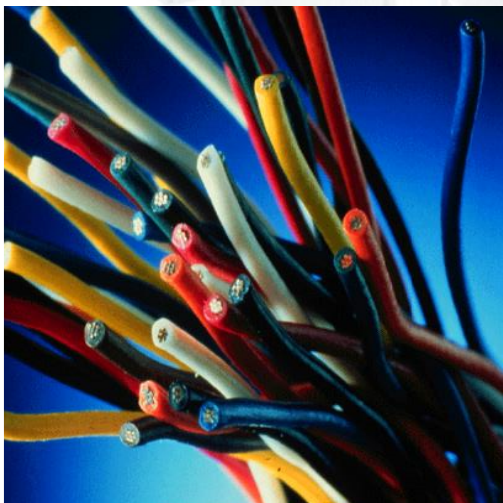




# NEORS D

## ELECTRICAL STANDARDS AND

## CONVENTIONS



Revision 2.2

Date: 05/01/2020

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## Revision History

Revision	Revision Date dd-mmm-yyyy	Author	Updated Section	Description
0.0.0	01-May-2012	NEORS	All	Issued for use. Extracted from Automation Standards
1.0.0	07-Jan-2013	PSIM	All	Updated formatting in all sections, added DeviceNet spec.
1.01	22-Feb-2013	P. McGuire	Section 4, <i>Instrumentation and Network Cable</i>	Removed DeviceNet cable specification from Section 4 and added note to refer to Section 9, <i>DeviceNet Networks</i>
1.01	22-Feb-2013	P. McGuire	Section 9, <i>DeviceNet Networks - Introduction</i>	Expanded list of DeviceNet publications and requirements.
1.01	22-Feb-2013	P. McGuire	All	Added page numbers to footer. Revised cover photos.
1.02	09-May-2013	P. McGuire	Section 1.B.8.a	Updated Brady conduit label part numbers.
1.02	09-May-2013	P. McGuire	Section 1.B.8.b.iii	Updated conduit label information.
1.02	09-May-2013	P. McGuire	Section 2.B.6.a	Updated conductor color codes.
1.02	09-May-2013	P. McGuire	Section 2.B.14	Added subsection for spare conductor requirements.
1.02	09-May-2013	P. McGuire	Section 2.B.15	Added subsection for cable and conductor separation requirements.
1.02	09-May-2013	P. McGuire	Section 2.B.16	Added subsection on wiring standards.
1.02	09-May-2013	P. McGuire	Section 2.B. – Reference Standards	Added IEEE 518.
1.03	17-May-2013	P. McGuire	Section 1.B.8.a.	Updated conduit label colors. Changed telephone to white label. Deleted yellow.
1.03	17-May-2013	P. McGuire	Section 1.B.8.b.iii.2.m	Changed data and communications from “K” prefix to “D” prefix.
1.04	05-Dec-2013	B. Buchanan	Section 1.A.5.a	Added external bonding strap requirement
1.04	05-Dec-2013	B. Buchanan	Section 1.A.7.b	Removed “deflection fittings”.
1.04	05-Dec-2013	B. Buchanan	Section 1.A.12	Revised requirements, added internal and external installations
1.04	05-Dec-2013	B. Buchanan	Section 1.B.1.b	Changed the support requirement to 8 feet
1.04	05-Dec-2013	B. Buchanan	Section 1.B.3	Added section ‘a’ to specify a 3000 psi concrete mix
1.04	05-Dec-2013	B. Buchanan	Section 1.B.3.g	Added “iii”, exception for 6x6 mesh
1.04	05-Dec-2013	B. Buchanan	Section 1.B.3.j	Revised warning ribbon requirements
1.04	05-Dec-2013	B. Buchanan	Section 1.B.8	Revised conduit labeling provisions
1.04	05-Dec-2013	B. Buchanan	Section 3.A.2.a	Revised attenuation losses and crush resistance
1.04	05-Dec-2013	B. Buchanan	Section 7	Added “true double conversion” to description.
1.04	05-Dec-2013	B. Buchanan	Section 7.A.1.c.vi	Revised enclosure description
1.04	05-Dec-2013	B. Buchanan	Section 7.A.6.f	Added Ethernet communication ports
2.0	11-Aug-2017	HDR	Removed UPS and DeviceNet sections. Update 4.A.5 & 6.A.1	Updated to contain electrical standards only. PCS specific standards are located in Division 40 specifications and NEORS PCS Standards and Conventions Manual. Updates to sections 4 & 6 to align with latest PCS standards.

2.1	29-Sep-2017	P. McGuire	Former Section 3 ( <i>Fiber Optic Cabling</i> ).	Removed section on <i>Fiber Optic Cabling</i> . See NEORS Division 27 specifications.
2.1	29-Sep-2017	P. McGuire	Section 1.B.8.a.iii	Changed Control/Instrumentation conduit label color from Light Blue to Blue since Light Blue will be used for Intrinsic Safe conduits. Reference NEC Article 504.80(C).
2.1	29-Sep-2017	P. McGuire	Section 1.B.8.a.iv	Changed Intrinsically Safe conduit label color from Purple to Light Blue. Reference NEC Article 504.80(C).
2.1	29-Sep-2017	P. McGuire	Section 1.B.8.b.iv	Changed Conduit label color for IS-001 INTRINSIC SAFETY WIRING from Purple to Light Blue. Reference NEC Article 504.80(C).
2.1	29-Sep-2017	P. McGuire	Section 2.B.6.a.iv	In addition to the single wire DC Control Wiring color of blue, the following colors were added for two-wire circuits: (+): Blue; (-) White with blue trace.
2.1	29-Sep-2017	P. McGuire	Section 6 – Modular Motor Protection System	Rockwell model 825-P identified as obsolete. Replace with Rockwell E300 electronic overload relay.
2.2	01-May-2020	P. McGuire	Section 2.B.7.a.v	Inserted conductor colors for DC Low Voltage Power Wiring.
2.2	01-May-2020	P. McGuire	Section 2.B.7.a.vi	Inserted Intrinsic Safe cable and conductor colors.
2.2	01-May-2020	P. McGuire	Section 3, 5 <sup>th</sup> bullet item	Deleted “PLC Data Highway” cable
2.2	01-May-2020	P. McGuire	Section 3.A.1	Added Belden No. 3090A for 1-pair cable and Belden No. 3091A for triads. Listed conductor colors for Belden 3090A and Belden 3091A. Specified conductor colors for (+) and (-) terminals for 1-pair cables.
2.2	01-May-2020	P. McGuire	Various sections	Deleted references to DeviceNet
2.2	01-May-2020	P. McGuire	Sections 1.A.2.b, 1.B.11.c	Added long radius conduit elbows and other requirements for fiber optic and similar cable that have limited bend radii.
2.2	01-May-2020	P. McGuire	Section 4	Deleted content from <i>Section 4 – Patch Panels</i> and added reference to NEORS specification 27 21 00, Part 2.02
2.2	01-May-2020	P. McGuire	Section 5	Deleted content from <i>Section 5 – Network Cabinets</i> and added reference to NEORS Specification Section 40 66 00, Part 2.07 and NEORS Specification Section 27 21 00, Part 2.02
2.2	01-May-2020	P. McGuire	Section 6	Removed obsolete Rockwell 825-P and replaced with Rockwell E300 electronic overload relay.

