SHIPBOARD ELECTRICAL CABLE REMOVAL, RELOCATION, SPLICE, REPAIR, AND INSTALLATION

1. SCOPE

1.1 Intent. This specification provides guidance and requirements for removal, relocation, splice, repair, and installation of shipboard electrical cables.

1.2 Terms and definitions. The terms used in this standard specification are defined below:

- **Cable repair**: The restoration of cable armor or the outermost cable sheath or both.
- **Cable splice**: The permanent connection of the conductors in one cable to those of another, including restoration of damage beneath the outermost cable sheath.
- **Flooding Water Level I (FWL-I)**: The highest water level (including an allowance for wave height) that can be expected on any particular intact main transverse watertight bulkhead when that bulkhead serves as a confining boundary to flooding which the ship is expected to be capable of surviving.
- **Flooding Water Level II (FWL-II)**: The highest water level (including an allowance for wave height) that can be expected above the bulkhead deck at any particular intact watertight subdivision after any flooding elsewhere in the ship which the ship is expected to be capable of surviving.

2. REFERENCES

COAST GUARD DRAWINGS

None

COAST GUARD PUBLICATIONS

Surface Forces Logistics Center Standard Specification 0740 (SFLC Std Spec 0740), Latest Edition, Welding and Allied Processes

Surface Forces Logistics Center Standard Specification 3041 (SFLC Std Spec 3041), Latest Edition, Shipboard Electric Cable Test

Surface Forces Logistics Center Standard Specification 6310 (SFLC Std Spec 6310), Latest Edition, Requirements for Preservation of Ship Structures

OTHER REFERENCES

MIL-STD-2003, Sep 2009, Electrical Plant Installation Standard Methods for Surface Ships & Submarines

MIL-DTL-24643, Dec 2011, Cables and Cords, Electric, Low Smoke, For Shipboard Use, General Specification for

MIL-STD-1310, Sep 2009, Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety

MIL-HDBK-299, Oct 1991, Cable Comparison Handbook – Data Pertaining to Electric Shipboard Cable

NSF International/American National Standards Institute (NSF/ANSI) 61, 2011, Drinking Water System Components - Health Effects

Society of Automotive Engineers (SAE) AMS-DTL-23053, Jul 1999, Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for

3. REQUIREMENTS

3.1 General.

3.1.1 Standard methods. Cable installation, support, and termination shall be in accordance with the standard methods of MIL-STD-2003, including the figures, tables, and notes of Sections 1 through 5.

3.1.2 Cableways.

3.1.2.1 Within the scope of the work item, inspect cableways, penetrations, hangers, and associated hardware that will be reused. Identify components that are not in compliance with MIL-STD-2003. Submit a CFR.

3.1.2.2 For areas exposed to weather and high moisture areas, all new fasteners shall be type 316 stainless steel; for other areas, zinc plated carbon may be used.

3.1.2.3 Cables for vital systems such as interior communication and weapons control systems shall not be secured to the overhead, to shell planking, to shell plating, or to ballistic bulkheads unless otherwise approved.

3.1.2.4 Cable hangers shall be bracketed away from deck and bulkhead surfaces in food handling and food storage spaces to permit spraying for insect control.

3.1.2.5 Only steel hangers and supports shall be used where the deck or bulkhead is steel. Aluminum shall be used where the structure is aluminum alloy.

3.1.2.6 When pulling armored cable, do not allow protruding strands to abrade or cut the jackets of non-armored cables in the same cableway.

3.1.2.7 Propulsion system power cables shall be installed in cableways separate from those used for other electrical system cables. Do not run new cables in propulsion power cable wireways unless they are for propulsion power.

3.1.2.8 Unless specified in the work item or drawing, double banking of power cables is prohibited.

3.1.2.9 On horizontal cable runs, a minimum of one cable strap shall be installed on every fourth hanger. Cable straps are also required where the hanger has no side brackets and at those locations where the cable runs change direction or pass through beams or bulkheads. Strap cables with stainless steel banding and rubber channel in accordance with Section 4 of MIL-STD-2003. Plastic cable ties are not an acceptable banding method and shall not be used.

