DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, D.C. 20350-2000

IN REPLY REFER TO

OPNAVINST 11310.3B
N46
12 Jan 07

OPNAV INSTRUCTION 11310.3B

From: Chief of Naval Operations

Subj: OPERATION AND MAINTENANCE POLICY FOR SHORE-TO-SHIP POWER

Ref: (a) OPNAVINST 11000.16A of 07 Feb 92
(b) Submarine Maintenance Standard MS NO.3420-081-089
(c) UFC 3-560-10N, Safety of Electrical Transmission and Distribution Systems; http://www.wbdg.org
(d) OPNAVINST 3500.39B Operational Risk Management of 30 Jul 04

Encl: (1) Operational Guidelines for Electrical Distribution Systems and Critical Components Supplying Shore to Ship Power

1. Purpose. To provide minimum operation/maintenance procedures and equipment specifications for electrical systems which provide shore-to-ship power.

2. Cancellation. OPNAVINST 11310.3A

3. Scope. Applies to all utilities distribution systems where Commander, Navy Installations Command (CNIC) or Commander, Naval Facilities Engineering Command (NAVFAC) is assigned as the Maintenance Unit Identification Code (UIC). Specifically, this instruction applies to components of the electrical distribution system from, and including, the shore power circuit breaker to the cable termination (connector) that plugs into the shipboard shore power receptacle.

4. Discussion. The safe and reliable operation of shipboard electrical equipment is critical in port as well as at sea. A malfunction or misapplication of shore-to-ship power equipment could cause at least an inconvenient interruption of electrical service to a ship at berth. At worst, it could threaten the lives of personnel, damage critical shipboard and shore power equipment, or completely disable a ship. Reference (a) establishes Chief of Naval Operations policy and command responsibility for Navy controlled land and shore facilities.

Enclosure (1) addresses specific elements that must be included in each activity's shore-to-ship power operation and maintenance program. Recent failures of shore power critical components have necessitated compliance with specific inspection procedures for submarines identified in reference (b). Reference (b) is available from Submarine Maintenance Engineering, Planning and Procurement (SUBMEPP) Activity. Contact them for more information or to receive a copy of this maintenance standard: http://www.submepp.navy.mil/ps_mid_ms.shtml. Electrical safety requirements and guidelines for safe practices to be followed during operation and maintenance are provided by references (c) and (d).

5. Action

a. Echelon II Commands

(1) Ensure that subordinate shore activities and applicable fleet units develop a shore to ship power operation and maintenance program conforming to enclosure (1).

(2) Assess waterfront facilities, as they relate to shore to ship power. Develop and execute projects to correct identified deficiencies.

b. Commanders of Forces Afloat

(1) Establish standards for shipboard personnel for the checkout and connection of the power cables on board ship and ensure that subordinate units apply the standards.

(2) Develop required changes to shipboard operating procedures in support of the shore to ship power operating procedures established by this instruction.

c. Commander, Naval Facilities Engineering Command

(1) Evaluate shore to ship electrical power outages and recommend corrective actions for design, operation, and maintenance of shore to ship power systems.

(2) Provide support to COMNAVSEASYSCOM for the identification and solution of interface problems between ships' electrical distribution systems and shore to ship power systems.

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United States Navy
Director, Material Readiness and Logistics

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OPERATIONAL GUIDELINES FOR ELECTRICAL DISTRIBUTION SYSTEMS AND CRITICAL COMPONENTS SUPPLYING SHORE TO SHIP POWER

1. **Attachments**.

a. Attachment 1 contains the list of references used in this enclosure. It also contains Internet links to these references.

b. Attachment 2 contains technical specifications for shore power cables.

