

IEEE Recommended Practice for Electrical Installations on Shipboard— Cable Systems

IEEE Industry Application Society

Sponsored by the
Petroleum and Chemical Industry Committee

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IEEE Recommended Practice for Electrical Installations on Shipboard— Cable Systems

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IEEE Industry Application Society

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Abstract: Recommendations are provided for selection, application, and installation of electrical power, signal, control, data, and specialty marine cable systems on shipboard.

Keywords: cable application, cable installation, cable selection, cable systems, control cable, data cable, IEEE 45.8™, offshore drilling and production platforms, power cable, shipboard systems, signal cable, specialty marine cable

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Introduction

This introduction is not part of IEEE Std 45.8-2016, IEEE Recommended Practice for Electrical Installations on Shipboard—Cable Systems.

IEEE Std 45.8 is a member of the IEEE Std 45™ series of documents. Although intended to provide a consensus of recommended practices for cable systems on shipboard, this document may also be of benefit for information purposes in the proper selection and installation of wire and cable in commercial or military coastal vessels, or offshore drilling and production platforms. These cables include low-voltage cables, medium voltage cables, and specialty cables.

Contents

1. Overview	9
1.1 Scope	9
1.2 Purpose	9
1.3 Application of various national and international standards	10
1.4 Equipment construction, testing, and certification	10
2. Normative references	10
3. Definitions	13
4. Cable types	14
4.1 Marine shipboard cable	14
4.2 Navy cable	15
4.3 Data and communication cables	15
4.4 Specialty cables	16
5. Cable applications	18
5.1 AC applications	18
5.2 DC applications	18
5.3 Electrical considerations	18
5.4 Accommodation spaces/areas containing sensitive electronic equipment	20
5.5 Variable frequency drive applications	20
5.6 Fieldbus cables	20
5.7 Ampacity	21
5.8 Armored cables	30
5.9 Corrosion protection	30
5.10 Skin effect ratio	30
5.11 Short-circuit considerations	31
5.12 Fire safety considerations	31
5.13 Spare conductors	31
6. Cable installation	31
6.1 Single-conductor ac cables- special considerations	31
6.2 Optical fiber cables—special considerations	32
6.3 Cable continuity and grounding	34
6.4 Cable locations	34
6.5 Cable penetrations	36
6.6 Cable protection	39
6.7 Cable rodent protection	39
6.8 Cable support and retention	39
6.9 Radii of bends	41
6.10 Cable pulling tension	42
6.11 Cable splicing	43
6.12 Medium voltage cable termination	44
6.13 Cold temperature installation	45
Annex A (informative) Bibliography	46
Annex B (informative) Ancillary topics	48
B.1 Corrosivity	48
B.2 Toxicity	48
B.3 Cable pulling tension	48

IEEE Recommended Practice for Electrical Installations on Shipboard—Cable Systems

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1. Overview

IEEE Std 45.8 is a member of the IEEE Std 45™ series of documents. Although intended to provide a consensus of recommended practices for cable systems on shipboard, this document may also be of benefit for information purposes in the proper selection and installation of wire and cable in commercial or military coastal vessels, or offshore drilling and production platforms. These cables include low-voltage cables, medium voltage cables, and specialty cables.

1.1 Scope

The scope of this document is to provide recommendations for selection, application, and installation of electrical power, signal, control, data, and specialty marine cable systems on shipboard. These recommendations include the present day technologies, engineering methods, and engineering practices.

1.2 Purpose

IEEE Std 45.8 is intended to provide a consensus of recommended practices for the selection, application, and installation of electrical power, signal, control, data, and specialty marine cable systems on shipboard.

1.3 Application of various national and international standards

It is recognized that various national and international standards for equipment and installations are not identical. However, it is recognized that mixing of standards is occasionally necessary. Therefore, the application of any of these standards is the choice of the user, authority having jurisdiction, and classification society.

1.4 Equipment construction, testing, and certification

Electrical apparatus and equipment should be constructed and tested in accordance with the requirements of appropriate national and international equipment standards. Standards specifically addressing marine requirements should be used whenever applicable. Many appropriate standards are referenced in this document. All electrical equipment should be tested and certified, with labeling and follow-up services (i.e., listed) by a recognized independent laboratory acceptable to the authority having jurisdiction.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI/NEMA WC-58-2008/ICEA S-75-381, Portable and Power Feeder Cables for Use in Mines and Similar Applications.¹

API RP 14F Ed. 5 (2008/2013), Design and Installation of Electrical Systems for Fixed and Floating Offshore API Petroleum Facilities for Unclassified and Class I, Division 1 and Division 2 Locations.²

API RP 14FZ Ed. 2 (2013), Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class 1, Zone 0, Zone 1, Zone 2 Locations.