3.1.2.10 Cables installed through error or rendered useless as a result of modifications shall be removed.

3.1.3 Cable penetrations.

3.1.3.1 Cables and elastomeric penetration seals shall not be intentionally painted. Removal of small areas of paint overspray from low voltage cables is not necessary as long as cable tags are still legible and the type of cable can be determined from the manufacturer's labeling on unpainted sections.

3.1.3.2 Riser boxes with stuffing tubes shall be installed for topside or explosionproof deck penetrations of three or more cables. Riser boxes with multiple cable penetrators or deck mounted multiple cable penetrators with shield for mechanical protection shall be installed for passing three or more cables through a watertight deck not open to the weather. Three or more cables passing through non-watertight decks shall be protected by a riser tube or welded collar.

3.1.3.3 Metal stuffing tubes or multiple cable penetrators (transits) shall be used for cable penetrations of the following (except multiple cable penetrators shall not be used in bulkheads or decks which are exposed to the weather):

- Watertight cable trunks, decks, or bulkheads
- Bulkheads designed to withstand a water head
- The portion of bulkheads specified to be watertight to a certain height
- That portion of bulkheads below the height of the sill or the coaming of compartment accesses
- Bulkheads surrounding compartments subject to flooding by sprinkling
- Garbage disposal rooms
- Battery shops
- Medical operating rooms and medical wards

3.1.3.4 Only metal stuffing tubes shall be installed in decks and bulkheads forming the boundaries of spaces containing volatile, combustible, or explosive materials.

3.1.4 New cable construction.

3.1.4.1 New cable shall conform to MIL-C-24643 and shall be of low smoke construction unless an alternative is authorized by the work item. Power conductors shall be stranded annealed copper, except that for high temperature applications, stranded nickel-clad copper may be used. Conductors shall not be tin coated copper or aluminum.

3.1.4.2 New armored cable shall not be installed unless required by the work item or drawing. If armor is specified, it shall be basket woven corrosion resistant aluminum alloy or bronze.

3.1.4.3 Low level signal cables that are susceptible to electromagnetic or radio frequency interference (EMI/RFI) shall be shielded. In severe cases, both an overall shield and individually shielded pairs or triads may be required. Shields shall remain insulated from one another except at the point where they bond to the hull.

3.1.4.4 Watertight cable, which contains a flexible waterblocking compound or solid insulation in the interstices between conductors, is recommended for all applications and is required below FWL-II. Watertight cable is also required for any cable run that extends beyond two contiguous compartments.

3.1.4.5 Shore to vessel power transfer cables and other portable topside cords shall be oil and sunlight resistant, while also remaining flexible down to 0ºF. Cables and cords with cross-linked polyolefin jackets (e.g., LSTHOF) are unsuitable for this application because of their stiffness at cold temperatures.

3.1.4.6 Medium voltage cables, used in applications where system voltage exceeds 1000 volts, shall be shielded and their jackets shall not be painted. If practicable, new medium voltage cables shall be furnished with distinguishing colored jackets (e.g., yellow or orange) to match that of existing cables operating at the same voltage.

3.1.4.7 All permanently installed cable shall generally be of the non-flexing type, although flexing type conductors may be used where such use is justified by service conditions and is approved by the Government. All temporary cables and portable cords shall be of the flexing type.

3.1.4.8 For power and lighting circuits, the current rating of a permanently installed cable or cord at the highest expected ambient temperature shall be no less than the rating of the associated overcurrent protective device.

3.1.4.9 The ampacity of cable shall be based on an ambient air temperature of 40°C, except that cables passing through machinery spaces, boiler flats, incinerator rooms, and other compartments with high temperature equipment shall be based on 50°C or the actual maximum ambient air temperature, whichever is higher.