2. **Training**. Training programs will be developed by each ship and shore activity for all ship and shore based personnel involved in the operation and maintenance of shore to ship power systems. The program will include the installation, fabrication, assembly, and testing of low and medium voltage cable, splices, terminations, connectors, switchgear, and receptacles, where applicable. Navy sponsored training courses and manufacturers' training will be used to the maximum extent possible to supplement local training. Safety training shall be included and emphasized by all cognizant commands. Fleet commanders will establish standards for personnel working on shore to ship power systems. The activities will maintain training records and conduct periodic refresher training programs.

3. **Safety**. Prevent accidents and injuries by adequate job planning, observing all safety precautions and practices, and following proper procedures. Evaluate, identify, and control hazards ensuring the principles of reference (d), OPNAVINST 3500.39B Operational Risk Management, are effectively addressed before starting work. Follow the guidelines of reference (c), UFC 3-560-10N, Safety of Electrical Transmission and Distribution Systems, National Fire Protection Association Standard for Electrical Safety in the Workplace (NFPA 70E) and activity specific Standard Operating Procedures (SOPs).

4. **Shore to Ship Power System Operating Procedures**. The following procedures will be applied to all shore to ship power systems.

a. **Standard Operating Procedures (SOPs)**. SOPs will be prepared by each shore facility (installation) and distributed to all personnel involved with the operation of shore to ship power systems. Reference (c), Unified Facility Criteria: UFC 3-560-10N, provides guidance for the development of Standard Operating Procedures for electrical work operations.

b. **Critical Component Identification**. All electrical components whose failure could affect the reliability of the electrical distribution system supplying power to ships are identified as critical components of the shore to ship power system and are placed under the maintenance program defined in this enclosure. Critical components are the shore power circuit breaker, the permanently installed cables between the shore power circuit breaker and the power connection station (turtleback), the power connection station receptacles, and the portable power cable assemblies used for supplying shore power services to ships. Each portable power cable assembly is defined to consist of two electrical connectors and the cable in between.

c. **Electrical Service Requirements**. The 480 volt system shall supply approximately 480 volts at no load and 450 volts (plus or minus 5 percent) under loaded conditions and at the

ship's load center. The 4160 volt system shall supply approximately 4160 volts at no load and 4100 volts (plus or minus 5 percent) under loaded conditions and at the ship's load center. Each circuit shall be rated for 400 amperes.

d. **Portable Substations**. Shore power circuit breakers and connectors associated with portable substations used to supply power to ships will be included in the maintenance program defined in this enclosure.

e. **Paralleling Transformers**. If a ship is supplied by two or more shore transformers, the ship's force will be directed, through standard ship operating procedures, not to parallel the transformers through the ship's bus unless the senior ship's electrician verifies correct phase orientation between power sources, and the supplying activity authorizes the parallel operation. If shore transformers are paralleled through the ship's bus, short circuit currents may be increased to unsafe levels and circulating currents may overheat and destroy cables, transformers, and switchgear on board ship or on shore.

f. **Paralleling Shipboard Generation with the Shore Power System**. Paralleling of ship's service generators with the shore power system is prohibited except for the shortest time necessary to transfer load to or from shore power.

5. Portable Power Cables.

a. **Low Voltage Cables.**

(1) Existing portable cables used for 480 volt shore to ship power service may be MIL-C-915G (incl SUP 1) type THOF-500 or type SHOF-500 in accordance with MIL-C-915G. Low smoke cable specified by MIL-C-24643 which is for use on ships, shall not be used for shore-to-ship power applications. Its softer jacket is susceptible to damage.