#### Revision Format: X.Y.Z

- X = Major modifications to any section of the document. These types of changes effect functionality or operation of a process. Adding or deleting sections also constitutes a major change. This level of change requires a review and approval by subject matter experts.
- Y = Intermediate modification to any section of the document. Typically a clarification to an existing section. This level of change requires a review and approval by subject matter experts.
- Z = Minor change to a proposed revision. Example: 1.1.0 is submitted for review, and a spelling error is caught. The document is revised up to 1.1.1 and continued through the review cycle. It is not necessary to go back to previous subject matter experts for a second review.

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# Electrical Standards and Conventions

## Section 1 - Conduit System

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This section provides the detailed requirements for conduit systems. The types of conduit and appurtenances detailed include the following:

- Aluminum conduit and fittings for all exposed conduit runs.
- PVC coated rigid conduit and fittings for exposed conduit runs in areas that contain an environment that is corrosive to aluminum.
- Schedule 80 PVC conduit and fittings for buried and concrete encased duct bank runs.
- Fiberglass conduit and fittings for transitions from concrete duct bank to exposed rigid conduit.
- Flexible metallic conduit and fittings.
- Sealing fittings.
- Expansion fittings.
- Outlet boxes.
- Pull and junction boxes.

### Section 1.A - Detailed Specifications

1. Aluminum Conduit, Elbows and Couplings:
  - a. Material: Rigid, heavy wall 6063 alloy, temper T-1 aluminum, smooth interior, tapered threads and carefully reamed ends; ¾ inch NPS minimum size.
  - b. For all exposed runs.
  - c. Joints: Threaded with lubricant by Burndy Pentrox or approved equal.
  - d. Manufacturer: Provide aluminum conduit from one of the following:
    - i. V.A.W. of America, Inc.
    - ii. Anamet Inc.
    - iii. Or Approved Equal
2. Aluminum Conduit Fittings and Outlet Bodies:
  - a. Material and construction: Cast copper-free aluminum bodies and covers with stainless steel screws. All units are to have gaskets and be watertight. Gaskets shall be neoprene. Improvised gaskets and cork gaskets are not acceptable. All units are to be the threaded type with five full threads. Material is to conform to ANSI and be listed by UL. The use of 'LB' fittings shall be avoided and type 'LBD' fittings applied wherever the use of fittings is unavoidable.
  - b. Conduit containing fiber optic cable and similar cables with limited bend radii shall utilize long radius elbows and junction or pull boxes to maintain minimum bend radii for the cabling. The use of fittings (such as LBs or LBDs) in lieu of long radius elbows, long radius field bends or oversized junction boxes shall not



- be permitted for installation of fiber optic and similar cables. These requirements apply to all conduit types and materials.
- c. The requirements of Section 1.A.2.b apply.
  - d. Manufacturer: Provide aluminum conduit fittings and outlet bodies from one of the following:
    - i. Crouse-Hinds Co.
    - ii. Appleton Electric Co.
    - iii. Or Approved Equal
3. PVC Coated Rigid Steel Conduit, Elbows and Couplings:
- a. Material: Rigid, heavy wall, mild steel, hot dip galvanized inside and out, smooth interior, tapered threads and carefully reamed ends; ¾” NPS minimum size.
  - b. PVC Coating: PVC coating to be bonded to the outer surface of the galvanized conduit. Ensure that the bond between the coating and the conduit surface is greater than the tensile strength of the coating. Provide the inside surfaces and threads of the conduit with a 2-mil urethane coating. Provide a PVC coating thickness of not less than 40 mils.
  - c. The requirements of Section 1.A.2.b apply.
  - d. Manufacturers:
    - i. Robroy Industries
    - ii. Thomas and Betts
    - iii. Or Approved Equal
4. Non-metallic conduit:
- a. PVC Plastic:
    - i. Material: Schedule 80 PVC plastic, NEMA Type EPC-80-PVD, 90 deg. C rated, conforming to UL No. 651.
    - ii. For buried and concrete encased ductbank runs
    - iii. The requirements of Section 1.A.2.b apply.
    - iv. Manufacturer: Provide non-metallic conduit from one of the following:
      1. Amoco Chemicals Corporation.
      2. Carlon, Division of Indian Head, Incorporated.
      3. Or Approved Equal.
  - b. Fiberglass:
    - i. Material: Fiberglass reinforced epoxy manufactured using a filament winding process. Resin systems shall be epoxy with no fillers. Glass used shall be E-type. Nominal wall thickness of ¼ inch. Rated for Class 1 Div. 2 applications.
    - ii. For a transition piece from concrete encased ductbanks to exposed conduit systems as they stub-up through a concrete slab.
    - iii. The requirements of Section 1.A.2.b apply.
    - iv. Manufacturer: Provide fiberglass conduit from one of the following:
      1. Champion Fiberglass.
      2. Or Approved Equal.
  - c. Non-metallic Fittings: Form elbows, bodies, terminations, expansions and fasteners of same material and manufacturer as base conduit. Provide