3.1.4.10 Cables and cords in contact with potable water shall be designed to meet the requirements of NSF/ANSI Standard 61. The jacket shall not leach hazardous compounds into the water and shall be resistant to the chemicals used to disinfect the tank.

3.1.5 Cable runs.

3.1.5.1 Do not bend cable to less than the minimum bend radius listed in MIL-HDBK-299. For cable and cord types not listed in MIL-HDBK-299, do not bend cable to a radius less than six times (unarmored) or eight times (armored) the overall diameter.

3.1.5.2 Bends at terminal entrances, where stuffing tubes are required, shall be made via angle stuffing tubes. Straight stuffing tubes may be used in place of angle stuffing tubes if the bend in the cable is not less than the minimum radius specified above.

3.1.5.3 Conductors from different cables shall be lugged and joined in enclosures or connection boxes.

3.1.5.4 Cable runs shall not be through personnel access or escape trunks, except for those supplying lighting to the access or trunk.

3.1.5.5 The main runs of interior communication and weapons control system cables shall follow the cable runs of the lighting and power installations. Do not run shielded cables in the same wireway as high current electric cables or radio antenna transmission lines.

3.1.5.6 Cables shall not be exposed to the weather unless absolutely necessary. Cables to mast mounted equipment shall be contained within the mast structure to the maximum extent possible.

3.1.5.7 Metal casings shall protect cables subject to mechanical damage because of their proximity to

areas frequented by personnel. Protect cableways in areas where their misuse as steps or handholds would cause damage. Install protective plates over cableways in all passages where cables might be stepped on or damaged by personnel or portable equipment. At hatch openings and in trunks where objects are raised or lowered, protect cables with stainless steel casings.

3.1.5.8 Route cables outside cargo spaces, voids, and normally inaccessible spaces wherever practicable. Where routing through cargo spaces is unavoidable, protect cables from mechanical damage, including that due to the shifting of cargo. Cables in voids and normally inaccessible spaces shall be supported clear of decks and bulkheads to avoid condensate which might form on such surfaces.

3.1.5.9 Avoid installation of cables in locations subject to excessive heat and risk of fire. Do not install unprotected cable adjacent to machinery, piping, or other surfaces having an exposed surface temperature greater than 70°C. Do not run cables over boilers, engines, turbines, incinerators, or route through other locations where they may be surrounded by hot air or exposed to stack gases.

3.1.5.10 Cables that supply vital emergency power to long range communications devices (e.g., INMARSAT, high frequency radio) shall not pass through hangars and other spaces containing gasoline or diesel fueled machinery such as engine, turbine, boiler, and incinerator rooms. Where vessel arrangement precludes routing outside such spaces, the affected cable shall be designed to maintain circuit integrity at temperatures up to 2000ºF.

3.1.5.11 Do not install cables in locations where they may be subjected to excessive moisture. Where cable runs near fire main, water, steam, oil, or other piping is unavoidable, provide dripproof shields for protection. Where cables must be installed in spaces subject to flooding, they shall be installed as high as practicable within the space.

3.1.5.12 Cables that pass through tanks or would normally be submerged shall be enclosed in rigid metallic conduit or pipe. Cables or cords that enter a tank to serve submerged tank level indicators or switches need not be so enclosed, but shall be of water blocked construction with fluid compatible jacket.

3.1.5.13 Cables and cable markers shall not be intentionally painted.

3.1.6 Cable entrance to equipment.

3.1.6.1 Cable entry into bulkhead mounted non-watertight equipment shall be through the bottom or lower half of the side. When practicable, cables shall enter switchboards from the bottom. Otherwise cables shall enter from the upper side or top of the switchboard.