(2) New portable cables used for 480 volt shore to ship power service shall be three conductor type "Enhanced THOF-500" or "Enhanced Plus THOF-500" in accordance with Attachment (2-1). Equivalent or better cables from other sources may be considered as approved by Navy technical authority.

b. **Medium Voltage Cables.** The portable cables used for 4160 volt and 13800 volt shore to ship power service shall be three conductor, 350 kcmil type SHD-GC with Chlorinated Polyethylene (CPE) jacket. Insulation and jacket shall conform to ICEA S-75-381. Cables for 4160 volt service shall be 8 kV or 15 kV. Cables for 13800 volt service shall be 15 kV. However, cable sizes larger than 350 kcmil may be used with approval by Navy technical authority.

c. **Standard Cable Lengths.** Activities will maintain an inventory of portable shore to ship electric power cables in lengths required for the ships. Lengths will be selected and constructed to minimize the requirements for in-line connections. All cable runs will be of equal length to minimize unequal load sharing.

d. **Cable Storage.** Cables not in use should be stored appropriately. Covered off pier storage locations are highly desirable.

e. **Number of Shore to Ship Circuits.** The number of circuits will be as requested by ship's force.

6. Overcurrent Protection of Shore to Ship Power Cables

a. **Low Voltage Cable Overcurrent Protection for Submarines.** The long-time pickup settings of the 450 volt shore to ship power service circuit breakers for submarines shall be adjusted so that they match nominal ratings of equipment on the submarine. (Currently, the nominal ratings for joy plug connectors and External Hull Fittings (EHFs) are 400 amperes. If the 400 ampere setting is not a standard setting on the existing equipment, then the next higher setting is acceptable.) Shore activities shall provide written notification to the submarines prior to connection focusing on the load requirements and load monitoring, breaker settings, and safety impacts. The instantaneous pickup setting shall be coordinated with the available short circuit amperes and associated system devices.

b. **Low Voltage Cable Overcurrent Protection for Surface Ships.** The long-time pickup settings of the 450 volt shore to ship power service circuit breakers for surface ships shall be adjusted to 430 amperes. If the 430 ampere setting is not a standard setting on the existing equipment, then the next higher setting is acceptable. The instantaneous pickup setting shall be coordinated with the available short circuit amperes and associated system devices.

c. **Medium Voltage Cable Overcurrent Protection.** The long-time pickup setting of the 4160 volt shore to ship power service circuit breakers shall be adjusted to 400 amperes. If the 400 ampere setting is not a standard setting on the existing equipment, then the next higher setting is acceptable. The instantaneous pickup setting shall be coordinated with the available short circuit amperes and associated system devices.

7. Portable Power Cable Connectors

a. Low Voltage Terminations

(1) All low voltage portable power cables will be terminated with a MIL-C-24368/1 (procured from vendors on the Qualified Products List (QPL)) plug at the ship end of the cable for surface ships.

(2) All low voltage portable power cables will be terminated with a MIL-C-24368/5 (procured from vendors on the QPL) plug at the ship end of the cable for submarines.

(3) The termination device at the service end of the cable must be compatible with the design of the dockside power connection station (turtleback) and may be terminated with one of the following:

(a) a MIL-C-24368/1 plug, for existing installations

(b) a single pole connector which meets the environmental and test requirements of the MIL-C-24368 and the additional requirements identified in Attachment 2-2

(c) a UL 486A listed plug.

(d) an equivalent or better connector as approved by Navy technical authority.

(4) Install terminations in accordance with manufacturer's recommendations.

b. **Medium Voltage Terminations.** All medium voltage portable power cables will be terminated at the ship end of the cable with a heat shrinkable termination (Institute of Electrical and Electronics Engineers standard IEEE-48 class 1) specifically designed for SHD-GC cables. The termination device at the service end of the cable must be compatible with the design of the dockside power connection station (turtleback) and may be terminated the same as the ship end of the cable or with a coupler plug that is compatible with the receptacle at the dockside power connection station. The termination devices shall be assembled on to the cable per the manufacturer's instructions. Terminate the SHD-GC cable ground and check conductors within the cable breakout boot or to the appropriate termination pin integral with the coupler plug.

c. **Low Voltage In-line Connections.** In-line single pole connectors and lug to lug connections shall meet the same requirements identified in paragraph 7. a. (3) above. Male and female cable mount in-line connectors may be used to connect shorter cable segments together to make longer cable circuits as necessary.

