

SCOPE

- I ↕ 1.1 **This practice** covers the design of wiring and cable systems.
- I 1.2 **The contents of this practice** are arranged as follows:

TABLE OF CONTENTS

SCOPE.....	1
SUMMARY OF ADDITIONAL REQUIREMENTS.....	1
DOCUMENTATION	1
DEFINITIONS.....	2
WIRE AND CABLE CONSTRUCTION.....	3
UNDERGROUND CONDUIT SYSTEMS	4
DIRECT BURIED CABLE SYSTEMS.....	4
ABOVEGROUND WIRING SYSTEMS.....	6
WIRING SYSTEMS EXPOSED TO EQUIPMENT WITH HIGH FIRE POTENTIAL.....	9
DIFFERENT CIRCUITS RUN TOGETHER.....	9
PARALLELED CABLES.....	10
SEPARATE PHASE ENTRIES	10
SPLICE AND TERMINATION DESIGN.....	10

- I ↕ 1.3 **An asterisk (*)** indicates that a decision or approval by the purchaser is required or that additional information is to be furnished by the purchaser.
- I ↕ 1.4 The following references are synonymous: **BP and IP**.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I ↕ 2.1 **Table 1** lists the practice which shall be used with this practice.
- I ↕ *2.2 **Purchase and use of wire, cable, and wiring materials** shall conform to nationally recognized codes and standards which are approved by Owner's Engineer and which are acceptable within the country where the equipment and materials will be used. **Table 2** lists specifications and standards which shall be applied for wire, cable, and wiring materials purchased to U.S.A. standards.

TABLE 1

PRACTICE
IP 14-3-1 Fireproofing

DOCUMENTATION

- M 3.1 **"As built" layout drawings** of all underground electrical distribution shall be furnished in sufficient detail and accuracy to serve as a record of the installation for maintenance. The drawings shall show all underground splice points.
- S 3.2 **For direct buried cable systems**, the contractor's drawings shall specify the procedures to be followed in the field to ensure that aboveground cable markers, as finally installed, accurately show cable trench locations. These drawings shall also include cross-section diagrams of all trenches and duct banks showing location of all cables.
- R ↕ 3.3 **For cables rated over 1000 volts** the contractor's construction drawings shall show complete details of, or specific reference to, cable manufacturer's specifications for all splices and terminations.
- S *3.4 **A list of all aboveground wiring circuits or sections of wiring circuits requiring fireproofing** shall be prepared by the contractor for approval by the Owner's Engineer. The list shall include:
 - a. An identification of the sources of sustained fire and the proximity to wiring
 - b. The length and location of that section of each circuit requiring fire protection

- I 3.5 **Vendor shall provide documentation showing equipment meets the approval requirements of the local authority.** Approval requirements may include labeling, listing, or certification by a nationally-recognized testing organization acceptable to the local authority.



TABLE 2

SPECIFICATIONS AND STANDARDS			
AEIC Specifications		ANSI / UL Standards (Cont.)	
CS1	Impregnated-Paper-Insulated Metallic-Sheathed Cable, Solid Type	UL 514C	Nonmetallic Outlet Boxes, Flush Device Boxes, and Covers
CS3	Impregnated-Paper-Insulated, Metallic-Sheathed Cable, Low-Pressure Gas-Filled Type	UL 651	Schedule 40 and 80 Rigid PVC Conduit
CS4	Impregnated-Paper-Insulated, Low and Medium Pressure Self-Contained Liquid Filled Cable	UL 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit
ANSI Standards		UL 719	Nonmetallic-Sheathed Cables
C80.1	Rigid Steel Conduit, Zinc Coated	UL 797	Electrical Metallic Tubing
C80.3	Electrical Metallic Tubing, Zinc Coated	UL 870	Wireways, Auxiliary Gutters and Associated Fittings
C80.4	Fittings for Rigid Metal Conduit and EMT	UL 884	Underfloor Raceways and Fittings
C80.5	Rigid Aluminum Conduit	ICEA / NEMA Standard	
ANSI / IEEE Standards		S-19-81	Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-3)
C2	National Electrical Safety Code Part 2 -- Safety Rules for Installation and Maintenance of Overhead Supply and Communication Lines	S-61-402	Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5)
ANSI / NFPA Standard		S-66-524	Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-7)
70	National Electrical Code	S-68-516	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-8)
ANSI / UL Standards		NEMA Standard	
UL 1	Flexible Metal Conduit	FB 1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
UL 4	Armored Cable	VE 1	Metallic Cable Tray Systems
UL 5	Surface Metal Raceways and Fittings	UL Standard	
UL 44	Rubber-Insulated Wires and Cables	6	Rigid Metal Conduit
UL 83	Thermoplastic-Insulated Wires and Cables		
UL 209	Cellular Metal Floor Raceways and Fittings		
UL 493	Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables		
UL 514A	Metallic Outlet Boxes		
UL 514B	Fitting for Conduit and Outlet Boxes		

