-up ice from sliding off the roof in large sheets.
- K. All permanent components shall consist of materials that do not freely support combustion. Use of wood or any other materials that freely support combustion shall not be allowed as permanent components.

#### 2.4 PERSONNEL AND EQUIPMENT ACCESS DOORS

- A. Personnel Doors and Equipment Access Doors: #4080 Single leaf, double wall, honeycomb reinforced personnel double door, galvanized, #18ga (1.214 mm), 1-3/4 inches (44 mm) thick.
  - a. Button Type Aluminum Panic thumb latch w/ keyed cylinder lock (Magnokrom #N1550-5XOT53-US28).
  - b. Closer w/ stopping arm (Yale series #50).
  - c. Wind safety chain.
  - d. Drip shield.
  - e. Threshold: Aluminum.
  - f. Factory frame.
  - g. Caps in top.
  - h. Weather stripping.
  - i. Stainless steel hinges.
  - j. R2.4 thermal resistance rating.
  - k. Fire resistance rating and label (1.5 hour minimum rating).

#### 2.5 FINISH



- A. All coatings shall be applied using an electrostatic application process as indicated.
- B. All exterior and interior surfaces shall be thoroughly cleaned prior to coating application per the coating manufacturer's recommended practice.
- C. Exterior surfaces:
- a. Cleaning:  
  
Clean exterior base surface to SSPC-SP3 (Power Tool Cleaning).  
  
Clean all other surfaces to SSPC-SP1 (Solvent Cleaning).
  - b. Primer:  
  
Base: Apply epoxy mastic primer 2.0 Mils (0.05 mm) dry film thickness (DFT).  
  
Walls, Roof and Fascia: Apply epoxy primer 1.5 Mils (0.04 mm) DFT.
  - c. Finish: Apply DuPont Imron 3.5HG high solids polyurethane enamel 1.8 Mils (0.045 mm) DFT.
  - d. Field Touch-up Paint: One quart (ships inside structure).
- D. Interior surfaces:
- a. Cleaning: Clean all surfaces to SSPC-SP1 (Solvent Cleaning).
  - b. Primer: Apply epoxy primer 1.5 Mils DFT\*\*.
  - c. Finish: Apply DuPont Imron 3.5HG high solids polyurethane enamel 1.8 Mils (0.045 mm) DFT\*\*
  - d. Field Touch-up Paint: One quart (ships inside structure).
- E. Floor (Top Side):
- a. Cleaning: Clean all surfaces to SSPC-SP1 (Solvent Cleaning).
  - b. Primer: Apply epoxy mastic primer 1.5 Mils DFT\*.
  - c. Finish: Apply DuPont Imron 3.5HG high solids polyurethane enamel 1.8 Mils (0.045 mm) DFT\* with non-skid additive.
  - d. Field Touch-up Paint: One quart (Ships inside structure).
- F. Base and Floor (Underside):
- a. Cleaning:  
  
Clean all surfaces to SSPC-SP3 (Power Tool Cleaning).

Clean to remove oil, dirt, water, and loose rust.

- b. Undercoat: Apply Transcoat #101 10 Mils (0.025 mm) DFT.

VOC: 0.0 g/l.

Federal Specification TT-C-520B.

Asbestos Free.

Flame Spread Rating: 0.

- G. All wall mounted HVAC units shall be painted the same color as the Equipment Center exterior walls.

## 2.6 ELECTRICAL UTILITIES

- A. Conduit:

a. Interior Conduit: As required by the specifications.

b. Exterior Conduit: As required by the specifications.

- B. All utilities shall be UL listed and recognized devices.

- C. All utilities shall be functionally tested prior to completion.

- D. Interior Lights: LED, 120V lighting to meet all applicable standards and as specified in section 26 51 19.

- E. Exterior lights: 120V LED wall pack egress and exterior lighting (as shown on the plans with a minimum one light on each side of building and one at each entry point) with integral photocell and as specified in section 26 51 19 and section 26 56 19.

- F. Light Switch:

a. Provide one switch for each lighting circuit at each entry point into the equipment center and as specified in section 26 27 26.

- G. Duplex Receptacles: Provide a minimum of 4 receptacles inside the equipment center and one receptacle on each exterior wall, each with an extra-duty in-use weatherproof cover and as specified in section 26 27 26.

- H. Wire Type: "THHN".

a. Power Wiring: #12 AWG minimum (sized as required for load).

- I. Grounding:

a. Ground Pads: 4-hole Stainless Steel Welded to base.

b. 2-Hole Copper Ground Lug #4/0.