8. Maintenance of Portable Power Cable Assemblies

a. **Tests and Inspections for Submarine Portable Power Cable Assemblies**: Electrical tests and inspections shall be in accordance with reference (b) Maintenance Standard (MS) Number 3420-081-089. These tests and inspections shall be conducted annually. Results of the contact tightness checks, conducted in accordance with paragraph 1.g of reference (b), shall be included on the written notification provided to ships forces prior to each shore power service connection to the submarine, identified in paragraph 6.a. above.

b. **Tests and Inspections for Surface Ship Portable Power Cable Assemblies**: Electrical tests and inspections shall be in accordance with InterNational Electrical Testing Association Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems (NETA MTS) (most recent edition) for cables and the manufacturer's instructions for connectors. Overpotential tests are not required, but may be performed on the cable assemblies that fail insulation-resistance tests as a means to locate cable faults and to verify cable integrity. These tests and inspections shall be conducted annually.

c. **Cable Repair:** Cables with damage other than to the outer jacket shall be removed from service permanently. Repair jackets using a heat shrinkable wrap around mining cable repair sleeve, cold repair elastomeric strips for mining cables, or a similar product. Repair of the coupler plugs and receptacles shall be performed in accordance with the manufacturers'

instructions of these cable repair products or shall be in accordance with reference (b) MS NO. 3420-081-089.

d. **Connector Repairs:** Repairs to Mil-C-24368/5 connectors shall be in accordance with reference (b) MS NO. 3420-081-089 Repairs to Mil-C-24368/1 and Mil-C-24368/4 connectors, and medium voltage coupler plugs shall be in accordance with manufacturer's instructions.

e. **Splicing:** Splicing of portable shore to ship power cables is not recommended. If splices cannot be avoided, follow approved procedures. Medium voltage portable power cables shall not be spliced under any conditions.

9. Maintenance of Shore To Ship Power Permanent Components.

a. **Electrical Tests and Inspections:** Electrical tests and inspections for the shore power circuit breakers and associated protective relay and the permanently installed cables between the shore power circuit breaker and the power connection station (turtleback) shall be performed in accordance with NETA MTS. Electrical tests and inspections for the power connection station receptacles shall be in accordance with the manufacturer's instructions. Overpotential tests are not required, but may be performed on the cable assemblies that fail insulation-resistance tests as a means to locate cable faults and to verify cable integrity. Note that complete visual inspection of inaccessible components is not required. Inspection interval (visual and mechanical tests) shall be annual. Maintenance interval shall be every two years. These intervals may be reduced, as required, based upon equipment condition or operating environment.

b. **Repair:** Repair of permanent components shall be performed in accordance with the manufacturer's instructions.

c. **Breaker Operation:** Whenever shore power circuit breakers operate on instantaneous trip, do not re-energize associated shore power circuits until the cause of the fault has been cleared and the circuit breaker has been inspected for damage to contacts, arc chutes, frame and operating mechanism. Whenever shore power circuit breakers operate because of an overcurrent, the ships forces shall be notified and the associated shore power circuits may be re-energized per local SOPs with concurrence from the ships forces.

10. **Critical Component Inventory Records**: A history record will be established and maintained covering each shore to ship power system critical component. The record will document via inspection checklists all work completed and by whom. Cable and connections shall be tagged in accordance with the Shore Power Cable Assembly Nomenclature Detail, Attachment (2-3) to this enclosure, and entered into Single Platform MAXIMO and other appropriate maintenance planning databases.

11. System Reliability

a. **One-line diagram:** One-line diagrams, illustrating the equipment ratings and system configuration from the utility point of service, are prepared and kept current by the activities in

accordance with NAVFAC Manual MO-201, Electrical Power Distribution Systems. Plot plans will be annotated to show the location of all shore to ship power system components.

b. **Power System Study:** An activity power system study, including load flow, fault current analysis, coordination of protective devices, and arc flash is prepared in accordance with MO-201, Electrical Power Distribution Systems.

