

**The Philadelphia Parking Authority  
701 Market Street, Suite 5400  
Philadelphia, PA 19106**

**Bid No. 19-10**

**Parking Access and Revenue Control Equipment – Center City Garages  
Addendum One**

To: See Email Distribution List

From: Mary Wheeler  
Manager of Contract Administration

Date: November 13, 2019

No Pages: 2 plus attachments

This addendum is issued on November 13, 2019 prior to the bid due date to add, delete, modify, clarify and/or to respond to questions submitted by prospective offerors regarding the work included in the above referenced solicitation.

**ADDITIONAL INFORMATION**

1. In your RFP documents, please replace the existing Appendix A with the attached Appendix A.
2. Please add Appendix D, Electrical and Communications Specifications, to your RFP document.
3. The due date has been extended to Friday, December 20, 2019 by 2:30 PM.

**QUESTIONS**

1. **Question:** Line 1.4, reference to integrating, are you looking to replace Great Plains with a stand-alone account receivable program, or are you looking to integrate into Great Plains with an active card file?  
**Response:** System should be able to provide a file, excel or CSV that can be imported into the general ledger.
2. **Question:** Traditionally the owner would provide a file transfer that we would just receive and then auto populate to our data base. Is that what you're looking for?  
**Response:** System should be able to provide a file, excel or CSV that can be imported into the general ledger.
3. **Question:** Regarding License Plate Recognition, is the awarded contractor required for the civil work for that portion if it is required per lane?  
**Response:** Yes. However, a separate detail proposal is required.
4. **Question:** So, separate server in each garage?  
**Response:** Yes.

5. **Question:** Is the intent to go enterprise? Have one central server location?

**Response:** No.

6. **Question:** Each garage has its own internet connection provided by the city, right?

**Response:** Yes.

7. **Question:** In reference to a firewall, are we to provide the firewall between our hardware locally at the location communicating to your network, or do you provide a firewall and we work with getting our equipment on your network with you providing and configuring that firewall?

**Response:** The Authority will provide the firewall.

8. **Question:** Do you want the License Plate Recognition portion as an alternate or part of the base bid?

**Response:** Alternate.

9. **Question:** Regarding License Plate Recognition, with the civil piece, is that to be union or prevailing wage?

**Response:** Prevailing wage and benefits with a certified apprenticeship program.

10. **Question:** The RFP states that the POF needs to accept coin payments. Is coin acceptance a requirement or an option?

**Response:** Coin acceptance is a requirement.

11. **Question:** Has an extension for the due date been requested? If not, we are requesting that the RFP due date be extended by two weeks.

**Response:** The Authority will grant an extension, please see additional informational section above.

**END OF ADDENDUM ONE**

**THE PHILADELPHIA PARKING AUTHORITY  
701 MARKET STREET – SUITE 5400  
PHILADELPHIA, PA 19106**

**RFP No. 19-10  
PARKING ACCESS AND REVENUE CONTROL SYSTEM FOR CENTER CITY GARAGES**

**PROPOSAL FORM**

1. The undersigned submits this proposal in response to the above referenced RFP No. 19-10 Parking Access and Revenue Control System, being familiar with and understanding the advertised notice of opportunity, Instructions, Work Statement, Proposal Form, Affidavit of Non-Collusion, and Addenda if any (the "Proposal Documents"), as prepared by the Philadelphia Parking Authority and posted on the Authority's Internet website and on file in the office of the Authority at 701 Market Street, Suite 5400, Philadelphia, PA 19106. The party submitting a proposal is the "Offeror".
  
2. The Authority reserves the right to withdraw and cancel this RFP prior to opening or to reject any and all proposals after proposals are opened if in the best interest of the Authority, in the Authority's sole discretion. If the Authority accepts Offeror's offer, Offeror agrees to execute a contract memorializing the proposal's terms if the contract is delivered to Offeror within 60 days of the proposal opening date. This provision will not be interpreted to preclude the execution of a contract related to this proposal outside of that 60 day period.
  
3. Offeror acknowledges receipt of the following addenda:

Addendum Number	Date Received
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

4. **Cost Form:** Offeror may include additional goods or services in the unit cost that are not listed below.

**A. Autopark at Old City - Total cost for PARCS replacement\_\_\_\_\_**

The total cost will be inclusive of all hardware, software and system functions described in the Work Statement along with the following:

- Removal and disposal of existing equipment
- Installation
- Facility to house the equipment during testing
- Server Equipment
- License Cost
- Spare parts
- Initial Warranty

**Replacement Parts:** Identify any parts or tools that may need to be purchased throughout the lifecycle of the system. Offerors should add additional line items below as warranted.

**REPLACEMENT PARTS LIST AND OTHER COSTS– PARCS**

	<b>Item Description</b>	<b>Unit Cost</b>
1		
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**B. Autopark at Independence Mall Garage - Total cost for PARCS replacement\_\_\_\_\_**

The total cost will be inclusive of all hardware, software and system functions described in the Work Statement along with the following:

- Removal and disposal of existing equipment
- Installation
- Facility to house the equipment during testing
- Server Equipment
- License Cost
- Spare parts
- Initial Warranty

**Replacement Parts:** Identify any parts or tools that may need to be purchased throughout the lifecycle of the system. Offerors should add additional line items below as warranted.

**REPLACEMENT PARTS LIST AND OTHER COSTS– PARCS**

	Item Description	Unit Cost
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**C. Parkade on 8th - Total cost for PARCS replacement\_\_\_\_\_**

The total cost will be inclusive of all hardware, software and system functions described in the Work Statement along with the following:

- Removal and disposal of existing equipment
- Installation
- Facility to house the equipment during testing
- Server Equipment
- License Cost
- Spare parts
- Initial Warranty

**Replacement Parts:** Identify any parts or tools that may need to be purchased throughout the lifecycle of the system. Offerors should add additional line items below as warranted.

**REPLACEMENT PARTS LIST AND OTHER COSTS– PARCS**

	Item Description	Unit Cost
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**D. Autopark at The Fashion District (Gallery Mall) - Total cost for PARCS replacement \_\_\_\_\_**

The total cost will be inclusive of all hardware, software and system functions described in the Work Statement along with the following:

- Removal and disposal of existing equipment
- Installation
- Facility to house the equipment during testing
- Server Equipment
- License Cost
- Spare parts
- Initial Warranty

**Replacement Parts:** Identify any parts or tools that may need to be purchased throughout the lifecycle of the system. Offerors should add additional line items below as warranted.