3.1.6.2 Cables shall enter watertight equipment in locations best suited to disposition of the cable installation. Entry of cables into enclosures, including switchboards, shall comply with the following:

- Spraytight, watertight, submersible, and explosionproof enclosures – Through stuffing tubes. These stuffing tubes shall be of plastic types in place of metal types except when used with explosionproof enclosures.
- Open type enclosures – By cable clamps (without retaining lip).
- All other types of enclosures – By cable clamp (without retaining lip). For top entry into these enclosures, the cable clamp shall be sealed with a plastic sealer to prevent entry of water dripping from above.
- Where an open type enclosure classification meets environmental requirements, but where a higher degree of enclosure is used, cable entrances may be as required for an open type

enclosure.

- Where a dripproof type enclosure classification meets environmental requirements, but where a higher degree of enclosure is used, cable entrances may be as required for a dripproof enclosure.

3.1.6.3 Cable entering enclosures shall be secured to the structure of the vessel close to the enclosure. Provide sufficient cable slack to allow for deflection of the enclosure or switchboard in response to vessel's motions in heavy seas.

3.1.6.4 Cable entry into permanently mounted or portable enclosures of fiberglass or molded plastic material shall be by insulating type clamps or nylon stuffing tubes. Metallic type clamps shall not be used.

3.1.7 Cable connection to machinery.

3.1.7.1 Sufficient slack shall be allowed to prevent damage to cables, due to shock and vibration, at locations where the cables pass from the structure of the vessel to the machinery.

3.1.7.2 Cables entering propulsion system equipment from above or from the sides shall enter through stuffing tubes and shall be braced and secured to prevent dislodgment under vibration, shock, and magnetic stresses.

3.1.7.3 Cables connected to equipment provided with resilient mounts or shock mounts shall have a minimum length of 18 inches with at least 3 inches of slack between the equipment and the last point of support of the cable to provide for flexibility and movement of the equipment under shock, vibration, and in service loading.

3.1.8 Cable installations in hazardous locations.

3.1.8.1 Cables within hazardous spaces shall be protected against mechanical damage. This protection shall be in the form of non-tight metal guards (expanded or solid) of sufficient strength to provide the required protection. Clearance shall be provided between the protective guards and the cables to provide ample ventilation. Protective guards shall be provided with drainage holes where required. Cables protected by the vessel structure or by permanently installed equipment are considered adequately protected.

3.1.8.2 Only cables having conductor insulation of silicone rubber (except for interior communication and cables totally within the compartment) shall be used. Through cables shall be of unbroken length within compartments. Cables terminating at explosionproof lighting fixtures or other non-lighting equipment shall be of unbroken lengths. Separate cables to each lighting fixture are not required; a single cable may be run between fixtures where more than one fixture is installed in a space.

3.1.9 Cable end sealing.

3.1.9.1 The ends of propulsion system cables 9 MCM and larger shall be sealed with solderless waterseal type lug terminals.

3.1.9.2 Cables terminating at the following equipment, where located below FWL-II, shall be end sealed per MIL-STD-2003:

- All power and lighting switchboards (includes ship service, emergency, and load center switchboards).
- Manual and automatic bus transfer equipment (whether mounted on a switchboard or panel or as an independent unit).
- Distribution power and lighting panels supplied from two sources of power (normal and alternate or normal and emergency).
- Automatic degaussing control panels.
- Degaussing switchboards and power supplies except where they supply power to only one degaussing coil.
- All watertight interior communication and weapons control equipment, including switchboards and connection boxes, where water seepage into the unit would jeopardize undamaged operable portions of the system.
- Top entrance cables to interior communication and weapons control switchboards of other than watertight construction.