- cement by same manufacturer as base conduit.
5. Flexible Conduit (non-hazardous areas):
    - a. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes  $\frac{3}{4}$  inch through 1- $\frac{1}{4}$  inch. Material shall be UL listed. An exterior bonding strap will be installed on all installations 1- $\frac{1}{2}$ " or greater.
    - b. Product and Manufacturer: Provide conduit from one of the following:
      - i. Sealtite UA by Anaconda Metal Hose Division, Anaconda American Brass Company.
      - ii. Liquatite Type L.A. by Electric-Flex Company.
      - iii. Or Approved Equal.
  6. Flexible Conduit Fittings:
    - a. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed. Fittings shall be vibration proof and weather proof with captive O-ring seal.
    - b. Manufacturer: Provide flexible conduit from one of the following:
      - i. Crouse-Hinds Company.
      - ii. Appleton Electric Company.
      - iii. Or Approved Equal.
  7. Expansion Fittings:
    - a. Material and Construction: Copper free aluminum or stainless steel body, stainless steel clamps and tinned copper braid bonding jumper. Fitting to be watertight, corrosion-resistant UL listed and compatible with the conduit system.
    - b. Product and Manufacturer: Provide expansion fittings from one of the following:
      - i. Type AX for expansion only by O/Z Gedney Company.
      - ii. Type XJ for expansion only by Crouse Hinds Company.
      - iii. Or Approved Equal.
  8. Device Boxes and Outlet Boxes:
    - a. Non-Hazardous and/or Non-Corrosive Areas:
      - i. Material:
        1. Flush Mounted: Cast copper-free aluminum.
        2. Surface Mounted: Cast copper-free aluminum.
      - ii. Device Cover Plates:
        1. Stainless steel Type 302 alloy for indoor finished areas.
        2. Stainless steel screws and hardware.
        3. Neoprene gaskets. Improvised or cork gaskets are not acceptable.
        4. Covers and gaskets are to be by the same manufacturer as the box.
      - iii. Manufacturers:
        1. Appleton Electric Company.
        2. Crouse-Hinds Company.
        3. Or Approved Equal.

9. Junction and Pull Boxes (12" x 12" and smaller):

- a. Materials and Construction:
  - i. NEMA 4X, 316 stainless steel or NEMA 4X, fiberglass bodies and covers.
  - ii. Neoprene gaskets. Improvised gaskets and cork gaskets are not acceptable.
  - iii. Stainless steel cover screws.
  - iv. External mounting lugs.
  - v. Boxes shall be provided with no knockouts.
  - vi. Boxes shall be constructed with welded seams and covers.
  - vii. Boxes where conduits enter a building below grade shall have ½ inch drain hole with a petcock type fitting attached for ½ inch tubing drain line. Provide ½ inch drain line and fittings of polyethylene tubing to nearest drain trench or sump.
- b. Manufacturer: Provide pull and junction boxes of one of the following:
  - i. Hoffman
  - ii. Saginaw Control & Engineering
  - iii. RobRoy
  - iv. Or approved equal.

10. Junction and Pull Boxes (larger than 12" x 12"):

- a. Materials and Construction:
  - i. NEMA 4X, 316 stainless steel or NEMA 4X, fiberglass bodies and covers.
  - ii. Neoprene gaskets. Improvised gaskets and cork gaskets are not acceptable.
  - iii. Stainless steel cover screws.
  - iv. External mounting lugs.
  - v. Boxes shall be provided with no knockouts.
  - vi. Boxes shall be constructed with welded seams and covers.
  - vii. Boxes where conduits enter a building below grade shall have ½ inch drain hole with a petcock type fitting attached for ½ inch tubing drain line. Provide ½ inch drain line and fittings of polyethylene tubing to nearest drain trench or sump.
  - viii. Boxes larger than 24" x 24" to have hinged doors. All clamps shall be stainless steel with stainless steel screws.
- b. Manufacturer: Provide pull and junction boxes of one of the following:
  - i. Hoffman
  - ii. Saginaw Control & Engineering
  - iii. RobRoy
  - iv. Or approved equal.

11. Conduit Hubs:

- a. Material: Threaded conduit hub, vibration proof, weather proof with captive O-ring seal, copper-free aluminum with insulated throat.
- b. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures.
- c. Manufacturer: Provide material manufactured by Myers Electrical Products Company or approved equal.

12. Thruwall Seals:

- a. Material:
  - i. Interior Walls: Use PVC sleeves with approved fire stop materials
  - ii. Exterior Walls: Use Link Seals with stainless steel hardware, if the wall is 8" thick or greater, use (2) sets of link seals
    - 1. CMU construction: Use PVC sleeve
    - 2. Solid concrete construction: No sleeve is required
- b. Or approved equal.

13. Supports:

- a. Rigidly support conduits by clamps, hangers or strut channels. Standard support strut shall be 1-5/8" wide x 12 gage (.105", minimum). Support strut used in exterior locations shall be 316 stainless steel. Support strut used in interior locations shall be either aluminum or fiberglass.
- b. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers with 316 stainless steel threaded hanger rods. Rods shall be not less than 3/8-inch diameter.
- c. All support hardware (nuts, bolts, washers, etc.) shall be manufactured from 316 stainless steel.
- d. For freestanding supports, provide doublewide strut with post base anchored to floor. Support strut used in exterior locations shall be 316 stainless steel. Support strut used in interior locations shall be either aluminum or fiberglass

### **Section 1.B - Installation Details**

This section does not contain all installation details for the equipment/ system shown, only those that are required by the NEORS. These details may exceed those required by the equipment manufacturer or local codes.

- 1. Exposed Conduit Installation:
  - a. All fastening hardware shall be stainless steel.
  - b. Provide aluminum conduit racks of suitable width, length and height and arranged to suit field conditions. Provide support at every eight feet minimum.
  - c. Maintain 6 inches from hot fluid lines and 1/4 inch from walls using non-metallic spacers.
  - d. All CMU through-wall penetrations shall be sleeved with PVC conduit.
  - e. All interior wall through-wall penetrations shall be sleeved with PVC conduit.
- 2. Conduit Embedded in Concrete Installation:
  - a. Separation: Three times outer diameter of larger conduit center to center.
  - b. Minimum distance from edge of slab:
    - i. With no crisscrossing of conduit, three times outer diameter of conduit.
    - ii. With crisscrossing of conduits, four times outer diameter of largest

conduit.