**REPLACEMENT PARTS LIST AND OTHER COSTS– PARCS**

	Item Description	Unit Cost
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**E. Autopark at Jefferson – Total cost for PARCS replacement \_\_\_\_\_**

The total cost will be inclusive of all hardware, software and system functions described in the Work Statement along with the following:

- Removal and disposal of existing equipment
- Installation
- Facility to house the equipment during testing
- Server Equipment
- License Cost
- Spare parts
- Initial Warranty

**Replacement Parts:** Identify any parts or tools that may need to be purchased throughout the lifecycle of the system. Offerors should add additional line items below as warranted.

**REPLACEMENT PARTS LIST AND OTHER COSTS– PARCS**

	Item Description	Unit Cost
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**F. The Family Courthouse Garage – Total cost for PARCS replacement \_\_\_\_\_**

The total cost will be inclusive of all hardware, software and system functions described in the Work Statement along with the following:

- Removal and disposal of existing equipment
- Installation
- Facility to house the equipment during testing
- Software License Cost
- Spare parts
- Initial Warranty

**Replacement Parts:** Identify any parts or tools that may need to be purchased throughout the lifecycle of the system. Offerors should add additional line items below as warranted.

**REPLACEMENT PARTS LIST AND OTHER COSTS– PARCS**

	<b>Item Description</b>	<b>Unit Cost</b>
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**G. Cost of Maintenance Agreement:**

	<b>YEARLY TOTAL</b>
<b>YEAR 3 THROUGH 5</b>	
<b>YEAR 6</b>	
<b>YEAR 7</b>	
<b>YEAR 8</b>	
<b>YEAR 9</b>	
<b>YEAR 10</b>	

**H. Unit Cost of Software License:** \_\_\_\_\_

**I. Gateway Fee (if applicable):** \_\_\_\_\_

5. **Requirement Statement:** The undersigned Offeror agrees to provide a Parking Access and Revenue Control System as specified in the Work Statement, any Addenda, if issued and the response submitted.

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Signature

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Name  
(Please Print)

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Title

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Date

**6. Offeror Signatures: Complete one section below.**

**If proposal is by a corporation, form must include the date and be signed here by (a) President or Vice President, and (b) Secretary, Assistant Secretary, Treasurer, Assistant Treasurer, or Officer and (c) a corporate seal must be affixed. If this form is not so signed, a corporate resolution authorizing form of execution must be attached to this proposal.**

_____ Signature	_____ Signature
_____ Typed or Printed Name	_____ Typed or Printed Name
_____ Title	_____ Title
_____ Business Name of Offeror	
_____ Street Address	_____ SEAL:
_____ City/State/ZIP Code	
_____ Telephone Number	_____ Date

**If offer is by a business entity other than a corporation form must be dated and signed here:**

_____ Authorized Signature	_____ Business Name of Offeror
_____ Typed or Printed Name	_____ Street Address
_____ Title	_____ City/State/ ZIP Code
_____ Date	_____ Telephone Number
_____ Type of Entity	

**7. Affidavit of Non-Collusion:**

State of: \_\_\_\_\_  
County of: \_\_\_\_\_

RFP No. \_\_\_\_\_

I state that I am \_\_\_\_\_ (Title) of \_\_\_\_\_ (Name of my organization) and that I am authorized to make this affidavit on behalf of my firm, and its owners, directors, and officers. I am the person responsible in my firm for the price(s) and the amount of this proposal and I have placed my signature below.

I state that:

(1) The price(s) and amount of this proposal have been arrived at independently and without consultation, communication or agreement with any other contractor, Offeror or potential Offeror.

(2) Neither the price(s) nor the amount of this proposal, and neither the terms nor the approximate price(s) nor approximate amount of this proposal, have been disclosed to any other firm or person who is a Offeror or potential Offeror, and they will not be disclosed before proposal opening.

(3) No attempt has been made or will be made to induce any firm or person to refrain from submitting a proposal in response to this Proposal, or to submit a proposal higher than this proposal, or to submit any intentionally high or noncompetitive proposal or other form of complementary proposal.

(4) The proposal of my organization is made in good faith and not pursuant to any agreement or discussion with, or inducement from, any firm or person to submit a complementary or other noncompetitive proposal. I have read, understand and will abide by the Authority's Contractor Integrity Provisions.

(5) \_\_\_\_\_ (my organization's name) its affiliates, subsidiaries, officers, directors and employees are not currently under investigation by any governmental agency and have not in the last four years been convicted or found liable for any act prohibited by State or Federal law in any jurisdiction, involving conspiracy or collusion with respect to bidding on any public contract, except as follows:

I state that \_\_\_\_\_ (my organization's name) understands and acknowledges that the above representations are material and important and will be relied on by The Philadelphia Parking Authority when awarding the contract for which this proposal is submitted. I understand and my organization understands that any misstatement in this affidavit is and shall be treated as fraudulent concealment from The Philadelphia Parking Authority of the true facts relating to the submission of proposals / proposals for this contract.

SWORN TO AND SUBSCRIBED  
BEFORE ME THIS \_\_\_\_ DAY  
OF 20 \_\_\_\_

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Notary Public  
My Commission Expires: \_\_\_\_\_

**8. Qualifications:**

- a. **Type of business:** Individually owned   
*Check one* Partnership   
Corporation   
Other

- b. **Number of employees:** Under 25   
*Check one* Under 50   
Under 100   
Over 100

c. **If you have had previous contracts with the Authority, list date and product or service provided:**

i. ....

ii. ....

iii. ....

d. **Philadelphia Business Activities License Number:** \_\_\_\_\_

e. **Federal EIN Number:** \_\_\_\_\_

## 9. Certified Apprenticeship Program Participation

For all applicable work, Offeror or subcontractor must be currently participating in an approved Apprenticeship Program which is currently registered with the U.S. Department of Labor or a state apprenticeship agency for each craft or trade that will be engaged in the Work. Bidders shall employ apprentices whose training and employment are in full compliance with the Apprenticeship and Training Act, approved July 14, 1961.

- 1) Does Offeror or subcontractor participate in an approved Apprenticeship Program which is currently registered with the U.S. Department of Labor or a state apprenticeship agency for each craft or trade that will be engaged in the Work? (Attach appropriate documents evidencing participation and enrollment in Apprenticeship Program[s])

Yes       No

- 2) Is Offeror or subcontractor a signatory to a collective bargaining agreement for each craft or trade that will be engaged in the Work? (Attach appropriate documents evidencing the relevant agreement[s])

Yes       No

**If the answer was "Yes" to questions 1 or 2, please answer question 3 (including sub-parts) below.**

- 3) Does Offeror or subcontractor, or its labor for each craft or trade, have apprentices and trainees currently participating in said Apprenticeship Program[s]?

Yes       No

- (a) If yes, has Offeror or subcontractor, or its labor for each craft or trade, graduated at least one (1) enrollee in each of the past three (3) years?