ASTM B3-13, Standard Specification for Soft or Annealed Copper Wire.³

ASTM B355-11, Standard Specification for Nickel Coated Soft or Annealed Copper Wire.

EN 50288-7:2005, Multi-element Metallic Cables Used in Analog and Digital Communication and Control. Sectional Specification for Instrumentation and Control Cables.⁴

CSA C22.2 No 239-09 (R2014), Control and Instrumentation Cables.⁵

CSA C22.2 No. 245-95 (R2014), Marine Shipboard Cable.

¹ANSI/NEMA publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

²API publications are available from the Publications Section, American Petroleum Institute, 1200 L Street NW, Washington, DC

³ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (<http://www.astm.org/>).

⁴EN publications are available from Thomson Reuters, <http://www.techstreet.com>

⁵CSA publications are available from the Canadian Standards Association (Standards Sales), 178 Rexdale Blvd., Etobicoke, Ontario, Canada M9W 1R3 (<http://www.csa.ca/>).

ICEA P-32-382, Ed. 7, Short Circuit Characteristics of Insulated Cables.⁶

ICEA P-45-482, Ed. 13, Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables.

IEC 60079-11 Ed. 6.0, Explosive atmospheres—Part 11: Equipment protection by intrinsic safety “i”.⁷

IEC 60079-14 Ed. 5.0, Explosive atmospheres—Part 14: Electrical installations design, selection and erection.

IEC 60079-28 Ed. 1.0, Explosive atmospheres—Part 28: Protection of equipment and transmission systems using optical radiation.

IEC 60331-11 Ed. 1.1, Tests for electric cables under fire conditions—Circuit integrity—Part 11: Apparatus—Fire alone at a flame temperature of at least 750 °C.

IEC 60331-21 Ed. 1.0, Tests for electric cables under fire conditions—Circuit integrity—Part 21: Procedures and requirements—Cables of rated voltage up to and including 0.6/1.0 kV.

IEC 60331-23 Ed. 1.0, Tests for electric cables under fire conditions—Circuit integrity—Part 23: Procedures and requirements—Electric data cables.

IEC 60331-25 Ed. 1.0, Tests for electric cables under fire conditions—Circuit integrity—Part 25: Procedures and requirements—Optical Fibre cables.

IEC 60794-2 Ed. 3.0, Optical Fibre Cables—Part 2: Indoor Cables—Sectional Specifications.

IEC 60966-1 Ed. 2.0, Radio frequency and coaxial cable assemblies—Part 1: Generic specification—General requirements and test methods.

IEC 61914, Cable cleats for electrical installations.

IEEE Std 45.7TM-2012, IEEE Recommended Practice for Electrical Installations on Shipboard—AC Switchboards.^{8, 9}

IEEE Std 48TM-2009, IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cable Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.

IEEE Std 515TM-2011, IEEE Recommended Practice for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.

IEEE Std 1202TM-2006, IEEE Standard for Flame-Propagation Testing of Wire & Cable.

IEEE Std 1580TM-2010, IEEE Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Platforms.

IEEE Std 1717TM-2012, IEEE Standard for Testing Circuit Integrity Cables Using a Hydrocarbon Pool Fire Test Protocol.

⁶ICEA publications are available from the IHS Standards Store, <https://global.ihs.com/>

⁷IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>).

⁸IEEE publications are available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>)

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Foundation™ Specification—H1 Cable Test Specification FF-844” Rev. FS.12- Jan. 6, 2011.

MIL-DTL-17H, Military Specification: General Specification for Cables, Radio Frequency, Flexible and Semirigid.¹⁰

MIL-DTL-915G, Detail Specification: General Specification for Cable, Electrical, For Shipboard Use.

MIL-DTL-24640C, Detail Specification: General Specification for Cables, Light-Weight, Electric, For Shipboard Use.

MIL-DTL-24643C, Detail Specification: General Specification for Cables, Electric, Low Smoke Halogen-Free For Shipboard Use.