DEFINITIONS

- I ♦ *4.1 **Acceptable and Preferred Practices.** Where this practice lists more than one type of equipment or method as acceptable, the contractor shall make the selection based on total installed cost. Where one particular type of equipment or method is listed as preferred, it shall be selected, provided it is lower or equivalent in total installed cost to other acceptable types or methods. Optimum cost benefits may be achieved by reducing maintenance and operating expense through initial added investment. Economic basis for calculating optimum cost benefits will be included in the general job specification. Owner's Engineer shall approve alternative choices.
- I 4.2 **Metal covered cables** are defined as cables having one of the following metallic coverings over the insulation:
- ♦
- a. Armor, including: flat or interlocked galvanized-steel tape; interlocked aluminum tape; galvanized-steel wire, polymer-coated steel wire, or copper wire; seamless or welded corrugated-steel or corrugated-bronze tube, or corrugated-aluminum tube (when approved by Owner's Engineer)
 - b. Lead sheath
 - c. Copper or stainless steel sheath, for mineral insulated (MI) type cables
 - * d. Aluminum sheath (when approved by the Owner's Engineer)
- I 4.3 **Cable sheaths** are defined as continuous metallic coverings.

- I 4.4 See [IP 14-3-1](#) for definitions of the following terms:
- Low temperature rated insulation**
 - High temperature rated insulation**
 - Fire-rated Cable**
 - Flammable liquids**
 - Equipment with high fire potential**

WIRE AND CABLE CONSTRUCTION

CONDUCTORS

- R 5.1 **Copper conductors** shall be used unless Owner's Engineer approves use of aluminum for medium-voltage cables or for overhead lines.
- R 5.2 **Stranding** is required for **conductors** 10 AWG (or 6 mm²) and larger.

INSULATION

- R 5.3 **Cross-linked polyethylene insulation** shall be of the **tree-retardant** type for cables rated at or above 5 kV between conductors.
- R 5.4 **Wires and cables insulated with polyvinyl chloride** shall not be used for **direct current** circuits in moist locations which carry sufficient current for sustained conductor heating.
- R 5.5 **Impregnant migration**. If elevation differences exceeding 30 feet (10 m) exist in any run of paper insulated cable and cable other than non-draining type is used, the following measures shall be taken:
- Cable sheath shall be specified to be suitable for the required elevation difference.
 - If the condition of **Subpar. a. above** cannot be met, stop joints shall be installed as recommended by the manufacturer.

SHIELDING

- C,R 5.6 **Insulation shielding** shall **not** be provided on single or multiple conductor cables **rated less than 5000 volts** between line conductors on grounded or ungrounded systems, unless shielding is approved by Owner's Engineer. Nonshielded cables operating above 2000 volts shall be listed by a nationally recognized testing organization and approved for the service in which they are to be applied. Insulation shielding is required for all cables operated above 8000 volts, and for direct burial cables operated above 5000 volts. Semiconductor insulation-shielding shall be extruded over the insulation. Tandem extrusion of strand shield, conductor insulation, and insulation semi-conducting shields is preferred.

JACKETS

- R 5.7 An outer thermosetting or thermoplastic jacket is required for cables with flexible steel armor installed indoors, and for outdoor and underground installations of cables with armor, or cables with lead sheaths or aluminum sheaths. Armored cables which operate above 1000 volts between phases shall also have a thermosetting or thermoplastic jacket under the armor. Asphaltic or similar flammable outside coatings shall not be used.
- S 5.8 Cables which operate above 2000 volts between phases and which do not have insulation shielding, metallic sheaths or armor shall have jackets which are resistant to ozone, electric discharge, and surface tracking. Such jackets for multiple conductor cables shall be a common covering over the assembled single conductor cables.
- S 5.9 **Silicone rubber insulated cable used to meet "high temperature rated" requirements** shall have a glass braid jacket over the insulation of each conductor. Additionally, as needed for moisture or mechanical protection, a polyvinyl chloride jacket, overall, shall be provided.