Yes       No

- (b) If yes, has Offeror or subcontractor (or its labor for each craft or trade) successfully graduated at least 75% of the program enrollees in each of the past three (3) years\*? (Graduation rate is calculated by dividing graduates in a calendar year by the number of enrollees in that year.)

Yes       No

The Undersigned hereby certifies that it participates, directly or through its labor for each craft or trade, in an approved Apprenticeship Program which is currently registered with the U.S. Department of Labor or a state apprenticeship agency for each craft or trade that will be engaged in the Work; that the attached documentation is true and correct proof of its current participation; and will continue to participate in applicable apprenticeship programs for each craft or trade for the full duration of the Work.

\_\_\_\_\_  
Authorized Signature

\_\_\_\_\_  
Print Name of Signer

\_\_\_\_\_  
Name of Company

\_\_\_\_\_  
Title of Signer

\_\_\_\_\_  
Date

**LIST OF SUBCONTRACTORS AND MATERIAL SUPPLIERS**

(copy page as needed)

Undersigned agrees, if notified of the acceptance of this bid, that he will utilize the following material suppliers, for the following noted types of work. No substitutions shall be made in the employment of material suppliers without written approval from the Authority. The undersigned acknowledges that the Philadelphia Parking Authority reserves the right to reject any material suppliers listed below after bids are opened at no additional cost to Authority.

SUBCONTRACTOR OR MATERIAL SUPPLIER		
Name:		
Type of Work:		
Phone:	Phone:	
Address:		
City:	City:	City:
Union Affiliation (if any):		
Signature of Individual, Owner or Partner:		
Name and Title of Signer:		
Name of Firm:		
Date:		
SUBCONTRACTOR OR MATERIAL SUPPLIER		
Name:		
Type of Work:		
Phone:	E-mail:	
Address:		
City:	State:	ZIP Code:
Union Affiliation (if any):		
Signature of Individual, Owner or Partner:		
Name and Title of Signer:		
Name of Firm:		
Date:		



# Philadelphia Parking Authority

## SMALL AND SMALL DIVERSE BUSINESS PARTICIPATION SUBMITTAL

RFP Name and Number: \_\_\_\_\_

Offeror: \_\_\_\_\_

Contact Name: \_\_\_\_\_ Email: \_\_\_\_\_

### OFFEROR INFORMATION:

Does the Offeror hold a Small Business Procurement Initiative (SBPI) certificate issued by the Pennsylvania Department of General Services?  Yes  No (MUST check one)

If yes, please identify each category that applies to your business:

1. \_\_\_\_\_.
2. \_\_\_\_\_.
3. \_\_\_\_\_.
4. \_\_\_\_\_.
5. \_\_\_\_\_.

**The Offeror must attach a copy of their SBPI certificate to this page.** Offeror will be required to maintain their status as a certified Small and Small Diverse Business throughout the entire term of the contract.

MANAGER CONTRACT ADMINISTRATION  
THE PHILADELPHIA PARKING AUTHORITY  
701 MARKET STREET, SUITE 5400  
PHILADELPHIA, PA 19106



**Proposal Decline Form:** RFP No. 19-10 – Parking Access and Revenue Control System Center City Garages

If you did not submit an offer to the Authority for this solicitation, please return this form immediately.

The undersigned contractor declines to submit an offer for this project.

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

- Requirements too “tight” (explain below)
- Unable to meet time period for responding to this Proposal
- We do not offer this product or service
- Our schedule would not permit us to perform
- Unable to complete Work Statement
- Work Statement unclear (explain below)
- Unable to meet Insurance Requirements
- Unable to meet Contract Requirements (explain below)
- Other (specify below)

Comments:


Upon completion of this form, please email the form to Mary Wheeler, Manager of Contract Administration at [mwheeler@philapark.org](mailto:mwheeler@philapark.org).

## Appendix D

### Electrical and Communications Specifications

#### Division 26 and Division 27

**SECTION 26 05 19**

**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Heat shrink tubing.
- E. Oxide inhibiting compound.
- F. Wire pulling lubricant.
- G. Cable ties.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- B. Section 26 05 33.13 - Conduit for Electrical Systems: Additional installation requirements for conductors installed in conduits.
- C. Section 26 05 33.16 - Boxes for Electrical Systems: Additional installation requirements for conductors installed in boxes.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- J. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- K. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- L. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- M. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Architect/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### **1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

#### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

#### **1.08 FIELD CONDITIONS**

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

### **PART 2 PRODUCTS**

#### **2.01 CONDUCTOR AND CABLE APPLICATIONS**

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
- G. Metal-clad cable is not permitted.

#### **2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS**

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- H. Conductor Material:
  - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
  - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
  - 3. Tinned Copper Conductors: Comply with ASTM B33.
- I. Minimum Conductor Size:
  - 1. Branch Circuits: 12 AWG.
    - a. Exceptions:
      - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
      - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
  - 2. Control Circuits: 14 AWG.
- J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- K. Conductor Color Coding:
  - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
  - 2. Color Coding Method: Integrally colored insulation.
    - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
  - 3. Color Code:
    - a. 208Y/120 V, 3 Phase, 4 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral/Grounded: White.
    - b. 240/120 V, 1 Phase, 3 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Neutral/Grounded: White.
    - c. Equipment Ground, All Systems: Green.
    - d. Isolated Ground, All Systems: Green with yellow stripe.
    - e. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
    - f. For control circuits, comply with manufacturer's recommended color code.

### **2.03 SINGLE CONDUCTOR BUILDING WIRE**

- A. Manufacturers:
  - 1. Copper Building Wire:
    - a. Cerro Wire LLC: [www.cerrowire.com/#sle](http://www.cerrowire.com/#sle).
    - b. Encore Wire Corporation: [www.encorewire.com/#sle](http://www.encorewire.com/#sle).
    - c. Southwire Company: [www.southwire.com/#sle](http://www.southwire.com/#sle).
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:

### **LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
  2. Control Circuits: Per manufacturer's instructions
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
1. Copper Building Wire: Type THHN/THWN-2, except as indicated below.
    - a. Size 4 AWG and Larger: Type XHHW-2.
    - b. Installed Underground: Type XHHW-2.
    - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

## 2.04 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
  2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
  2. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
    - a. 3M: [www.3m.com/#sle](http://www.3m.com/#sle).
    - b. Ideal Industries, Inc: [www.idealindustries.com/#sle](http://www.idealindustries.com/#sle).
    - c. NSI Industries LLC: [www.nsiindustries.com/#sle](http://www.nsiindustries.com/#sle).
- H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
    - a. Burndy LLC: [www.burndy.com/#sle](http://www.burndy.com/#sle).
    - b. IlSCO: [www.ilsco.com/#sle](http://www.ilsco.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
    - a. Burndy LLC: [www.burndy.com/#sle](http://www.burndy.com/#sle).
    - b. IlSCO: [www.ilsco.com/#sle](http://www.ilsco.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:

- a. Burndy LLC: [www.burndy.com/#sle](http://www.burndy.com/#sle).
- b. IIsco: [www.ilsco.com/#sle](http://www.ilsco.com/#sle).
- c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).