MIL-HDBK-299, Military Handbook: Cable Comparison Handbook Data Pertaining To Electrical Shipboard Cable.

MIL-PRF-85045G, Performance Specification: Fiber Optic, General Specification For.

NFPA 70, National Electrical Code® (NEC®).

UL 13, Ed. 3, July 23, 2007 Standard for Safety for Power-Limited Circuit Cables.¹¹

UL 44, Ed. 18, February 9, 2014, Standard for Safety for Thermoset-Insulated Cables.

UL 60079-11 Ed. 6.0, Explosive atmospheres—Part 11: Equipment protection by intrinsic safety “i” .

UL 62, Ed. 19, March 14, 2014, Standard for Safety for Flexible Cords and Cables.

UL 486A-486B, Ed. 2, January 11, 2013, Standard of Safety for Wire Connectors.

UL 486E, Ed. 4, May 7, 2009, Standard for Safety for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

UL 1277, Ed. 5, April 21, 2010, Standard for Safety For Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

UL 1309, Ed. 2, April 5, 2011, Standard for Safety Marine Shipboard Cable.

UL 1569, Ed. 4, November 23, 2014, Standard for Safety for Metal-Clad Cables.

UL 1651, Ed. 3, July 8, 2008, Standard for Safety for Optical Fiber Cable.

UL 2196, Ed. 1, March 30, 2012, Standard for Safety for Tests for Fire Resistive Cables.

UL 2225, Ed. 4, September 30, 2013, Standard for Safety for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

UL 2250, Ed. 2, April 3, 2006, Standard for Safety for Instrumentation Tray Cable.

UL 2556, Ed. 3, March 22, 2013, Standard for Safety for Wire and Cable Test Methods.

¹⁰MIL publications are available from Customer Service, Defense Printing Service, 700 Robbins Ave., Bldg. 4D, Philadelphia, PA 19111-5094 (<http://store.mil-standards.com>).

¹¹UL standards are available from Underwriters Laboratories standards website (www.ulstandards.com).

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.¹²

accommodation spaces: Spaces provided for passengers and crew members that are used for berthing, dining rooms, mess spaces, offices, private baths, toilets and showers, lounges, and similar spaces.

adjustable speed drive (variable frequency drive): A converter using solid state switching devices that has the capability of adjusting the frequency and voltage of the output waveform to provide speed and torque control of motors.

communication and electronics circuits: Electrical circuits supplying equipment and systems for voice, sound, or data transmission, such as telephone, engine order telegraph, data communication, interior communication, paging systems, wired music systems, fire and general alarm systems, smoke and fire detection systems, closed circuit television, navigational equipment, and microprocessor-based automated alarm and control systems.

deluge: A condition where equipment is exposed to an abnormal volume of water during extreme weather, testing, maintenance, or fire suppression.

double banked: The arrangement of cables in a cable tray or raceway wherein the cables are stacked in two layers.

feeder: A cable or set of conductors that originates at a main distribution center (main switchboard) and supplying secondary distribution centers, transformers, or motor control centers. (Bus tie circuits between generator and distribution switchboards, including those between main and emergency switchboards, are not considered as feeders.)

hydrocarbon pool fire: A fire that occurs when a flammable liquid leaks from a vessel or pipeline to form a fluid reservoir, which then ignites.

intrinsically safe circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

lug: A wire connector device to which the electrical conductor is attached by mechanical pressure or solder.

machinery spaces: Spaces that are primarily used for machinery of any type, or equipment for the control of such machinery, such as boiler, engine, generator, motor, pump, and evaporator rooms.

multicable penetrator (multicable transit MCT): A device consisting of multiple nonmetallic cable seals assembled in a surrounding metal frame, for insertion in openings in decks, bulkheads, or equipment enclosures and through which cables may be passed to penetrate decks or bulkheads or to enter equipment without impairing their original fire or watertight integrity.

NRTL: A nationally recognized testing laboratory as recognized by the U.S. Occupational, Safety, and Health Administration (OSHA) or the Authority Having Jurisdiction.

single banked: The arrangement of cables in a cable tray or raceway wherein the cables are installed in a single layer with a spacing of less than one cable diameter.

switchboard: A metal-enclosed panel or assembly of panels that may contain molded case, insulated case or power circuit breakers, bolted pressure contact or fusible switches, protective devices, and instruments. These devices may be mounted on the face or the back of the assembly. Switchboards are generally accessible from the rear as well as from the front; however, they can be front accessible only.