ENCLOSURE 1, ATTACHMENT 1 - REFERENCES

GOVERNMENT PUBLICATIONS

1. Department of Defense Unified Facilities Criteria Program http://dod.wbdg.org	UFC 3-560-10N, Safety of Electrical Transmission and Distribution Systems
2. Office of the Chief of Naval Operations (CNO) 2000 Navy Pentagon (N00) Washington, CD 20350-2000 http://neds.daps.dla.mil	OPNAVINST 3500.39B, Operational Risk Management (ORM)
3. Naval Facilities Engineering Command (NAVFACENGCOM) Capital Improvements Engineering Criteria and Programs (CIENG) 6506 Hampton Blvd Norfolk, VA 23508-1278 http://dod.wbdg.org	MO-201, Electrical Power Distribution Systems
4. Naval Sea Systems Command Washington, DC http://www.navsea.navy.mil http://assist.daps.dla.mil/online/start/	MIL-C-24368, Connector Assemblies; Plugs and Receptacles, Electric Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Number 1160 MIL-C-24368/1, Connector Assemblies; Plug, Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Number 1160 MIL-C-24368/4, Connector Assemblies; Plugs and Receptacles, Electric, Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Numbers 1162.1, 1162.2, & 1162.3

4. (continued) Naval Sea Systems Command Washington, DC http://www.navsea.navy.mil http://assist.daps.dla.mil/online/start/	MIL-C-24368/5, Connector Assemblies, Plug, Submarine Shore Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 400 Amperes, 60 Hertz, Three-Phase, Symbol Number 1149 MIL-C-24643, Cables and Cords, Electric, Low Smoke, for Shipboard Use, General Specification MIL-C-915G, Cable, Electrical, for Shipboard Use, General Specification
5. Submarine Maintenance Engineering, Planning and Procurement Activity (SUBMEPP) P.O. Box 2500 Portsmouth Naval Shipyard Portsmouth, NH 03804-2500 http://www.submepp.navy.mil	Maintenance Standard (MS) Number 3240-081-089 REV B, Inspect and Repair Shore Power Cables

NON-GOVERNMENT PUBLICATIONS

1. Institute of Electrical and Electronics Engineers 3 Park Avenue, 17th Floor New York, NY 10016-5997 http://www.ieee.org/portal/site	IEEE-48, Standard Test Procedures and Requirements for Alternating Current Cable Terminations 2.5 kV through 765 kV
2. Insulated Cable Engineers Association P.O. Box 1568 Carrollton, GA 30112 http://www.icea.net	ICEA S-75-381, Portable Power Feeder Cables for Use in Mines and Similar Applications (Also known as NEMA WC 58.) ICEA T-27-581, Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation and Portable Cables for Test (Also known as NEMA WC 53.)
3. InterNational Electrical Testing Association P.O. Box 687 Morrison, CO 80465 http://www.netaworld.org	Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems

4. National Fire Protection Association 1 Batterymarch Park Quincy, MA 02169-7471 http://www.nfpa.org	NFPA 70E, Standard for Electrical Safety in the Workplace
5. Underwriters Laboratories, Inc, (UL) 333 Pfingsten Road Northbrook, IL 60062-2096 http://www.ul.com	UL 44, UL Standard for Safety Thermoset-Insulated Wires and Cables UL 94, UL Standard for Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances UL 486A-486B, UL standard for Safety for Wire Connectors
6. International Organization for Standardization (ISO) 1, rue de Varembé Case Postale 56 CH-1211 Geneva 20, Switzerland http://www.iso.org/iso/en/ISOOnline.frontpage	ISO 4649, Rubber, Vulcanized or Thermoplastic - Determination of Abrasion Resistance Using Rotating Cylindrical Drum Device

