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An American National Standard

Standard Guide for Cable Splicing Installations[1]

This standard is issued under the fixed designation F1835; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide provides direction and recommends cable splicing materials and methods that would satisfy the requirements of extensive cable splicing in modular ship construction and offers sufficient information and data to assist the shipbuilder in evaluating this option of cable splicing for future ship construction.

1.2 This guide deals with cable splicing at a generic level and details a method that will satisfy the vast majority of cable splicing applications.

1.3 This guide covers acceptable methods of cable splicing used in shipboard cable systems and provides information on current applicable technologies and additional information that the shipbuilder may use in decision making for the cost effectiveness of splicing in electrical cable installations.

1.4 This guide is limited to applications of 2000 V or less, but most of the materials and methods discussed are adaptable to higher voltages, such as 5-kV systems. The cables of this guide relate to all marine cables, domestic and foreign, commercial or U.S. Navy.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

D2671 Test Methods for Heat-Shrinkable Tubing for Electrical Use

2.2 *IEEE Standards:*[3]

IEEE 45 Recommended Practice for Electrical Installations on Shipboard

2.3 *UL Standards:*[4]

UL STD 224 Extruded Insulating Tubing

UL STD 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

2.4 *IEC Standards:*

IEC 228 Conductors of Insulated Cables[5]

2.5 *Federal Regulations:*[6]

Title 46 Code of Federal Regulations (CFR), Shipping

2.6 *Military Specifications:*

MIL-T-16366 Terminals, Electric Lug and Conductor Splices, Crimp-Style

MIL-T-7928 Terminals, Lug, Splices, Conductors, Crimp-Style, Copper

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *adhesive, n*—a wide range of materials used extensively for bonding and sealing; coating added to the inner wall of heat-shrinkable tubing to seal the enclosed area against moisture. Adhesive is for pressure retention and load-bearing applications (see also *sealant*).

3.1.2 *barrel, n*—the portion of a terminal that is crimped; designed to receive the conductor, it is called the wire barrel.

[1] This guide is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.10 on Electrical.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, http://www.ieee.org.

[4] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.

[5] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, https://www.iec.ch.

[6] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

3.1.3 *butt connector, n*—a connector in which two conductors come together end to end with their axes in line, but do not overlap.

3.1.4 *butt splice, n*—device for joining conductors by butting them end to end.

3.1.5 *circumferential crimp, n*—final configuration of a barrel made when crimping dies completely surround the barrel and form symmetrical indentations.

3.1.6 *compression connector, n*—connector crimped by an externally applied force; the conductor is also crimped by such force inside the tube-like connector body.

3.1.7 *cold-shrink tubing, n*—tubular rubber sleeves that are factory expanded and assembled onto a removable core. No heat is used in installation. Also known as *prestretched tubing* (PST).

3.1.8 *crimp connectors, n*—tubular copper connectors made to match various wire sizes and fastened to the conductor ends by means of a crimping tool.

3.1.9 *crimping die, n*—portion of the crimping tool that shapes the crimp.

3.1.10 *crimping tool, n*—a mechanical device, which is used to fasten electrical connectors to cable conductors by forcefully compressing the connector onto the conductor. This tool may have interchangeable dies or "jaws" to fit various size connectors.

3.1.11 *heat-shrink tubing, n*—electrical insulation tubing of a polyolefin material, which shrink in diameter from an expanded size to a predetermined size by the application of heat. It is available in various diameter sizes.

3.1.12 *primary insulation, n*—the layer of material that is designed to do the electrical insulating, usually the first layer of material applied over the conductor.

3.1.13 *sealant, n*—inner-wall coating optional to shrinkable tubing to prevent ingress of moisture to the enclosed area (see also *adhesive*).

3.1.14 *splice, n*—a joint connecting conductors with good mechanical strength and good conductivity.

3.1.15 *tensile, n*—amount of axial load required to break or pull wire from the crimped barrel of a terminal or splice.

4. Significance and Use

4.1 Splicing of cables in the shipbuilding industry, both in Navy and commercial undertakings, has been concentrated in repair, conversion, or overhaul programs. However, many commercial industries, including aerospace and nuclear power, have standards defining cable splicing methods and materials that establish the quality of the splice to prevent loss of power or signal, ensure circuit continuity, and avoid potential catastrophic failures. This guide presents cable splicing techniques and hardware for application to commercial and Navy shipbuilding to support the concept of modular ship construction.

4.2 This guide resulted from a study that evaluated the various methods of cable splicing, current technologies, prior studies and recommendations, performance testing, and the expertise of manufacturers and shipbuilders in actual cabling splicing techniques and procedures.

4.3 The use of this guide by a shipbuilder will establish cabling splicing systems that are: simple and safe to install; waterproof; corrosion- and impact-resistant; industry accepted with multiple suppliers available; low-cost methods; and suitable for marine, Navy, and IEC cables.

5. General Requirements for Cable Splicing

5.1 Cable splicing requires that cable joints be insulated and sealed with an insulation equal in electrical and mechanical properties to the original cable. Cable splicing shall consist of a conductor connector, replacement of conductor insulation, replacement of the overall cable jacket, and where applicable, reestablishment of shielding in shielded cables and electric continuity in the armor of armored cables.

5.2 *Nonsplice Applications*—Unacceptable areas for cable splices are established by regulations and concern the restriction of being unable to splice cables in defined hazardous areas. Hazardous areas are locations in which fire or explosion hazards may exist as a result of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

6. Cable Splicing

6.1 Cable splicing as presented in this guide uses a system of compression-crimp, tubular-metal connectors for butt connection of cable conductors and insulating systems of shrinkable tubing to reinsulate the individual conductors and replace the overall cable jacket.

6.2 *Crimp Connectors*—For splice connection of conductors, compression-crimped connectors shall be used for joining an electrical conductor (wire) to another conductor. The joint requires proper compression to achieve good electrical performance while not overcompressing and mechanically damaging the conductor. Compression connections are accomplished by applying a controlled force on a barrel sleeve to the conductor with special tools and precision dies.

6.3 *Conductor Reinsulation*—Thin-wall shrinkable tubing shall be used to reinsulate the conductor and the installed connector. The insulation tubing, when shrunk or recovered, shall be equal in electrical and mechanical properties to the original conductor insulation. Tubing used for conductor reinsulation does not require an interior adhesive sealant coating.

6.4 *Cable Jacket Reinsulation*—Shrinkable tubing shall be used to envelop the overall splice. To satisfy more abusive conditions that cable jackets are exposed to, a flame-retardant, thick-wall tubing construction with factory applied sealant shall be used.

7. Cable Preparation

7.1 Cables to be spliced shall be prepared to the dimensions specified in Fig. 1 and Fig. 2. Fig. 1 provides cable preparation for power cables from single to four conductor sizes. Dimensions for multiple conductor cables (conductor size of No. 14 or less) are shown in Fig. 2.