## 2.05 ACCESSORIES

- A. Electrical Tape:
  - 1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
  - 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- E. Cable Ties: Material and tensile strength rating suitable for application.
  - 1. Heavy Duty Nylon - with-in enclosures.
    - a. Self-locking
    - b. Black Nylon 6.6- UV resistant
    - c. U.L. Listed, Type 21, and tested to U.L. Standard 62275 for Cable Management Systems.
    - d. UL Labeled as suitable for outdoor use.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

### 3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

### 3.03 INSTALLATION

- A. Circuiting Requirements:
  - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
  - 2. When circuit destination is indicated without specific routing, determine exact routing required.
  - 3. Arrange circuiting to minimize splices.
  - 4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
  - 5. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.



- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:
  - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
  - 2. Pull all conductors and cables together into raceway at same time.
  - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
  - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- G. Terminate cables using suitable fittings.
- H. Install conductors with a minimum of 12 inches of slack at each outlet.
- I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- K. Make wiring connections using specified wiring connectors.
  - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
  - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
  - 3. Do not remove conductor strands to facilitate insertion into connector.
  - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
  - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- M. Insulate ends of spare conductors using vinyl insulating electrical tape.
- N. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- O. Identify conductors and cables in accordance with Section 26 05 53.
- P. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

### **3.04 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA ATS, except Section 4.

PHILADELPHIA PARKING AUTHORITY  
Parking Access and Revenue Control Equipment  
at Center City Garages  
Philadelphia, PA

- B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for services and feeders. The resistance test for parallel conductors listed as optional is not required.
- C. Correct deficiencies and replace damaged or defective conductors and cables.

**END OF SECTION**

**SECTION 26 05 26**

**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
  - 1. Includes oxide inhibiting compound.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

**1.03 REFERENCE STANDARDS**

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Verify exact locations of underground metal water service pipe entrances to building.
  - 2. Notify Architect/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

**1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

**1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
  - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect/Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
  - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
  - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:
  - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
    - a. Provide continuous grounding electrode conductors without splice or joint.
    - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
  - 2. Ground Rod Electrode(s):
    - a. Provide single electrode unless otherwise indicated or required.
    - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
    - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
  - 3. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
  - 4. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
    - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
    - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
    - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- G. Bonding and Equipment Grounding:
  - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and

other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.

2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
  3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
  4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
  5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
  6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
- H. Communications Systems Grounding and Bonding:
1. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
    - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
    - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
    - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
    - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

## 2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
  2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
1. Use insulated copper conductors unless otherwise indicated.
    - a. Exceptions:
      - 1) Use bare copper conductors where installed underground in direct contact with earth.
      - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
  2. Unless otherwise indicated, use mechanical connectors or compression connectors for accessible connections.
  3. Manufacturers - Mechanical and Compression Connectors:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
    - b. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - c. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
  2. Size: 1/4" x 2" x 12" unless otherwise indicated or required.
  3. Holes for Connections: As indicated or as required for connections to be made.
  4. Manufacturers:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. ThermOweld, a brand of Continental Industries, Inc: [www.thermoweld.com](http://www.thermoweld.com).
- E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
  - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
  - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
  - c. Galvan Industries, Inc: [www.galvanelectrical.com](http://www.galvanelectrical.com).

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

#### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
  1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
  2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Make grounding and bonding connections using specified connectors.
  1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  3. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  4. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 05 53.

#### **3.03 FIELD QUALITY CONTROL**

- A. Inspect and test in accordance with NETA ATS except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.13.
- C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

**END OF SECTION**

**SECTION 26 05 29**

**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

**1.03 REFERENCE STANDARDS**

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
  - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
  - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
  - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 5. Notify Architect/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

**1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems and post-installed concrete and masonry anchors.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

**1.06 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
  - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
  - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or approved equivalent unless otherwise indicated.
    - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
  - 1. Conduit Straps: One-hole or two-hole type; Galvanized Steel.
  - 2. Conduit Clamps: Bolted type unless otherwise indicated.
  - 3. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. O-Z/Gedney, a brand of Emerson Industrial Automation: [www.emersonindustrial.com](http://www.emersonindustrial.com).
    - d. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
  - 1. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. O-Z/Gedney, a brand of Emerson Industrial Automation: [www.emersonindustrial.com](http://www.emersonindustrial.com).
    - d. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
  - 1. Comply with MFMA-4.
  - 2. Channel Material:
    - a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.



3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
5. Manufacturers:
  - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
  - b. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
  - c. Unistrut, a brand of Atkore International Inc: [www.unistrut.com](http://www.unistrut.com).
- E. Hanger Rods: Threaded galvanized steel unless otherwise indicated.
  1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.
    - b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
    - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
    - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
    - e. Outlet Boxes: 1/4 inch diameter.
    - f. Luminaires: 1/4 inch diameter.
- F. Anchors and Fasteners:
  1. Material:
    - a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use Stainless Steel.
  2. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  3. Concrete: Use Resin Bonded Anchor.
  4. Solid or Grout-Filled Masonry: Use Resin Bonded Anchor.
  5. Hollow Masonry: Use toggle bolts.
  6. Hollow Stud Walls: Use toggle bolts.
  7. Steel: Use beam clamps or machine bolts.
  8. Sheet Metal: Use sheet metal screws.
  9. Wood: Use wood screws.
  10. Plastic and lead anchors are not permitted.
  11. Powder-actuated fasteners are not permitted.
  12. Hammer-driven anchors and fasteners are not permitted.
  13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
  14. Manufacturers - Mechanical Anchors:
    - a. Hilti, Inc: [www.us.hilti.com/#sle](http://www.us.hilti.com/#sle).
    - b. ITW Red Head, a division of Illinois Tool Works, Inc: [www.itwredhead.com/#sle](http://www.itwredhead.com/#sle).
    - c. Simpson Strong-Tie Company Inc: [www.strongtie.com/#sle](http://www.strongtie.com/#sle).