- c. Run conduit in center of slab.
3. Underground Conduit Installation:
  - a. Duct banks shall be constructed using a 3000 psi concrete mix.
  - b. All conduits installed in duct banks shall be Schedule 80 PVC.
  - c. Assemble duct banks using non-magnetic saddles, spacers and separators. Separators are to be positioned to provide 3-inch minimum concrete separation between the outer surfaces of the ducts.
  - d. Manufacturer:
    - i. Underground Devices Inc.
    - ii. Or approved equal.
  - e. Provide a 3-inch minimum concrete covering on both sides, top and bottom of concrete envelopes around conduits. Add red dye to concrete used for envelopes for easy identification during subsequent excavation. Dye is to be mixed inside the concrete truck. Pricing shall include appropriate truck clean-out.
  - f. Make bends with sweeps of not less than 48-inch radius or 5 degree angle couplings.
  - g. Make a transition from non-metallic to PVC coated rigid steel or fiberglass conduit where duct banks enter structures or turn upward for continuation above grade.
  - h. Reinforce duct banks:
    - i. Reinforce with No. 4 longitudinal steel bars (minimum) placed at each corner and along each face at a maximum parallel spacing of 18-inches on centers, and No. 3 tie-bars transversely placed at 18-inch maximum longitudinal intervals.
    - ii. Maintain a maximum clearance of one inch from bars to the edge of the concrete encasement.
    - iii. An exception shall be when 1 or 2 conduits only make up the duct bank. In this case a cage using 6"x6" road mesh will be acceptable as reinforcement.
  - i. Where ducts enter structures such as manholes, handholes, pullboxes, or buildings, terminate the ducts in suitable end bells, insulated bushings or couplings on PVC coated rigid steel or fiberglass conduits.
  - j. Slope duct runs for drainage away from buildings with a slope of approximately 3 inches per 100 feet.
  - k. Install a bare stranded copper duct bank ground in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system and connect to ground buses and to PVC coated rigid steel or fiberglass conduit extensions of underground duct system.
  - l. Install a detectable warning ribbon approximately 12 inches above all underground duct banks carrying cables of 480 volts and higher. The identifying ribbon shall be a PVC tape, 2-inches wide, red color, permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW" in black letters.
4. Empty Conduits:
  - a. Install nylon pull wire in each empty conduit and cap conduits not

- terminating in boxes with permanent fittings designed for the purpose.  
Nylon pull line shall have a minimum 500 lb. tensile strength.
- b. Identify each empty conduit with a durable tag showing the conduit number.
  - c. Install appropriate conduit caps with line attachment provisions.
5. Conduit Terminations:
- a. Install insulated bushings on conduits entering boxes or cabinets, except on threaded hub type boxes.
  - b. Provide locknuts on both inside and outside of enclosure for grounding. If hubs are not used, provide locknut and sealing O-ring on outside of enclosure with a bushing and locknut on the inside.
  - c. Bushings are not to be used in lieu of locknuts.
  - d. Grounding bushings shall be installed on all metallic conduits.
6. Corrosion Protection:
- a. In concrete slabs or floors, provide a four-inch high chamfered curb extending two inches from the outer surface of the conduit penetrating the floor, to prevent corrosion.
  - b. Terminate conduit stub-ups in couplings, slightly above the finished concrete curb. In exposed traffic areas transition PVC conduit to a PVC-coated rigid steel or fiberglass conduit stub-up.
  - c. Use plastic/nylon 1/4" minimum spacers to prevent aluminum in contact with masonry or concrete.
7. Non-metallic Conduit Installation:
- a. During installation provide expansion fittings for expansion and contraction to compensate for temperature variations. Expansion fittings shall be watertight and of the type suitable for direct burial.
  - b. Make transition to PVC coated rigid steel or fiberglass conduit before making turn up to enclosures.
  - c. Provide watertight expansion/deflection fittings at all wall and floor penetrations of all buildings and equipment concrete pads.
  - d. Minimum spacing for supports shall be 5'
8. Conduit Labeling System:
- a. All conduits shall be labeled using self-adhesive Brady B-580 or B-595 vinyl film conduit & voltage markers, color coded, minimize size: 1-1/8" x 4-1/2" with a 7/8" character height, as manufactured by the W.H. Brady Co. or approved equal.
    - i. Medium Voltage Power conduits (13.2KVAC, 4,160VAC) – Red
    - ii. Low Voltage Power conduits (480VAC to 120VAC) – Orange
    - iii. Control/Instrumentation (Control wires regardless of voltage) – Blue
    - iv. Intrinsically Safe conduits – Light Blue
    - v. Data & Communications (telephone, Ethernet, CCTV) – White
    - vi. Fiber Optic - Yellow
  - b. Installation:
    - i. All conduit including lighting and receptacle circuits shall be provided with unique conduit labels unless otherwise specified.
    - ii. Flexible conduit shall not be labeled.

- iii. Conduit labels shall convey the following information:
  1. Conduit Number: Alphanumeric, format provided by NEORS.
  2. Markers/purpose shall be provided to convey Conduit Purpose, with identifier prefix, as applicable, from the following list. All voltages are AC unless otherwise identified:
    - a. M (13,200 V/4160 V Power)
    - b. MT (13,200 V/4160 V Power Cable Tray)
    - c. P (480 V/277 V Power)
    - d. PT (480 V/277 V Power Cable Tray)
    - e. L (120 V Power or 24V AC Power)
    - f. C (120 V Control or 24V AC Control)
    - g. PC (480 V/277 V Power and 120 V Control Combined)
    - h. S (120 V or 24 V DC Status)
    - i. SC (120 V Status and 120 V Control Combined)
    - j. IN (4 to 20 mA DC Instrumentation)
    - k. H (24 V DC Control)
    - l. IH (4 to 20 mA DC Instrumentation and 24 V DC Control Combined)
    - m. IS (Intrinsically Safe)
    - n. D (Data and communications such as WAN, LAN, PLC, Modbus, telephone, and similar)
    - o. SH (24 V DC Status and 24 V DC Control Combined)
    - p. FA (Fire Alarm)
    - q. E (Empty conduit)

iv. Conduit Naming Convention:

P-	001 =	Conduit tag P-001
↑	↑	Conduit label color - Orange
Marker/Purpose,	Unique conduit identifier	
(from 8.b.iii.2 list)	(3 digit)	
(480V/277V Power)+(Conduit 001)		

Per NEC Art. 504, Intrinsically Safe conduits must be labeled “Intrinsic Safety Wiring”. Example:

**IS-001 INTRINSIC SAFETY WIRING**  
 Conduit label color – Light Blue

- v. Conduit labels shall be installed at the following locations:
  1. Where conduit enters and exits walls, ceilings, floors or slabs.
  2. Where conduit enters or exits boxes, cabinets, consoles, panels or enclosures, except conduit bodies used for pull boxes.
  3. At intervals of not more than 50 feet along the length of the conduit.
  4. Per NEC Art. 504, Intrinsically Safe conduits at intervals of not

- more than 25 feet along the length of the conduit.
- vi. Conduit labels shall be oriented so as to be readable.
- vii. All conduits including lighting and receptacle shall have a unique label. Multi-circuit conduits shall change when circuits are split at a pullbox or TEE fitting.