3.1.9.3 Cables terminating at the equipment designated above need not be end sealed where one or more of the following conditions apply:

- Flexible cables to rotating structures.
- Cables which do not pass through a watertight deck or bulkhead.
- Cables which penetrate FWL-II but do not pass through a watertight deck or bulkhead below FWL-II.
- Where end sealing would prevent bringing the shields of a cable into the enclosure, as required for shielding and grounding.
- Where water seepage into a unit of an interior communication or weapons control system through a damaged cable would result in no loss of function beyond that already sustained due to the cable casualty.
- In interior communication and weapons control systems, cable types LSTTSU and LSMSCU, and all two, three, and four-conductor cable with conductors no larger than 9 MCM.
- Where space is not available inside interior communication and weapons control units to accommodate the end seal. However, the other end of the cable involved shall be end sealed regardless of its location.

3.1.10 Cable terminations.

3.1.10.1 Cables ending in connectors shall be terminated in accordance with Section 5 of MIL-STD-2003. Mated connectors that are held together solely by friction shall be lock wired or otherwise restrained to prevent disconnection from incidental vibration or inadvertent contact.

3.1.10.2 For cables not ending in connectors, compression type ring terminals shall generally be installed on each connected conductor. Two-hole types shall be used where there is a possibility of a lug turning and making contact with an adjacent terminal lug or conductor.

3.1.10.3 Solderless type lug terminals shall be used for all applications except for equipment having solder type terminals provided by the manufacturer or in wiring boxes or equipment in which electrical clearances would be reduced below minimum standards by the use of solderless types.

3.1.10.4 Lug terminals shall be silver plated. Tinned lugs are also permissible when the stud or bus bar to which the lug connects is not silver plated. Neither mercury nor cadmium shall be included in the finish coating or in the pre-plating immersion treatment solution for lugs or terminals.

3.1.10.5 Solderless type lug terminals shall be of the proper size for the conductor and the barrels shall be insulated. All conductor strands shall enter the lug barrel and none shall be cut off. Compression shall be accomplished with a crimping tool and properly sized die approved by the lug manufacturer.

3.1.10.6 The use of uninsulated connectors and insulating caps (e.g., Wire-Nut®, Scotchlok™) in place of terminal board connections is prohibited, except that in lighting and power systems (including lighting fixtures, connection boxes, branch boxes, door switches, small appliances, and small motors of less than one horsepower rating used for housekeeping, food service and shop equipment) such connectors may be used when not otherwise prohibited by the work item.

3.1.11 Cable slack requirements.

3.1.11.1 Cables shall be installed so that sufficient slack exists to allow for deflection of bulkheads, and for two reconnections of the cable lug terminals or end connector. Sag between hangers shall be uniform for each row of cables so that clearance between rows will be the same throughout the cable runs. Where cables spread out to enter bulkhead stuffing tubes or multiple cable penetrators, bends shall have liberal sweep to provide as much flexibility as practicable.

3.1.11.2 Cables having only a minimum spread where they pass through bulkhead stuffing tubes shall have enough slack to give them the same flexibility as other cables in the group. Cables from switchboards or other electrical equipment shall enter cableways in a curve of sufficient radius to prevent transmission of stresses to the equipment during severe cableway deflection. Similarly, severe deflections of switchboards or other electrical equipment shall not result in stress on cables entering such enclosures.

3.1.12 Cable handling and stowage.

3.1.12.1 All cable with a cross-linked polyolefin jacket shall be installed in temperatures above 35°F whenever possible as such cables become stiff and brittle at lower temperatures. If the compartment in which the cable is to be installed cannot be heated, the cable shall first be stored in an ambient temperature of at least 50°F but not above 120°F until it is warm enough to be completely installed before it cools to 35°F. The radius of bends shall be no shorter than necessary and never less than the minimum values in paragraph 3.1.5.1 above. Before bending to the final radius, that portion of the cable comprising the bend shall be warmed thoroughly by a portable warm air blower.

3.1.12.2 Cable shall be stored in a dry place which is not subject to accidental flooding, protected from the weather, and subjected to a minimum variation of temperature.

3.1.12.3 Cable that has been in storage shall not be installed if it has sustained mechanical damage that would impair the watertight integrity of its outer sheath.