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

#### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Equipment Support and Attachment:
  - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  - 2. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  - 3. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- G. Conduit Support and Attachment: Also comply with Section 26 05 33.13.
- H. Box Support and Attachment: Also comply with Section 26 05 33.16.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

**3.03 FIELD QUALITY CONTROL**

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

**END OF SECTION**

**SECTION 26 05 33.13**  
**CONDUIT FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. Intermediate metal conduit (IMC).
- C. PVC-coated galvanized steel rigid metal conduit (RMC).
- D. Flexible metal conduit (FMC).
- E. Liquidtight flexible metal conduit (LFMC).
- F. Electrical metallic tubing (EMT).
- G. Conduit fittings.
- H. Accessories.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for electrical power conductors..
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
  - 1. Includes additional requirements for fittings for grounding and bonding.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 33.16 - Boxes for Electrical Systems.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 27 10 00 - Structured Cabling for Voice and Data: Additional requirements for communications systems conduits.

**1.03 REFERENCE STANDARDS**

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- J. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- K. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- L. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- M. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- N. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
  - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
  - 5. Notify Architect/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not begin installation of conductors until installation of conduit is complete between outlet, junction and splicing points.

#### **1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- B. Project Record Documents: Record actual routing for all conduit installations.

#### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

### **PART 2 PRODUCTS**

#### **2.01 CONDUIT APPLICATIONS**

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- D. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- E. Exposed, Interior, Not Subject to Physical Damage: Use intermediate metal conduit (IMC) or electrical metallic tubing (EMT).
- F. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
  - 1. Locations subject to physical damage include, but are not limited to:
    - a. Where exposed below 5 feet, except within electrical and communication rooms or closets.
- G. Exposed, Exterior: Use galvanized steel rigid metal conduit.

- H. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.
- I. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit.
- J. Connections to Vibrating Equipment:
  - 1. Dry Locations: Use flexible metal conduit.
  - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
  - 3. Maximum Length: 6 feet unless otherwise indicated.
- K. Fished in Existing interior Walls, Where Necessary: Use flexible metal conduit.

## **2.02 CONDUIT REQUIREMENTS**

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Communications Systems Conduits: Also comply with Section 27 10 00.
- C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.
- D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for the purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
  - 1. Branch Circuits: 1/2 inch (16 mm) trade size.
  - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
  - 3. Control Circuits: 1/2 inch (16 mm) trade size.
  - 4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

## **2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)**

- A. Manufacturers:
  - 1. Allied Tube & Conduit: [www.alliedeg.com/#sle](http://www.alliedeg.com/#sle).
  - 2. Republic Conduit: [www.republic-conduit.com/#sle](http://www.republic-conduit.com/#sle).
  - 3. Wheatland Tube, a Division of Zekelman Industries: [www.wheatland.com/#sle](http://www.wheatland.com/#sle).
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  - 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.
  - 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

## **2.04 INTERMEDIATE METAL CONDUIT (IMC)**

- A. Manufacturers:
  - 1. Allied Tube & Conduit: [www.alliedeg.com/#sle](http://www.alliedeg.com/#sle).
  - 2. Republic Conduit: [www.republic-conduit.com/#sle](http://www.republic-conduit.com/#sle).
  - 3. Wheatland Tube, a Division of Zekelman Industries: [www.wheatland.com/#sle](http://www.wheatland.com/#sle).

- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  - 2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.
  - 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

#### **2.05 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)**

- A. Manufacturers:
  - 1. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
  - 2. Robroy Industries: [www.robroy.com](http://www.robroy.com).
  - 3. Calbond: [www.calbond.com](http://www.calbond.com).
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. PVC-Coated Fittings:
  - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
  - 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
  - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

#### **2.06 FLEXIBLE METAL CONDUIT (FMC)**

- A. Manufacturers:
  - 1. AFC Cable Systems, Inc: [www.afcweb.com](http://www.afcweb.com).
  - 2. Electri-Flex Company: [www.electriflex.com](http://www.electriflex.com).
  - 3. International Metal Hose: [www.metalhose.com](http://www.metalhose.com).
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
  - 1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.

#### **2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)**

- A. Manufacturers:
  - 1. AFC Cable Systems, Inc: [www.afcweb.com](http://www.afcweb.com).

2. Electri-Flex Company: [www.electriflex.com](http://www.electriflex.com).
  3. International Metal Hose: [www.metalhose.com](http://www.metalhose.com).
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.

## **2.08 ELECTRICAL METALLIC TUBING (EMT)**

- A. Manufacturers:
1. Allied Tube & Conduit: [www.alliedeg.com](http://www.alliedeg.com).
  2. Republic Conduit: [www.republic-conduit.com/#sle](http://www.republic-conduit.com/#sle).
  3. Wheatland Tube Company: [www.wheatland.com](http://www.wheatland.com).
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
1. Manufacturers:
    - a. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - b. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - c. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
  2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  3. Material: Use steel or malleable iron.
    - a. Do not use die cast zinc fittings.
  4. Connectors and Couplings: Use compression (gland) type.
    - a. Do not use indenter type connectors and couplings.
    - b. Do not use set-screw type connectors and couplings.
  5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.

## **2.09 ACCESSORIES**

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- B. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- C. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).

- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- F. Conduit Routing:
  - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
  - 2. When conduit destination is indicated without specific routing, determine exact routing required.
  - 3. Conduits in the following areas may be exposed, unless otherwise indicated:
    - a. Electrical rooms.
    - b. Mechanical equipment rooms.
    - c. Within concrete beams in areas with no ceiling..
    - d. Across building interior and exterior concrete and masonry surfaces.
  - 4. Route all conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
  - 5. Arrange conduit to maintain adequate headroom, clearances, and access.
  - 6. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
  - 7. Arrange conduit to provide no more than 150 feet between pull points.
  - 8. Route conduits above water and drain piping where possible.
  - 9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
  - 10. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
  - 11. Maintain minimum clearance of 12 inches between conduits and hot surfaces.
  - 12. Group parallel conduits in the same area together on a common rack.
- G. Conduit Support:
  - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
  - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
  - 4. Use conduit strap to support single surface-mounted conduit.
    - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
  - 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
  - 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
  - 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
  - 8. Use of spring steel conduit clips for support of conduits is not permitted.
  - 9. Use of wire for support of conduits is not permitted.
  - 10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
- H. Connections and Terminations:
  - 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
  - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
  - 3. Use suitable adapters where required to transition from one type of conduit to another.



4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
  5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
  6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
  7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
  2. Make penetrations perpendicular to surfaces unless otherwise indicated.
  3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
  4. Conceal bends for conduit risers emerging above ground.
  5. Provide metal escutcheon plates for conduit penetrations exposed to public view.
- J. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
  2. Where conduits are subject to earth movement by settlement or frost.
- K. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
  2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- L. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- M. Provide grounding and bonding in accordance with Section 26 05 26.
- N. Identify conduits in accordance with Section 26 05 53.