Flexible Conduit Installation:

- c. Limit flexible conduit length to six feet maximum.
9. Installation of Expansion Fittings:
    - a. Install expansion/deflection fittings where conduits cross structural expansion joints.
    - b. Exterior exposed conduits, every 200' maximum
  10. Installation of Outlet and Device Boxes:
    - a. To avoid mounting boxes directly on brick, masonry or concrete walls, provide suitable 1/2-inch non-metallic spacers to prevent mounting back of box directly against wall.
    - b. Leave no open conduit holes in boxes.
    - c. Outlet boxes/bodies to have external mounting provisions. Back drilling will not be permitted.
    - d. Label each cable and/or wire in boxes and identify with durable tag as to what circuit the cable and/or wire is connected.
  11. Installation of Pull and Junction Boxes:
    - a. Securely fasten boxes to walls or other structural surfaces with 1/2" spacing on which they are mounted. Provide independent supports where no walls or other structural surface exists. Interior supports are to be aluminum while exterior locations shall be stainless steel or fiberglass.
    - b. Install pull boxes in runs so that there are no more than (3) 90 degree bends, runs exceeding 200 feet and where required to conform with the National Electrical Code.
    - c. Raceways containing fiber optic cables and similar cable shall utilize long radius elbows and junction or pull boxes to maintain minimum bend radii for the cabling. The use of fittings (such as LB's) in lieu of long radius elbows, long radius field bends or oversized junction boxes shall not be permitted for installation of fiber optic cables.
    - d. Provide terminal blocks in junction boxes where cable terminations or splices are required. Terminal blocks are to be sized per the National Electrical Code.
    - e. Ceiling mounted enclosures are not to be permitted without the expressed written consent of the Engineer.
  12. Pull and Junction Box Labeling System:
    - a. All pull and junction boxes shall be labeled with nameplates. Nameplates shall be engraved laminated plastic with black letters and numerals engraved on a white background and shall have beveled edges. Nameplates shall be engraved with characters 1" high on boxes larger than 12" x 12" and 1/2" high on boxes smaller than 12" x 12". Nominal size of nameplates shall be 2"x 6", except where larger sizes are required to contain all data required or where smaller is necessary to fit on the face size of a smaller junction box. Attach nameplates using stainless steel machine



screws, drilled and tapped with thread seal, in order to maintain the NEMA rating of the enclosure.

13. Spare Conductor Requirements:

- a. For conduit runs that are entirely within NEC unclassified (non-hazardous) areas, provide 10% spares for each type and size of conductor in the conduit, with a *minimum* of two spares for each type and size. For calculations of spare capacity, round all fractional amounts up to the next whole number. For example, if there are 21 conductors, round the 2.1 spare conductor calculation to 3.
- b. Conduit that is routed in part or entirely within NEC classified (hazardous) areas, provide 15% spares for each type and size of conductor in the conduit, with a *minimum* of two spares for each type and size. For calculations of spare capacity, round all fractional amounts up to the next whole number. For example, if there are 21 conductors, round the 2.1 spare conductor calculation to 3.

14. Cable and Conductor Separation Requirements:

- a. Follow the minimum standards of the latest publication of IEEE 518, Paragraph 6.4.
- b. The following are minimum standards. If noise coupling, EMI, or RFI become an issue in any installation, then measures shall be taken above and beyond those in IEEE 518 in order to eliminate the coupling or interference.
- c. Voltage level and signal types are defined as follows:
  - i. Level 1 – Analog signals of less than 50 V and digital signals of less than 16 V.
  - ii. Level 2 – Analog signals greater than 50 V and switching circuits.
  - iii. Level 3 – Switching signals greater than 50 V, analog signals greater than 50 V, regulating signals of 50 V with currents less than 20 A, and AC feeders less than 20 A.
  - iv. Level 4 - AC and DC busses of 0 V to 1000 V with currents between 20 A and 800 A.
  - v. Level 4S – AC and DC busses greater than 1000V and/or greater than 800A.
- d. Separation Tables:

<i>Spacing Within a Tray, Wireway or Enclosure (inches)</i>					
Level	1	2	3	4	4S
1	0	1	6	26	26
2	1	0	6	18	26
3	6	6	0	6	12
4	26	18	6	0	0
4S	26	26	12	0	0

<i>Tray to Conduit Spacing (inches)</i>					
Level	1	2	3	4	4S
1	0	1	4	18	18
2	1	0	4	12	18
3	4	4	0	0	8
4	18	12	0	0	0
4S	18	18	8	0	0

<i>Conduit to Conduit Spacing (inches)</i>					
Level	1	2	3	4	4S
1	0	1	3	12	12
2	1	0	3	9	12
3	3	3	0	0	6
4	12	9	0	0	0
4S	12	12	6	0	0

15. Wiring Standards:
- a. Jumpering of control, signal, and common or return conductors shall not be allowed unless specifically called out in contract drawings.
  - b. All PLC I/O modules have isolated inputs and outputs. Therefore, PLC I/O and field devices shall not have any signals jumpered or shared at the device or I/O module.
  - c. All field devices, including but not limited to switches, shall not share a conductor for any signals. For example, a pair of limit switches shall be wired with four conductors and not three.

**Reference Standards**

1. NEC Article 300, Wiring Methods.
2. NEC Article 346, Rigid Metal Conduit.
3. NEC Article 347, Rigid Nonmetallic Conduit.
4. NEC Article 351, Liquid-Tight Flexible Metal Conduit.
5. NEC Article 370, Outlet, Switch and Junction Boxes and Fittings.
6. NEC Article 500, Hazardous (Classified) Locations.
7. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
8. UL Standard No. 6, Rigid Metal Electrical Conduit.
9. UL Standard No. 6A, Rigid Metal Electrical Conduit – Aluminum, Red Brass, and Stainless Steel
10. UL Standard No. 50, Electrical Cabinets and Boxes.
11. UL Standard No. 360, Liquid-Tight Flexible Steel Conduit.
12. UL Standard 467, Electrical Grounding and Bonding Equipment.

13. UL Standard No. 514, Electrical Outlet Boxes and Fittings.
14. UL Standard No. 651, Schedule 40 and 80 PVC Conduit.
15. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
16. ANSI C80.1, Specification for Zinc Coated Rigid Steel Conduit.
17. ANSI C80.5, Specification for Rigid Aluminum Conduit.
18. NEMA TC3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
19. NEMA RN1, PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
20. IEEE 518, Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources.

## Section 2 - 600 Volt Conductors

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This section provides the detailed requirements for 600-volt conductors. The types of 600-volt conductors and appurtenances detailed include the following:

- Insulated cable for installation in raceways.
- Multi-conductor power cables for installation in Cable Tray systems.