ENCLOSURE 1, ATTACHMENT 2–INDEX

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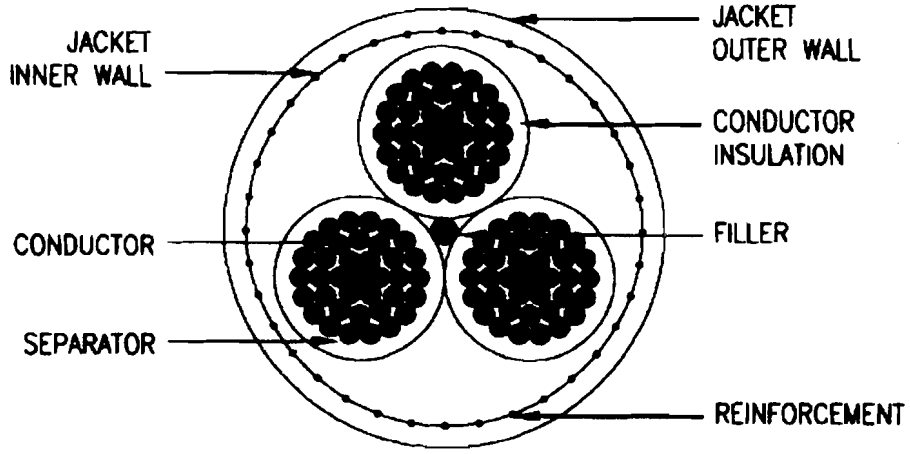
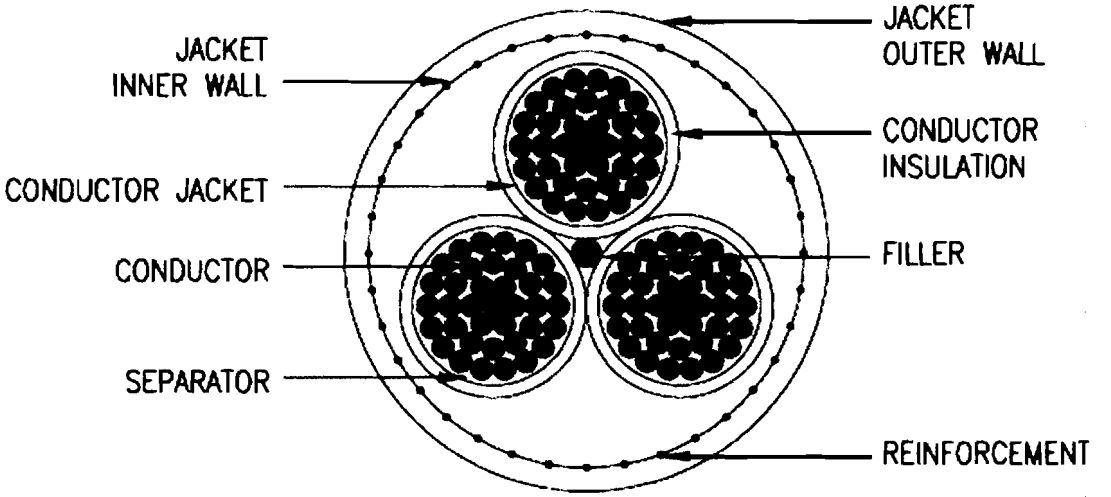