### **3.03 FIELD QUALITY CONTROL**

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

### **3.04 CLEANING**

- A. Clean interior of conduits to remove moisture and foreign matter.

### **3.05 PROTECTION**

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

**END OF SECTION**

**SECTION 26 05 33.16**  
**BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Accessories.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 33.13 - Conduit for Electrical Systems:
  - 1. Conduit bodies and other fittings.
  - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 27 26 - Wiring Devices:
  - 1. Wall plates.
  - 2. Additional requirements for locating boxes for wiring devices.
- F. Section 27 10 00 - Structured Cabling for Voice and Data: Additional requirements for communications systems outlet boxes.

**1.03 REFERENCE STANDARDS**

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with equipment installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

#### **1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, and cabinets and enclosures.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual locations for outlet and device boxes, junction boxes, pull boxes, and cabinets and enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  1. Keys for Lockable Enclosures: Two of each different key.

#### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

### **PART 2 PRODUCTS**

#### **2.01 BOXES**

- A. General Requirements:
  1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
  2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
  3. Provide products listed, classified, and labeled as suitable for the purpose intended.
  4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
  5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
  1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
  2. Use cast iron boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

3. Use cast iron boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use suitable concrete type boxes where flush-mounted in concrete.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
8. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
9. Boxes for Supporting Luminaires: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
10. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
11. Minimum Box Size, Unless Otherwise Indicated:
  - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
  - b. Communications Systems Outlets: Comply with Section 27 10 00.
  - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
12. Wall Plates: Comply with Section 26 27 26.
13. Manufacturers:
  - a. Cooper Crouse-Hinds, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
  - b. Hubbell Incorporated; RACO Products: [www.hubbell-rtb.com/#sle](http://www.hubbell-rtb.com/#sle).
  - c. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
  1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    - a. Indoor Clean, Dry Locations: Type 1, galvanized steel.
    - b. Outdoor Locations: Type 4, painted steel.
  3. Junction and Pull Boxes Larger Than 100 cubic inches:
    - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
  4. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
  5. Manufacturers:
    - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Hoffman, a brand of Pentair Technical Products: [www.hoffmanonline.com](http://www.hoffmanonline.com).
    - c. Hubbell Incorporated; Wiegmann Products: [www.hubbell-wiegmann.com](http://www.hubbell-wiegmann.com).

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.

- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- G. Box Locations:
  - 1. Unless dimensioned, box locations indicated are approximate.
  - 2. Locate boxes as required for devices installed under other sections or by others.
    - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.
    - b. Communications Systems Outlets: Comply with Section 27 10 00.
  - 3. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
  - 4. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
  - 5. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
    - a. Concealed above accessible suspended ceilings.
    - b. Within concrete beams with no ceilings.
    - c. Electrical rooms.
- H. Box Supports:
  - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
  - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
- I. Install boxes plumb and level.
- J. Close unused box openings.
- K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- L. Provide grounding and bonding in accordance with Section 26 05 26.
- M. Identify boxes in accordance with Section 26 05 53.

### **3.03 CLEANING**

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

### **3.04 PROTECTION**

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

**END OF SECTION**

**SECTION 26 05 53**  
**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 26 27 26 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- C. Section 27 10 00 - Structured Cabling for Voice and Data: Identification for communications cabling and devices.

**1.03 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
  - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
  - 2. Do not install identification products until final surface finishes and painting are complete.

**1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

**1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.

**1.07 FIELD CONDITIONS**

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

**PART 2 PRODUCTS**

**2.01 IDENTIFICATION REQUIREMENTS**

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
  - 1. Use identification nameplate or identification label to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

2. Use identification label to identify highest voltage present for each piece of electrical equipment.
  3. Use identification nameplate or identification label to identify disconnect location for equipment with remote disconnecting means.
  4. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
- C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
  2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
  3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment.
  4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    - a. At each source and load connection.
    - b. Within boxes when more than one circuit is present.
    - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
  5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
  6. When conductors and cables enter or leave a stubbed-up buried conduit.
- D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
  2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
    - a. For exposed boxes, provide identification on inside face of cover.
- E. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 10 00.
  2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
  3. Use identification label to identify serving branch circuit for all receptacles.
  4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

## 2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Manufacturers:
    - a. Brimar Industries, Inc: [www.brimar.com/#sle](http://www.brimar.com/#sle).
    - b. Kolbi Pipe Marker Co: [www.kolbipipemarkers.com](http://www.kolbipipemarkers.com).
    - c. Seton Identification Products: [www.seton.com](http://www.seton.com).
  2. Materials:
    - a. Indoor Clean, Dry Locations: Use plastic nameplates.
    - b. Outdoor Locations: Use plastic nameplates suitable for exterior use.
  3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
    - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
  4. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
1. Manufacturers:
    - a. Brady Corporation: [www.bradyid.com](http://www.bradyid.com).

- b. Brother International Corporation: [www.brother-usa.com/#sle](http://www.brother-usa.com/#sle).
- c. Panduit Corp: [www.panduit.com/#sle](http://www.panduit.com/#sle).
- 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
- 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
  - 1. Minimum Size: 1 inch by 2.5 inches.
  - 2. Legend:
    - a. Equipment designation or other approved description.
    - b. Information as indicated.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Color:
    - a. Normal Power System: White text on black background.
- D. Format for Caution and Warning Messages Nameplate:
  - 1. Minimum Size: 2 inches by 4 inches.
  - 2. Text: All capitalized unless otherwise indicated.
  - 3. Minimum Text Height: 1/2 inch.
  - 4. Color: Black text on yellow background unless otherwise indicated.
  - 5. information as indicated.
- E. Format for Receptacle Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Power source and circuit number or other designation indicated.
    - a. Include voltage and phase for other than 120 V, single phase circuits.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Black text on clear background.
- F. Format for Control Device Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Load controlled or other designation indicated.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Black text on clear background.

### **2.03 WIRE AND CABLE MARKERS**

- A. Manufacturers:
  - 1. Brady Corporation: [www.bradyid.com](http://www.bradyid.com).
  - 2. HellermannTyton: [www.hellermanntyton.com](http://www.hellermanntyton.com).
  - 3. Panduit Corp: [www.panduit.com/#sle](http://www.panduit.com/#sle).
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.



## **2.04 VOLTAGE MARKERS**

- A. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl type markers.
- B. Minimum Size:
  - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
  - 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
  - 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- C. Legend:
  - 1. Markers for Voltage Identification: Highest voltage present.
- D. Color: Black text on orange background unless otherwise indicated.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

### **3.02 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
  - 1. Surface-Mounted Equipment: Enclosure front.
  - 2. Flush-Mounted Equipment: Inside of equipment door.
  - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
  - 4. Elevated Equipment: Legible from the floor or working platform.
  - 5. Interior Components: Legible from the point of access.
  - 6. Boxes: Inside face of cover.
  - 7. Conductors and Cables: Legible from the point of access.
  - 8. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws or self-adhesive backing and to interior surfaces using self-adhesive backing.
  - 1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Secure rigid signs using stainless steel screws.
- G. Mark all handwritten text, where permitted, to be neat and legible.