3.1.12.4 Cable armor showing signs of corrosion shall be thoroughly cleaned and a coat of high build epoxy primer applied to all corroded areas.

3.1.13 Cable and conductor identification.

3.1.13.1 Tag all permanently installed cables as close as practicable to each point of connection, and on both sides of decks and bulkheads except as follows:

- Where through cable runs within a compartment are direct (such as a vertical run between decks), a single tag will suffice.
- Cables with both points of connection within a compartment and which can be readily traced need not be tagged

3.1.13.2 Where compartments are subdivided by internal bulkheads or where machinery or installed equipment makes tracing of cable runs difficult, additional tags shall be provided.

3.1.13.3 Tags and strips for marking cables shall be of soft aluminum tape having a natural finish, except where used with cables having bronze armor, in which cases sheet brass of commercial quality shall be used. Install tags in accordance with Section 1 of MIL-STD-2003.

3.1.13.4 For multiple cable penetrations of decks and bulkheads (main cableways) individual cable tags can be omitted, and in lieu thereof, an identification plate shall be installed adjacent to the cableway penetration area showing each cable designation in the order of location in the penetration area.

3.1.13.5 Install wire markers conforming to SAE-AMS-DTL-23053, Class 1, white, marked with indelible ink in accordance with referenced drawings and/or equipment technical manual. Wire markers shall be fabricated from polyolefin and be of flame retardant composition.

3.2 Removal.

3.2.1 Isolate and remove (in its entirety) each cable designated for removal, renewal or replacement by the work item.

3.2.2 Blank each bulkhead, deck penetration and multi-cable transit device from which cable was removed and which will not be reused in accordance with Section 3 of MIL-STD-2003. Test any disturbed watertight penetration in accordance with SFLC Std Spec 0740.

3.2.3 Blank each hole not being reused in equipment from which cable was removed.

3.2.4 Remove unused hangers from which cable was removed and which will not be reused, and grind areas flush in way of removals. The Contractor shall prepare and touch-up coat all new and disturbed surfaces to match existing adjacent surfaces, in accordance with Std Spec 6310, paragraph 3.1.13 (Touch-ups and minor coating repairs).

3.2.5 If the remaining cable in a cableway is no longer adequately secured as a result of cable removal, tighten or replace banding in accordance with paragraph 3.1.2.9 above.

3.3 Relocation.

3.3.1 Isolate each cable to be pulled back, rerouted, relocated, or reused due to work required by the work item.

3.3.2 Inspect each cable end for correct identification sleeving, including size, type, and legible lettering

in accordance with reference drawings. Ensure that lugs are tightly secured to each conductor and are of correct size and type. Report any discrepancies, including damaged insulation or jacket, that would preclude reuse to the Coast Guard Inspector via CFR.

3.3.3 Record electrical hookup configuration prior to disconnection and retain for reconnection.

3.3.4 Remove each cable from the designated equipment. Coil disconnected cable up out of the way to prevent damage.

3.3.5 Reinstall each cable to the equipment in accordance with MIL-STD-2003 utilizing existing cableways and penetrations wherever possible. Penetrations shall be correctly sized in accordance with Section 3 of MIL-STD-2003. For new cableways, coat steel surfaces in accordance with SFLC Std Spec 6310.

3.3.6 Secure disturbed cable in accordance with paragraph 3.1.2.9 above.

3.3.7 Bond and ground each cable in accordance with MIL STD-1310.

3.3.8 If a relocated cable has been shortened or its function changed, perform the following:

3.3.8.1 For hard-wired cables, install new wire markers in accordance with section 3.1.13 above.

3.3.8.2 Install new lugs of the correct size and shape in accordance with section 3.1.10 above.

3.3.8.3 Install new cable identification tags in accordance with section 3.1.13 above.

3.3.9 Perform the cable tests of SFLC Std Spec 3041 upon completion of banding and prior to reconnecting.

3.3.10 Test any new or disturbed watertight penetration in accordance with SFLC Std Spec 0740.

3.3.11 Prepare each cable end and serve the lead bundles in accordance with section 3.1.9 above.

3.3.12 Reconnect each cable, using reference drawings or retained hookup data.

3.3.13 Install new cable identification tags in accordance with 3.1.13 above.

3.3.14 For three phase or direct current power circuits, perform phase rotation or polarity test to verify proper phase sequencing.