### Section 2.A - Detailed Specifications

1. Insulated Cable in Raceways:
  - a. Material: Single, stranded, copper conductor cable conforming to ASTM B 3 and B 8 with cross-linked polyethylene, cross-linked polyolefin, ethylene propylene, or thermoplastic insulation, rated 90 degree C in dry locations and 75 degree C in wet locations and listed by UL as Type XHHW.
  - b. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for control except No. 16 AWG is permitted in multi-conductor tray cables on power limited circuits.
  - c. Stranding: All conductors shall be stranded copper.
  - d. Products and Manufacturers:
    - i. Wire and Cable Division of Continental Wire and Cable.
    - ii. The Okonite Company.
    - iii. Pirelli Cable Corporation.
    - iv. Anaconda Wire and Cable, a Division of Cablec.
    - v. ITT Royal Electric.
    - vi. Or approved equal.
2. Power Conductors in Cable Tray:
  - a. Material:
    - i. Exterior Applications: Multi-conductor type TC tray cable, 90 degree C wet or dry rating. Sunlight resistant with cross-linked polyethylene insulation; impervious, continuous, corrugated aluminum sheath and low temperature PVC jacket. Individual conductors to have type XHHW insulation and are to be color coded for identification.
    - ii. Interior Applications: Multi-conductor type TC tray cable, 90 degree C wet or dry rating. Sunlight resistant, low temperature PVC jacket. Individual conductors to have type XHHW insulation and are to be color coded for identification.
  - b. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for control.
  - c. Stranding: All conductors shall be stranded copper.
  - d. Products and Manufacturers:
    - i. Southwire.
    - ii. The Okonite Company.
    - iii. Or approved equal.
3. Cable Connectors, Solderless Type:
  - a. For wire sizes up to #6 AWG, use compression type.

- b. Products and Manufacturer:
    - i. Burndy Hylug.
    - ii. T & B Sta-Kon.
    - iii. Or approved equal.
  - c. For sizes #4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
  - d. For sizes #250 KCM and larger, use connectors with at least 2 cable clamping elements or compression indents and provision for at least 2 bolts for joining to apparatus terminal
4. Wire Identification:
- a. Heat Shrinkable Wire and Cable Labeling System:
    - i. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be at least 2 inches in width.
    - ii. Products and Manufacturers:
      - 1. B-341 by Brady.
      - 2. Or approved equal.
  - b. Wrap-Around Wire and Cable Labeling System:
    - i. Self-laminating white/transparent self-extinguishing vinyl strips. Length shall be sufficient to provide at least two and one half wraps. Labels shall be thermally printed. Labels shall be at least 2 inches in width.
    - ii. Products and Manufacturers:
      - 1. B-427 by Brady.
      - 2. Or approved equal.

## **Section 2.B - Installation Details**

This section does not contain all installation details for the equipment/ system shown, only those that are required by the NEORS. These details may exceed those required by the equipment manufacturer or local codes.

- 1. Installation: Unless otherwise specified or shown, install all 600-volt wire and cable in conduit.
- 2. Bending Radius: To be limited to 6 times cable overall diameter, minimum except where the NEC requires a larger minimum limit.
- 3. Splices:
  - a. Install cable continuous, without splice, from termination to termination.
  - b. Where required, splice in junction box using terminal blocks.
  - c. Splices in conduits or condulets not permitted.
- 4. Wire and Terminal Labeling System:
  - a. All wire shall be labeled using heat, oil water and solvent resistant, vinyl, self-laminating, self-adhesive wrap type labels as manufactured by the W.H. Brady Co. or approved equal.
  - b. Wire and Cable Labels shall be provided as follows:
    - i. New, rerouted, or revised wire or cable shall be labeled.

- ii. All insulated conductors shall be labeled.
  - iii. Bare (uninsulated) conductors shall not be labeled unless otherwise shown or specified.
  - iv. Wire and cable terminations shall be labeled.
  - v. Wire labels shall be applied between half an inch and one inch of the completed termination.
  - vi. Cable labels shall be applied between half an inch and one inch of cable breakout into individual conductors.
  - vii. Individual conductors in a cable shall be labeled after the breakout as specified for wires.
  - viii. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
    - 1. Wires or cables shall be labeled within two inches of the entrance to the conduit.
  - ix. Wire or cable in junction boxes and pull boxes shall be labeled
    - 1. Wires or cables shall be labeled within two inches of the entrance to the conduit.
  - x. Wire and cable installed in cable tray shall be labeled.
    - 1. Wire and cable shall have labels applied at 20 foot maximum intervals.
  - xi. Wire and cable installed without termination in electrical manholes shall be labeled.
    - 1. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
  - xii. Hand written labels are not permitted.
5. Wire and Cable Identification System:
- a. Wire and Cable labels shall be imprinted with an identifying designator.
    - i. Wire and cable extending between two devices or items and which does not undergo a change of function shall be identified by a single unique designator as specified below.
  - b. All panel wires and field wires shall be color-coded and have an alphanumeric identification tag at each point of termination.
    - i. Wire within conduits accessible by removing covers of junction boxes and other devices in the conduit system shall be labeled.
6. Wire and Cable Tags for PLC to Field Devices:  
Format:

Source/Destination with Source being the PLC location (or MCC, etc.) and Destination being the field device tag (Instrument, valve, etc.)/wire tag number. Same tag installed on both ends of the wire (the PLC end and the field device end). Wire tag can be one extra-long self-adhesive, machine-printed wrap-around tag or two tags side by side. If two wire tags are used, then the Source goes on the first tag and Destination on the second tag. If the signal source was an MCC or other piece of equipment, then the PLC acronym would be replaced by the MCC or equipment number in the examples below. For analog signals, the cable is also tagged as shown below.

### **General Format: Source\_Destination.**

For a PLC to Field Device:

**PLC Acronym\_Rack#:Slot#:Point#\_Device (Instrument Tag).**

For an MCC to a Field Device/Wire Number:

**MCC (Panel ID & bucket)\_Device/Wire Number.**

*The Wire Number could be from a schematic, loop diagram, or other drawing.*

### **Examples:**

CSF is the acronym for the Easterly Chemical Storage and Feed Facility PLC, E\_23\_PLC\_**CSF**. Only use the PLC acronym (alpha-numeric abbreviation) that is shown in bold to represent the PLC. (The assumption is that the area number of the PLC will match the area number of the field device. If this is not the case, then use the full PLC ID. Example: 23-PLC-CSF)

Analog Input:

**CSF\_R3:S3:CH0+\_E-23-FIT-1010.**

**CSF\_R3:S3:CH0-\_E-23-FIT-1010.**

**Cable tags (both ends): CSF\_E-23-FIT-1010.**

Analog Output:

**CSF\_R3:S8:CH1+\_E-23-LI-1131.**

**CSF\_R3:S8:CH1-\_E-23-LI-1131.**

**Cable tags (both ends): CSF\_E-23-LI-1131.**

Discrete Input:

**CSF\_R2:S5:I.12\_E-23-ZSC-1011:**

*I.12 for IN-12 on the DI module.*

**Fused 120 VAC source of power for field contact/Discrete Input point:**

*22011\_E-23-ZSC-1011 (where 22011 is a sample numeric wire tag).*

Discrete Output:

**CSF\_R2:S14:O.1\_E-23-PB-1011:**

*0.1 for OUT1 on the DO module.*

**Fused 120 VAC source of power for Discrete Output point:**

*8601\_E-23-PB-1011 (where 8601 is a sample numeric wire tag).*

Label spare PLC I/O as follows:

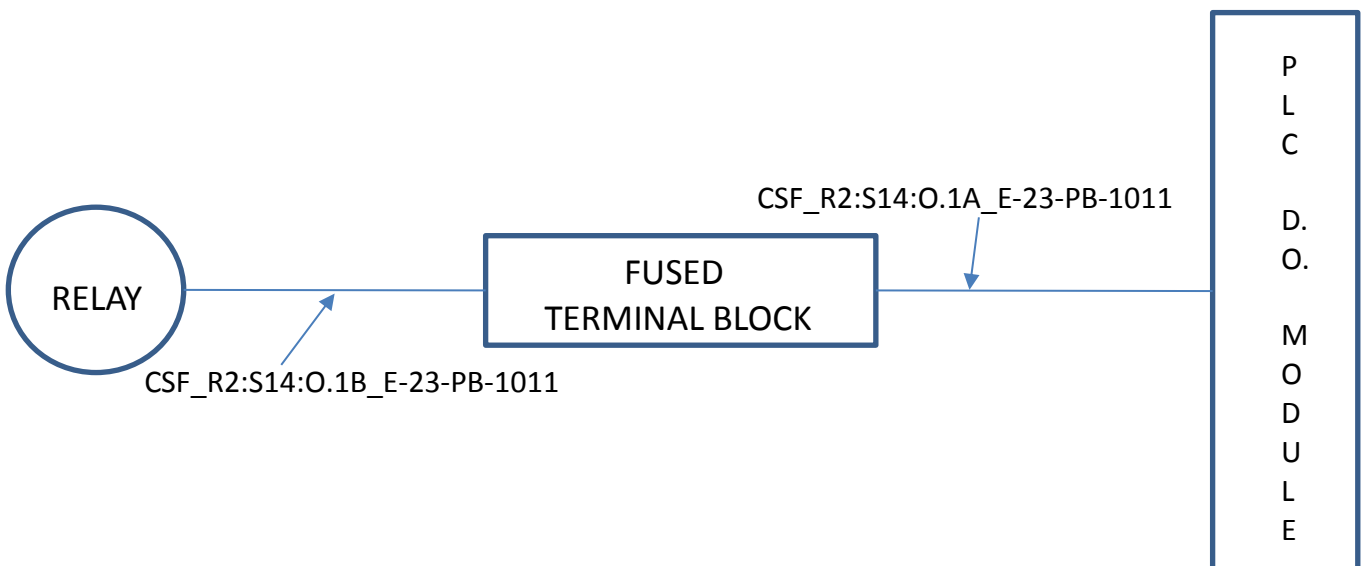
**CSF\_R3:S3:CH0+\_Spare 0+.**

**CSF\_R3:S3:CH0-\_Spare 0-.**

**CSF\_R2:S5:I.12\_Spare 12.**

**Label the wire from the PLC terminal to the interposing field terminal block. Place the label(s) at the end of the wire connected to the interposing field terminal block.**

**See below for sample wire tags for discrete outputs (D.O.) that are fused and wired to an interposing relay (suffixes A and B added after discrete output identifier to distinguish between the two wires).**





- a. Wiring terminated at a Cabinet, Console, Panel and Enclosure (no PLC)
    - i. The wire designator shall consist of an assigned alpha numeric designator.
  - b. Cables shall be labeled using the equipment/instrument tag number.
  - c. All terminals and terminal strips and posts shall be numbered with Mylar applique number labels.
7. Color Code Cables:
- a. Identification: Identify all conductors by circuit number and phase at each terminal location. Color code conductors as follows:
    - i. 120/208 Volt Systems (includes control power):
      - 1. Three Phase: Black, Red, Blue - Phases, White-Neutral.
      - 2. Single Phase: Black, Red – Phases, White Neutral.
    - ii. 480 Volt Systems: Brown, Orange, Yellow - Phases; Gray- Neutral.
    - iii. AC Control Wiring: Red
    - iv. DC Control Wiring: Blue (single wire circuits). For (+) DC Control Wiring: Blue; For (-) DC Control Wiring: White with blue trace.
    - v. DC Low Voltage Power Wiring: For (+): Red with white trace; For (-): Black with white trace.
    - vi. Intrinsic safe circuits: Light blue jacket; For (+) IS wiring: Light blue; For (-) IS wiring: Light blue with white trace.
    - vii. Conductors that remain energized when main disconnecting means is off: Yellow
    - viii. Grounding Conductors: Green.
  - b. Cable color to be continuously applied by manufacturer.

### **Reference Standards**

1. ASTM B 3, Soft or Annealed Copper Wire.
2. ASTM B 8, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-hard or Soft.
3. ICEA S-73-532/NEMA WC57, Control, Thermocouple Extension, and Instrumentation Cables
4. ICEA T-33-655 Low-Smoke, Halogen-Free (LSHF) Polymeric Cable Jackets.
5. IEEE/ANSI C2 Nation Electrical Safety Code.
6. NFPA Standard 70, National Electrical Code.
7. UL 44 Thermoset-Insulated Wires and Cables.
8. UL 83, Thermoplastic-Insulated Wires and Cables.
9. UL 83A, Fluoropolymer Insulated Wire.
10. UL 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
11. UL 1581, Electrical Wires, Cables, and Flexible Cords.
12. UL 1685, Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

## Section 3 – Instrumentation and Network Cabling

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This section provides the detailed requirements for instrumentation cabling. The types of instrumentation cabling include the following:

- Single Shielded Pairs and Triads for Analog Signals
- Multipair Shielded for Analog Signals
- Data Cable for RS-422 Communication
- Computer Communication Cable for Ethernet Protocol
- Remote I/O Communication Cable