### **3.03 FIELD QUALITY CONTROL**

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

**END OF SECTION**

**SECTION 26 05 83**  
**WIRING CONNECTIONS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Electrical connections to equipment.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 27 26 - Wiring Devices.

**1.03 REFERENCE STANDARDS**

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
  - 2. Determine connection locations and requirements.
- B. Sequencing:
  - 1. Install rough-in of electrical connections before installation of equipment is required.
  - 2. Make electrical connections before required start-up of equipment.

**1.05 SUBMITTALS**

- A. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

**1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
  - 1. Colors: Comply with NEMA WD 1.
  - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
  - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

- B. Wiring Devices: As specified in Section 26 27 26.
- C. Flexible Conduit: As specified in Section 26 05 33.13.
- D. Wire and Cable: As specified in Section 26 05 19.
- E. Boxes: As specified in Section 26 05 33.16.

## **2.02 EQUIPMENT CONNECTIONS**

- A. As per equipment manufacturer and/or equipment supplier.
  - 1. Power
  - 2. Control
  - 3. Communications
  - 4. Data

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

### **3.02 ELECTRICAL CONNECTIONS**

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

**END OF SECTION**

**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 83 - Wiring Connections: Cords and plugs for equipment.
- F. Section 27 10 00 - Structured Cabling for Voice and Data: Voice and data jacks.

**1.03 REFERENCE STANDARDS**

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

**1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the placement of outlet boxes equipment installed under other sections or by others.
  - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
  - 3. Coordinate the installation and preparation of uneven surfaces to provide suitable surface for installation of wiring devices.
  - 4. Notify Architect/Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
  - 1. Do not install wiring devices until final surface finishes are complete.

### **1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual installed locations of wiring devices.

### **1.06 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### **1.07 DELIVERY, STORAGE, AND PROTECTION**

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

## **PART 2 PRODUCTS**

### **2.01 WIRING DEVICE APPLICATIONS**

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Unless noted otherwise, do not use combination switch/receptacle devices.

### **2.02 WIRING DEVICE FINISHES**

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: Gray with galvanized steel wall plate.
- C. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
- D. Wiring Devices Installed in Wet or Damp Locations: Gray with specified weatherproof cover.

### **2.03 WALL SWITCHES**

- A. Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).
  - 2. Leviton Manufacturing Company, Inc: [www.leviton.com/#sle](http://www.leviton.com/#sle).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us/#sle](http://www.legrand.us/#sle).
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw as indicated on the drawings.

### **2.04 RECEPTACLES**

- A. Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).

2. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  3. Lutron Electronics Company, Inc; Designer Style: [www.lutron.com/#sle](http://www.lutron.com/#sle).
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
  2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
    - a. Provide test and reset buttons of same color as device.
  2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R.
  3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

## **2.05 WALL PLATES**

- A. Manufacturers:
1. Hubbell Incorporated: [www.hubbell-wiring.com](http://www.hubbell-wiring.com).
  2. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  3. Lutron Electronics Company, Inc: [www.lutron.com](http://www.lutron.com).
- B. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  2. Size: Standard.
  3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- D. Weatherproof Covers for Damp Locations: Gasketed, zinc die-cast, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- E. Weatherproof Covers for Wet Locations: Gasketed, zinc die-cast, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

- D. Verify that final surface finishes are complete.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

### **3.02 PREPARATION**

- A. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### **3.03 INSTALLATION**

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
  - 1. Mounting Heights: As indicated on the drawings.
  - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
  - 3. Where multiple receptacles or wall switches are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- E. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- G. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- H. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- N. Identify wiring devices in accordance with Section 26 05 53.

### **3.04 FIELD QUALITY CONTROL**

- A. Inspect each wiring device for damage and defects.
- B. Operate each wall switch with circuit energized to verify proper operation.
- C. Test each receptacle to verify operation and proper polarity.
- D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E. Correct wiring deficiencies and replace damaged or defective wiring devices.

**3.05 ADJUSTING**

- A. Adjust devices and wall plates to be flush and level.

**3.06 CLEANING**

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

**END OF SECTION**



**SECTION 27 10 00**  
**STRUCTURED CABLING FOR VOICE AND DATA**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications equipment room fittings.
- F. Communications outlets.
- G. Communications grounding and bonding.
- H. Communications identification.

**1.02 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products.
- E. Section 26 27 26 - Wiring Devices.

**1.03 REFERENCE STANDARDS**

- A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Alliance/Electrical Components Association; Revision E, 2005.
- B. ICEA S-83-596 - Indoor Optical Fiber Cables; Insulated Cable Engineers Association; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 2012.
- E. TIA-492AAAD - Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; Telecommunications Industry Association; 2009.
- F. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Rev C, 2015.
- G. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2015.
- H. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2009c, with Addendum (2016).
- I. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2016d.
- J. TIA-569 - Telecommunications Pathways and Spaces; 2015d, with Addendum (2016).
- K. TIA-570 - Residential Telecommunications Infrastructure Standard; 2012c.
- L. TIA-598 - Optical Fiber Cable Color Coding; 2014d.
- M. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2017c.
- N. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2015c, with Addendum (2017).
- O. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Rev C, 2009 (with Addenda; 2014).

- P. TIA-569-C - Commercial Building Standard for Telecommunications Pathways and Spaces; Rev C, 2012 (with Addenda; 2013).
- Q. TIA-570-C - Residential Telecommunications Infrastructure Standard; Rev C, 2012.
- R. TIA-606-B - Administration Standard for the Telecommunications Infrastructure; Rev B, 2012.
- S. TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev B, 2012 (with Addenda; 2013).
- T. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- U. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- V. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.
- W. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
  - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
  - 3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
  - 4. Notify Architect/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Coordinate with Owner for Communications Service Provider to provide service.
- C. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

#### **1.05 SUBMITTALS**

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- B. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- C. Field Test Reports.
- D. Project Record Documents:
  - 1. Record actual locations of outlet boxes and distribution frames.
  - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
  - 3. Identify distribution frames and equipment rooms by room number on drawings.

#### **1.06 QUALITY ASSURANCE**

- A. Installer Qualifications: A company having at least three (3) years experience in the installation and testing of the type of system specified.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Store products in manufacturer's unopened packaging until ready for installation.

- B. Keep stored products clean and dry.