3.4 Splicing.

3.4.1 When authorized by the work item or a related contract change, isolate and splice cables in accordance with Section 1 of MIL-STD-2003. The following cables may not be spliced:

- Antenna systems
- Cables for repeated flexing service
- Portable cables, except shore power

- Cables in voids or normally inaccessible spaces
- Cables in hazardous spaces
- Cables exposed to the weather

3.4.2 Perform the cable tests of SFLC Std Spec 3041 for each spliced cable.

3.5 Repair.

3.5.1 When authorized by the work item or a related contract change, isolate and repair cable jackets and armor in accordance with Section 1 of MIL-STD-2003. The following cables may not be repaired:

- Cables for repeated flexing service
- Portable cables, except shore power

3.5.2 Perform the cable tests of SFLC Std Spec 3041 for each repaired cable.

3.6 Installation.

3.6.1 Install each new cable, cableway, and penetration in accordance with MIL-STD-2003, MIL STD-1310, referenced drawings, and section 3.1 above to support work required by the work item.

3.6.2 Unless authorized by the work item or applicable drawing, new cable shall meet all requirements of section 3.1.4 above.

3.6.3 Utilize existing cableways and penetrations wherever possible. Penetrations shall be correctly sized in accordance with Section 3 of MIL-STD-2003. Secure cables in accordance with paragraph 3.1.2.9 above. For new cableways, coat steel surfaces in accordance with SFLC Std Spec 6310.

3.6.4 For hard-wired cables, install new wire markers in accordance with section 3.1.13 above.

3.6.5 Install new lugs of the correct size and shape in accordance with section 3.1.10 above.

3.6.6 Install new cable identification tags in accordance with section 3.1.13 above.

3.6.7 Perform the cable tests of SFLC Std Spec 3041 after completion of lugging, connector attachment, and banding.

3.6.8 For non-watertight penetrations, repack collars with appropriate putty to prevent spread of smoke or fumes between compartments.

3.6.9 Test any new or disturbed watertight penetrations in accordance with SFLC Std Spec 0740.

3.6.10 Prepare each cable end and serve the lead bundles in accordance with section 3.1.9 above.

3.6.11 Connect leads to terminal boards and equipment using referenced drawings.

3.6.12 For three phase or direct current power circuits, perform phase rotation or polarity test to verify proper phase sequencing.

4. NOTES

4.1 Very old cables. Cables in service for longer than 50 years or exposed to high temperatures are subject to age degradation and may become brittle, sometimes to the point where insulation crumbles when conductors are moved. When practicable, such cables should be renewed, rather than reused, when they must be disconnected or relocated to accomplish other work. If renewal is not practicable, consider installing cross-linked polyolefin heat shrink sleeving over conductors that are not protected by cable jacketing.

4.2 Asbestos. Asbestos insulation was used extensively in the past for high-temperature insulation. Older boats and cutters may still contain asbestos-insulated wiring and it is generally not a health hazard unless disturbed for work. Such cables are usually insulated with a combination of asbestos and varnished cambric. The varnished cambric covers the inner layer of felted asbestos. This prevents moisture from reaching the innermost layer of asbestos, as asbestos becomes a conductor when wet. When the conductors are disturbed or insulation is stripped back, asbestos fibers may become airborne, a potential inhalation hazard to anyone working nearby. The following armored cables are known to contain asbestos and should be handled appropriately:

4.2.1 Commercial marine cable types TAVIA (aluminum armor) and TAVIB (bronze armor) were used as propulsion and ship service generator AC power feeders on POLAR icebreakers.