### Section 3.A - Detailed Specifications

1. Single Shielded Pair and Triad Instrument Cable:
  - a. Tinned copper, stranded conductors, No. 18 AWG minimum, color coded polyethylene insulation on twisted conductors with 100 % coverage aluminum-polyester shield, stranded and tinned No. 18 AWG minimum copper drain wire and overall PVC jacket. Rated for 300 volts minimum.
  - b. Color code of pairs shall be black and clear for Belden No. 8719 or equal and black and white for Belden No. 3090A or equal. Black conductor shall be connected to the (+) terminal on devices and terminal blocks. Clear or white conductor shall be connected to the (-) terminal or common on devices and terminal blocks.
  - c. Color code of triads shall be black, red, and clear for Belden No. 8618 or equal and black, red, and white for Belden No. 3091A or equal.
  - d. Pair manufacturer and type:
    - i. Belden No. 8719
    - ii. Belden No. 3090A
    - iii. Or approved equal.
  - e. Triad manufacturer and type:
    - i. Belden No. 8618
    - ii. Belden No. 3091A
    - iii. Or approved equal.
2. Multipair Shielded:
  - a. Tinned copper, 18 AWG, 7 strand XLPE insulated conductors, twisted in pairs with aluminum-Mylar shield over each pair, silicone rubber fiberglass fire barrier tape, tinned copper drain wire, aluminum Mylar overall shield, Hypalon outer jacket. Rated for 300 volts minimum.
  - b. Products and Manufacturers:
    - i. Dekoron Poly-set.
    - ii. Okonite type SP-OS.
    - iii. Belden
    - iv. Or approved equal.
3. Data Cable for RS-422 Communication:
  - a. Precision-twisted shielded wire of EIA RS-232 and RS-422 standards type, having a uniform number of twists per unit of length. High

- characteristic impedance, not less than 150 ohms.
  - b. Capacitance between wires less than 20pF/foot (60pF/meter).
  - c. Solid foil with an overlapped folded seam and drain wire. Coverage shall be not less than 95%.
  - d. Outer jacket: Polypropylene.
  - e. Product and Manufacturers:
    - i. Belden 9182.
    - ii. Or approved equal.
4. Computer Communication Cable for Ethernet Protocol:
- a. Application: Enhanced Category 6 for non-plenum installation (most applications).
    - i. Conductor material: solid bare copper
    - ii. Conductor size and type: 23 AWG unshielded twisted pairs
    - iii. Number of conductor pairs: 4 (with rip cord)
    - iv. Conductor insulation: Polyolefin
    - v. Jacket material: PVC
    - vi. Impedance: 100 Ohms
    - vii. Maximum capacitance, unbalanced: 49.2 pf/100m
    - viii. UL approved
    - ix. Product and Manufacturers:
      - 1. Belden 1874A for plenum applications.
      - 2. Or approved equal.
  - b. Application: Enhanced Category 6 for plenum installation.
    - i. Conductor material: solid bare copper
    - ii. Conductor size and type: 23 AWG unshielded twisted pairs
    - iii. Number of conductor pairs: 4 (with rip cord)
    - iv. Conductor insulation: FEP Teflon
    - v. Jacket material: Flamarrest
    - vi. Impedance: 100 Ohms
    - vii. Maximum capacitance, unbalanced: 49.2 pf/100m
    - viii. UL approved, plenum rated
    - ix. Product and Manufacturers:
      - 1. Belden 1874A for plenum applications.
      - 2. Or approved equal.
  - c. Conductor insulation color codes:
    - i. Pair No. 1: white/blue stripe & blue
    - ii. Pair No. 2: white/orange stripe & orange
    - iii. Pair No. 3: white/green stripe & green
    - iv. Pair No. 4: white/brown stripe & brown
5. PLC Remote I/O Communication Cable:
- a. Application: Communication between PLCs and Remote I/O.
    - i. Conductor: Twin axial stranded, tinned copper 20 AWG.
    - ii. Conductor insulation: Polyethylene
    - iii. Shield: 100% coverage foil & minimum 55% coverage tinned copper braid with drain wire
    - iv. Impedance: 78 Ohms.

- v. Nominal capacitance: 19.7 pf/ft.
  - vi. Nominal attenuation: 7.5 dB/100 ft. @ 100.0 MHz.
  - vii. Outer Jacket: Blue PVC.
  - viii. Product and Manufacturers:
    - 1. Belden 9463.
    - 2. Or approved equal.
- b. Conductor insulation color codes: clear and blue

### **Section 3.B - Installation Details**

This section does not contain all installation details for the equipment/ system shown, only those that are required by the NEORS. These details may exceed those required by the equipment manufacturer or local codes.

1. Ground shield at panel end only. Opposite end is to be isolated.
2. Shield wires are to be terminated in panels, on their appropriate terminal, with their corresponding circuits.
3. Terminate stranded conductors with pre-insulated crimp type spade, insulated pin type or ring tongue terminal properly sized to fit fastening device and to fit wire size.
4. Instrumentation, communications, or network cable to be continuous. Splicing of these cables is not permitted.

### **Reference Standards**

1. NFPA 70, National Electrical Code.
2. ANSI C2, National Electrical Safety Code.
3. Underwriters Laboratories, Inc. (UL)

## **Section 4 – Patch Panels (Deleted)**

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See NEORSD Specification 27 21 00, Part 2.02 for patch panel, fiber patch panel, and fiber patch panel enclosure requirements.

## **Section 5 – Network Cabinets (Deleted)**

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Refer to NEORSD Specification Section 40 66 00, Part 2.07 and NEORSD Specification Section 27 21 00, Part 2.02 for the detailed requirements for network cabinets.

## **Section 6 – Modular Motor Protection System**

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This section provides the requirements for a motor protection system (MPS).

### **Section 6.A - Specifications**

Provide the Rockwell E300 Electronic Overload Relay or latest series of Rockwell Electronic Overload Relay

1. Modular design for application customization with sensing, control, and communication modules
2. Diagnostic information to monitor motor performance
  - a. Voltage, Current and Energy
  - b. Trip / Warning Histories
  - c. % Thermal Capacity Utilization
3. Logix integration with add-on profiles, add-on instructions, and faceplates
4. Supports Automatic Device Configuration
5. DeviceLogix™ Technology Enabled
6. Dual port EtherNet/IP
7. Provide modules and expansion I/O required for the application or as specified.

### **Section 6.B - Installation Details**

CONTRACTOR to provide and install all options, cables, and wiring that was not factory installed. CONTRACTOR to install MPS with all options and provide and install all mounting hardware and supports. CONTRACTOR to provide all programming and configuration of the MPS.