## **1.08 WARRANTY**

- A. Correct defective Work within a two (2) years period after Date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Cabling and Equipment: Basis of Design: Belden Inc.
- B. Other Acceptable Manufacturers: Products of equal quality and performance from any of the following manufacturers are approved for use.
  1. 3M Communications Technologies: solutions.3m.com.
  2. Siemon Company: www.siemon.com.
  3. Belden Inc.: www.belden.com.

### **2.02 SYSTEM DESIGN**

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
  1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
  2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
  3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
- B. System Description:
  1. Building Entrance Cable: By others.
  2. Backbones - Within Building: Fiber optic, multi-mode-fiber.
  3. Revenue Control Equipment: Copper, CAT 6 UTP.
  4. Provide additional outlets where indicated on drawings.
- C. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to exterior revenue control equipment, functioning as point of presence to external service provider.
  1. Locate main distribution frame as indicated on the drawings.
  2. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
- D. Backbone Cabling: Cabling, pathways, and terminal hardware connecting Network Interface Device (NID) with main distribution frame (MDF).
- E. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

### **2.03 PATHWAYS**

- A. Conduit: As specified in Section 26 05 33.13; provide pull cords in all conduit.

### **2.04 COPPER CABLE AND TERMINATIONS**

- A. Copper Horizontal Cable: Basis of Design: Belden Inc.
  1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
  2. Cable Type - Voice and Data: TIA-568-C.2 Category 6 UTP (unshielded twisted pair); 24 AWG, gel-filled.
  3. Cable Capacity: 4-pair.
  4. Cable Applications:
    - a. General Purpose Applications: Use listed NFPA 70 Type CM/CMG general purpose cable, Type CMR riser cable, or Type CMP plenum cable.

5. Cable Jacket Color - Data Cable: Blue.
  6. Cable Jacket Color - Voice Cable: Grey.
- B. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- C. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
1. Performance: 500 mating cycles.
  2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
- D. Copper Patch Cords:
1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
  2. Patch Cords for Patch Panels:
    - a. Quantity: One for each pair of patch panel ports.
    - b. Length: 3 feet.

## 2.05 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Fiber Optic Backbone Cable:
1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
  2. Cable Type: Multimode, laser-optimized 50/125 um (OM4) complying with TIA-492AAAD.
  3. Cable Capacity: Quantity of fibers as indicated on drawings.
  4. Cable Applications:
    - a. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
  5. Cable Jacket Color:
    - a. Laser-Optimized Multimode Fiber (OM3/OM4): Aqua.
- B. Fiber Optic Interconnecting Devices:
1. Connector Type: Type SC.
  2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
  3. Maximum Attenuation/Insertion Loss: 0.3 dB.
- C. Fiber Optic Patch Cords:
1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
  2. Patch Cords for Patch Panels:
    - a. Quantity: One for each pair of patch panel ports.
    - b. Length: 3 feet.

## 2.06 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Copper Cross-Connection Equipment:
1. Patch Panels for Copper Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
    - a. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
    - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
    - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
    - d. Provide incoming cable strain relief and routing guides on back of panel.
- B. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.

1. Size: 48 by 96 inches or as required.
  2. Do not paint over UL label.
- C. Equipment Frames, Racks and Cabinets:
1. Component Racks: EIA/ECA-310 standard 19 inch wide.
  2. Wall Mounted Racks: Steel construction, hinged to allow access to back of installed components.
  3. Wall Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.
    - a. Roof mounted fan, capacity as per manufacturer's recommendations for proposed equipment loads.
    - b. Duplex AC power outlet inside cabinet.
  4. Cabinets: Steel construction with corrosion resistant finish.
  5. Locks: Keyed alike.

## **2.07 COMMUNICATIONS OUTLETS**

- A. Outlet Boxes: Comply with Section 26 05 33.16.
1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
- B. Wall Plates:
1. Comply with system design standards and UL 514C.
  2. Accepts modular jacks/inserts.
  3. Capacity:
    - a. Voice Only Outlets: 1 ports.
    - b. Data or Combination Voice/Data Outlets: 2 ports.
    - c. Fiber Optic Outlets: As required by equipment manufacturer.
  4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 27 26.

## **2.08 GROUNDING AND BONDING COMPONENTS**

- A. Comply with TIA-607.
- B. Comply with Section 26 05 26.

## **2.09 IDENTIFICATION PRODUCTS**

- A. Comply with TIA-606.
- B. Comply with TIA-606-B.
- C. Comply with Section 26 05 53.

## **2.10 SOURCE QUALITY CONTROL**

- A. Factory test cables according to TIA-568 (SET).

## **PART 3 EXECUTION**

### **3.01 INSTALLATION - GENERAL**

- A. Comply with latest editions and addenda of TIA-570, TIA-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

### **3.02 INSTALLATION OF PATHWAYS**

- A. Install pathways with the following minimum clearances:
1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
  2. 12 inches from power conduits and cables and panelboards.

3. 5 inches from fluorescent and high frequency lighting fixtures.
  4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit, in Addition to Requirements of Section 26 05 33.13:
1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
  2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
  3. Arrange conduit to provide no more than 100 feet between pull points.
  4. Do not use conduit bodies.
- C. Outlet Boxes:
1. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of telecommunications outlets provided under this section.
    - a. Mounting Heights: Unless otherwise indicated, as follows:
      - 1) Telephone and Data Outlets: 18 inches above finished floor.
    - b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
    - c. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.

### 3.03 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
  2. Do not over-cinch or crush cables.
  3. Do not exceed manufacturer's recommended cable pull tension.
  4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches.
  2. At Outlets - Copper: 12 inches.
  3. At Outlets - Optical Fiber: 39 inches.
- C. Copper Cabling:
1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
  2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
  3. Use T568B wiring configuration.
- D. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
  2. Support vertical cable at intervals as recommended by manufacturer.
- E. Wall-Mounted Racks and Enclosures:
1. Install to plywood backboards only, unless otherwise indicated.
  2. Mount so height of top most panel does not exceed 78 inches above floor.
- F. Identification:
1. Use wire and cable markers to identify cables at each end.
  2. Use manufacturer-furnished label inserts or identification labels to identify each jack at communications outlets with unique identifier.
  3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

**3.04 FIELD QUALITY CONTROL**

- A. Comply with inspection and testing requirements of specified installation standards.
- B. Visual Inspection:
  - 1. Inspect cable jackets for certification markings.
  - 2. Inspect cable terminations for color coded labels of proper type.
  - 3. Inspect outlet plates and patch panels for complete labels.
- C. Testing - Copper Cabling and Associated Equipment:
  - 1. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- D. Testing - Fiber Optic Cabling:
  - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
  - 2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
- E. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

**END OF SECTION**