4.2.2 Commercial marine cable type SAVIA were used as DC power feeders on POLAR icebreakers, except on POLAR SEA's No. 2 main propulsion motor, which was replaced in 2006 back to the setup switch.

4.2.3 Military cable type SHFA, DHFA, THFA, FHFA, and MHFA cables were widely used for general power and lighting system wiring on vessels constructed before 1965:

4.2.3.1 Cables with 3, 4, and 9 MCM conductors have polyvinyl chloride (PVC) and asbestos insulation.

4.2.3.2 Cables with 14 MCM and larger conductors have asbestos and varnished cloth insulation.

4.3 Cable jacket color. Cable color can often be used as a clue to determine the age and function of the wiring run.

4.3.1 Gray. Armored and unarmored cables with gray PVC jackets (MIL-C-915) were installed after 1965 and before the advent of low smoke cables.

4.3.2 Black. Armored and unarmored cables with black jackets (MIL-C-24640 and MIL-C-24643) were introduced in 1984. Many commercial marine cables also have black jackets, although they are not widely used on Coast Guard vessels. These modern cables generally are constructed with cross-linked polyolefin jackets and are classified as low smoke (LS) or zero halogen (LSZH), meaning that when they burn, they do not emit significant quantities of acid gases and dense smoke that severely hampered damage control efforts on several Navy ships with MIL-C-915 cables.

4.3.3 White. Since about 2005, MIL-C-24643 cables have been manufactured with white jackets to better blend with the typical compartment paint scheme.

4.3.4 Yellow. Yellow jacketed cables are used only on medium voltage power systems operating at

potentials of less than 5 kV. They are typically over one inch in diameter and should never be painted.

4.3.5 Orange. Orange jacketed cables are used only on medium voltage power systems operating at potentials between 5 kV and 15 kV. They are typically over one inch in diameter and should never be painted. Much thinner orange jacketed runs are typically fiber optic cable used for computer and control networks.

4.3.6 Purple. Relatively thin purple cable is typically used for high speed control system network cables.

4.4 Armor. Armored cable is more costly, heavier, and difficult to handle than unarmored types. Occasional strands of armor poking out of the basket weave can damage the jackets of adjacent cables in the wireway and lacerate handlers during installation. Consequently, virtually all cable is now of unarmored construction. Armor is not a proper substitute for electrostatic shielding; use unarmored shielded cables for such applications. In general, armored cable should not be installed without Coast Guard Electrical Engineering review.

4.5 Electrostatic shielding. Many light gauge military grade cables are available with woven or foil electromagnetic shielding under the jacket. Shields may be applied over each twisted pair or triad, or over all conductors, or both (double shielded). To be effective, shields must be bonded to the hull at one location and insulated from each other and the hull elsewhere. At terminal boxes and other splice points, shields from incoming and outgoing cables must be joined together to preserve continuity. Where heavy gauge shielded power feeders are required (typically for TEMPEST certification of spaces handling classified material), consider using type LSTSGS, manufactured by The Monroe Cable Company of Middletown, NY (not to be confused with James Monroe Wire and Cable Corporation of South Lancaster, MA) to the same standards as military type LSTSGU but with overall electrostatic shield.

4.6 Variable frequency drives. Power cables connecting variable frequency drives (VFDs) to their motors must typically be shielded with a special cable containing three concentric grounding conductors. Cable of this type with a low smoke jacket may be difficult to obtain in lengths under 1000 feet or more. Such cable may require a long lead time to manufacture with high production setup costs. If available, consider AmerCable type 37-103VFD power cable with low smoke halogen-free insulation and jacket for this application. AmerCable type 37-102VFD cable is similar, but lacks the low smoke halogen-free insulation and jacket, and can be used for short runs when no other alternatives are feasible.