IP 16-3-1	Wiring Methods and Material Selection	
Page 4 of 11		
Rev. 0 June 1997		

UNDERGROUND CONDUIT SYSTEMS

DUCT BANKS

- S ♦ 6.1 All underground conduit runs in an underground conduit system shall be **encased in red concrete**, and shall be composed of rigid metal, intermediate metal, or thin-walled thermoplastic conduit (including conduit fittings). Steel conduit shall be hot-dipped galvanized inside and out. Aluminum conduit shall be made of a corrosion-resistant alloy containing not more than 0.4% copper. Encased conduit runs are referred to in this practice as **duct banks**. The minimum thickness of encasement shall be 3 in. (75 mm) on the top, and 2 in. (50 mm) on the sides and bottom. Where conduits rise above grade, the concrete encasement shall extend 6 in. (150 mm) above grade. Where conduits run through equipment foundations or building floor slabs, the red concrete encasement shall butt the underside of the foundation or slab.
- S ♦ *6.2 The top of concrete encasement of duct banks shall be a minimum of 18 in. (450 mm) below grade. Unless otherwise specified, the top of the encasement at road and railroad crossings shall be a minimum of 30 in. (750 mm) below the road surface or rail base. Duct banks shall be reinforced as required.
- S 6.3 Non-metallic conduits shall not be extended above grade except for stub-ups in unclassified locations within switchgear, control centers, and similar equipment enclosures. Where above grade extensions are required, transition to rigid metal conduit shall be made underground.
- I ♦ 6.4 Conduit sealing shall be per **Pars. 8.2 through 8.4**.

PULL POINTS

- S ♦ *6.5 In **Class I Division 1 and 2** locations, all **pull points shall be located** above grade, unless a sand-filled pull pit is specified and the design is approved by Owner's Engineer. Below grade pull points, such as manholes shall not be used in other locations unless specified. When specified, design requirements will be furnished by the Owner's Engineer.
- C 6.6 Where above grade pull points are used, a **separate pull box or enclosure** shall be provided for each circuit. However, a **common pull box or enclosure** may be used for power circuits and their associated control circuits when run in the same conduit, such as motor feeder and associated pushbutton circuit.

DIRECT BURIED CABLE SYSTEMS

- S ♦ 7.1 **Metal-covered cable** shall be used in direct buried cable systems **for the following voltages**:
 - a. Grounded systems operating above 125 V from line-to-ground
 - b. Ungrounded systems operating above 125 V between lines

Note: Use of flexible metal-tape armor (non-interlocked), where it emerges above ground into Class I Division 2 areas, requires the approval of Owner's Engineer.
- R ♦ 7.2 **For lower voltages** than described in **Par. 7.1**, **cables need not be metal-covered** if they are multi-conductor and have an outer jacket at least 0.045 in. (1.14 mm) thick.

CABLE TRENCHES

- M,R ♦ 7.3 **Cable tiers and congested areas.** Cables shall be laid in trenches without crossings except at transitions to multi-tier duct banks. Cables shall normally be laid in a **single horizontal tier**. When direct buried cables must pass through **congested areas** where a single tier does not fit, Owner's Engineer may approve either a design using **two tiers** of cables in a cable trench, or a design using duct bank with the option of a single tier of direct buried cables installed above the duct bank.
- R 7.4 **The route of cable trenches** shall avoid above-ground and underground obstructions so as to maintain reasonable access to the buried cables. Wherever practical, trenches shall run in unpaved areas. A minimum clearance of 12 inches (300 mm) shall be maintained between cables and parallel runs of underground piping. Cables shall not be located under parallel runs of low-level above-ground piping which could block access to the cables, or close to parallel runs that will be expanded over the cables in the future.
- S ♦ 7.5 **Sand bedding and protective covering.** Cables shall be laid on top of a layer of sand 4 in. (100 mm) thick, and then covered with a layer of sand 4 in. deep as measured from the top of the largest cable. A 2 in. (50 mm) thick protective covering of red concrete, either precast slabs (preferred) or cast-in-place concrete (alternative) shall be provided on top of the sand and the remainder of the trench backfilled with soil.