¹²IEEE Standards Dictionary Online subscription is available at: <http://ieeexplore.ieee.org/xpls/dictionary.jsp>.

triplex cable assembly: A cable assembly composed of three insulated single conductor cables twisted together.

variable frequency drive (VFD): A converter using solid state switching devices that has the capability of adjusting the frequency and voltage of the output waveform to provide speed and torque control of motors.
Syn: **adjustable speed drive.**

vital services: Services normally considered to be essential for the safety of the ship and its passengers and crew. These usually include propulsion, steering, navigation, firefighting, emergency power, emergency lighting, electronics, and communications functions.

4. Cable types

Cables for installation on shipboard shall be listed as marine shipboard cable, Navy cable, or other cable as described in this clause.

Various cable constructions are detailed in IEEE Std 1580, permitting a selection of conductor insulation types, jacket types, armor, and ampacities. Cable constructions intended for specific applications and different voltages are also included. The application of each respective type is defined in the following paragraphs of this subclause.

4.1 Marine shipboard cable

Marine shipboard cables shall be listed as Marine Shipboard Cable by a Nationally Recognized Testing Laboratory (NRTL). These cables should meet the performance and construction requirements of IEEE Std 1580, UL 1309, or CSA 22.2 No. 245.

4.1.1 Power cables

4.1.1.1 Low-voltage cables (600 V to 2000 V)

These cables should be used for the distribution of power up to their voltage rating throughout the system, and they may be used in lighting, communication, control, and electronic circuits as desired.

4.1.1.2 Medium-voltage cables (2001 V to 35000 V)

These cables should be used for the distribution of power up to their voltage rating. Distribution cables rated 2001 V and above shall be shielded.

4.1.1.3 Variable frequency drive (VFD) cables

These cables should be used for AC adjustable speed drives (ASD). In the absence of drive manufacturer's recommendations, refer to IEEE Std 1580 for specific cable construction.

4.1.2 Control and signal (Instrumentation) cables

4.1.2.1 Signal (Instrumentation) cables (300 V, 600/1000 V)

These cables should be used for signal transmission where twisted groups of conductors are desired. Individual or overall group shielding may be provided by means of a polyester/metal laminate tape and drain (ground) wire or a tinned copper braid, or a combination of both to prevent electrostatic or electromagnetic interference.

4.1.2.2 Control cables (600/1000 V)

These cables should be used for control, communication, indicating, electronic, and similar circuits.

4.2 Navy cable

Navy cables manufactured and tested in accordance with U.S. Navy military specifications MIL-DTL-24640C, MIL-DTL-24643C, MIL-DTL-915G, or MIL-PRF-85045G may also be used, provided they meet the IEEE Std 1202 or UL 2556 FT-4 Vertical Flame Test.

4.3 Data and communication cables

Data cables designed for use onboard ships and other areas such as drilling and production platforms, and on drillships, should be “ruggedized” to meet the operating conditions in such areas. These cables include, but are not limited to, Controller Area Network (CAN) cables; Category Cables; Low Voltage Differential Signaling Cables (LVDS); Differential balanced lines like RS-485; unbalanced (Single Ended) unidirectional cables like RS-232; Fieldbus and Profibus cables; Optical Fiber Cables; Composite Cables for CCTV, Coaxial Cables; Triaxial Cables; Mineral Insulated Cables, etc.

These data cables shall be constructed in accordance with their applicable standards and, when possible, meet the flammability requirements of IEEE Std 1202. It should be noted that data and communication cables may not meet the flame test of IEEE Std 1202. Where these cables do not comply with the IEEE Std 1202 flame test, the installation is to be provided with suitable fire stop arrangements meeting statutory and classification requirements.

In view of the wide variety of data cables, only some of them are highlighted in this subclause. Additional data cable types can be added as they find wider use in the maritime applications.

4.3.1 Fieldbus cables

Fieldbus cable is a Local Area Network cable for use in industrial automation applications establishments for process control. Fieldbus cable provides two-way communication protocol for devices such as actuators, transmitter and flame detectors, temperature and pressure measurement, motor starters, and limit switches.

4.3.2 Profibus cables

Profibus cables are designed for low level serial communication. The generic name Profibus is derived from the term “Process Field Bus”. It utilizes an application independent communication protocol. It allows