- J. HVAC:
- a. Provide an HVAC system, including a redundant HVAC unit and lead-lag thermostat, for the equipment center that is sized to accommodate the heat load of all of the equipment being installed inside of the equipment center (as shown on the plans and including future equipment shown on the plans) while maintaining a maximum 85 degree F temperature inside of the equipment center. Coordinate with all necessary equipment manufacturers to accomplish the heat load calculations and provide them with the submittal material. Show location and routing of drain lines for HVAC unit(s) on the submittal drawings as well.
  - b. The unit shall be capable of operating at 208V, 3phase.

## 2.7 ACCESSORIES

- A. Removable Lift Lugs: Spaced along base length at approximate 15 feet (4.6 m) centers per shipping piece.
- B. Removable End Wall: Provide demountable end wall across the entire width to allow for future expansion of equipment and aisle. Main structural reinforcing post located in the removable wall may remain following expansion; however, it shall be located not to interfere with the equipment line-up extension.
- C. Floor Cutouts: Under equipment for cable entry and exit from below floor with gasketed 12ga (1.214 mm) galvanized top cover plates attached to the floor by screws.
- D. Wall penetrations as required.

## 2.8 EQUIPMENT LIST TO BE INSTALLED IN BUILDING PACKAGE

- A. New 400HP high service pump VFD with SMC bypass & active filtering to meet IEEE 519 requirements.
- B. Existing, relocated, 200HP VFD (To be relocated and installed in the field by the electrical contractor)
- C. New 30kVA(minimum, upsize as required), 480V-120/208V, 3 $\Phi$ , 4W dry-type transformer
- D. New 200A (minimum, sized as required), 120/208V, 3 $\Phi$ , 4W panelboard with MCB.
- E. Surge protection for new VFD and Panel B, as required.
- F. New remote I/O panel for SCADA monitoring and communications (By others, installed in the field)
- G. General lighting (interior & exterior), receptacles, HVAC, etc.

## 2.9 FACTORY TESTING

- A. Finish: The following minimum finish system test results shall be certified (from in process, manufacturer's samples) by independent laboratory tests performed under ASTM criteria. Copies of the test results and certification shall be submitted for review:

- a. Substrate: Prepared G90 galvanized sheet: Corrosion Resistance (Salt spray): Passes 2500 hours per ASTM B117.
- B. Control systems: As recommended by the manufacturer.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Do not begin installation until supporting foundation or building pad has been properly prepared and inspected by an authorized manufacturer's representative.
- B. If building pad preparation is the responsibility of another installer, notify owner, engineer or architect of unsatisfactory preparation before proceeding.

#### 3.2 PREPARATION

- A. Locate and verify utility services and structural foundation prior to installation.
- B. Prepare foundation using the methods recommended by the manufacturer.

#### 3.3 INSTALLATION

- A. Equipment Center shall be installed by the contractor as required by the manufacturer.

#### 3.4 PROTECTION

- A. Protect delivered units, accessories and installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 26 47 00

**Exhibit C – Sample Lien Waiver**

The undersigned hereby acknowledge that the amount of

\_\_\_\_\_

was received from

\_\_\_\_\_

The Owner

as Payment for the following goods and/or services:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

delivered to the property described as:

\_\_\_\_\_

The undersigned hereby waives the right to assert a lien and release any lien against the owner to this extent only. This lien waiver does not affect the right of the undersigned to recover payment for any other goods or services supplied before or after this release date not compensated by the progress payment or any rights which the undersigned may have by contract.

\_\_\_\_\_

Title and Name of Claimant

\_\_\_\_\_

\_\_\_\_\_

Company Details

\_\_\_\_\_

Signature

\_\_\_\_\_

Date

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_  
E-mail address: \_\_\_\_\_

A Joint Venture

First Joint Venturer Name: \_\_\_\_\_ (SEAL)

By: \_\_\_\_\_  
*(Signature - attach evidence of authority to sign)*

Name (typed or printed): \_\_\_\_\_

Title: \_\_\_\_\_

Business address: \_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

E-mail address: \_\_\_\_\_

Second Joint Venturer Name: \_\_\_\_\_ (SEAL)

By: \_\_\_\_\_  
*(Signature - attach evidence of authority to sign)*

Name (typed or printed): \_\_\_\_\_

Title: \_\_\_\_\_

Business address: \_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

E-mail address: \_\_\_\_\_

Phone and Facsimile Number, and Address for receipt of official communications to Joint  
Venture: \_\_\_\_\_

(Each joint venturer must sign. The manner of signing for each individual, partnership,  
corporation, and limited liability company that is a party to the joint venture should be in the  
manner indicated above.)

**GMC**

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