		TYPICAL
1.	CONDUCTOR – 500 KCMIL (37 x 33 / 0.0201") 1221W TINNED COPPER.	OD: 0.888"
2.	SEPARATOR – 2 MIL WHITE MYLAR PULLED LONGITUDINALLY.	OD: 0.893"
3.	CONDUCTOR INSULATION – 90 MILS (MIN AVG) OF UV RESISTANT ETHYLENE PROPYLENE RUBBER (EPR).	OD: 1.100"
4.	PHASE ID – PIGMENT COLORED INSULATION (BLACK, WHITE, RED).	
5.	FILLER – RUBBER AS REQUIRED TO FILL CENTER INTERSTICE.	
6.	JACKET INNER WALL – APPX. 100 MILS OF BLACK HEAVY DUTY CHLORINATED POLYETHYLENE (CPE).	
7.	REINFORCEMENT – TWO REVERSE/OPEN WRAPS OF POLYPROPYLENE FILAMENT.	
8.	JACKET OUTER WALL – APPX. 135 MILS OF BLACK EXTRA-HEAVY DUTY CHLORINATED POLYETHYLENE (CPE) 90°C RATED.	
9.	APPX WEIGHT – 7,563 POUNDS PER THOUSAND FEET.	OD: 2.875"
10.	CABLE IDENTIFICATION – INDENT MARKING TO READ: (MFG NAME) 500 KCMIL 3/C 600V ENHANCED SHORE-TO-SHIP POWER CABLE 90C (YEAR OF MFG) PROPERTY OF U.S. NAVY.	
11.	VOLTAGE RATING – 600 VOLTS.	
12.	TEMPERATURE RATING OF CONDUCTOR – 90°C.	
13.	TOLERANCE: +/–5%, DRAWING NOT TO SCALE.	
14.	SEE SPECIFICATION SHEET FOR ADDITIONAL INFORMATION.	

3/C ENHANCED THOF

REVISED: CIEE	MARCH 24, 2006	ATTACHMENT 2-1.1



TYPICAL

1. CONDUCTOR – 500 KCMIL (37 x 33 / 0.0201") 1221W TINNED COPPER. OD: 0.888"
2. SEPARATOR – 2 MIL WHITE MYLAR PULLED LONGITUDINALLY.
3. CONDUCTOR INSULATION – 65 MILS (MIN AVG) OF ETHYLENE PROPYLENE RUBBER (EPR).
4. CONDUCTOR JACKET – 65 MILS (MIN AVG) OF UV RESISTANT CHLORINATED POLYETHYLENE (CPE) OR HYPALON.
5. PHASE ID – PIGMENT COLORED INSULATION (BLACK, WHITE, RED).
6. FILLER – RUBBER AS REQUIRED TO FILL CENTER INTERSTICE.
7. JACKET INNER WALL – APPX. 100 MILS OF BLACK HEAVY DUTY CHLORINATED POLYETHYLENE (CPE).
8. REINFORCEMENT – TWO REVERSE/OPEN WRAPS OF POLYPROPYLENE FILAMENT.
9. JACKET OUTER WALL – APPX. 125 MILS OF BLACK EXTRA-HEAVY DUTY CHLORINATED POLYETHYLENE (CPE) 90°C RATED.
10. APPX WEIGHT – 7,854 POUNDS PER THOUSAND FEET. OD: 3.003"
11. CABLE IDENTIFICATION – INDENT MARKING TO READ: (MFG NAME) 500 KCMIL 3/C 600V ENHANCED PLUS SHORE-TO-SHIP POWER CABLE 90C (YEAR OF MFG) PROPERTY OF U.S. NAVY.
12. VOLTAGE RATING – 600 VOLTS.
13. TEMPERATURE RATING OF CONDUCTOR – 90°C.
14. TOLERANCE: +/-5%, DRAWING NOT TO SCALE.
15. SEE SPECIFICATION SHEET FOR ADDITIONAL INFORMATION.

3/C ENHANCED PLUS THOF

REVISED: CIEE	MARCH 24, 2006	ATTACHMENT 2-1.2

CONDUCTOR – CLASS I, UNIDIRECTIONAL LAY-UP, MAXIMUM RESISTANCE: 23.8 OHMS/1000FT AT 25°C.

CONDUCTOR INSULATION – EPR PER ICEA S-75-381.
ABRASION RESISTANCE TEST IN ACCORDANCE WITH ISO 4649 – INDEX OF 100 MAXIMUM.
PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381.
TEAR RESISTANCE, MINIMUM, 20LB/IN.
UN-AGED VALUES.
TENSILE STRENGTH, MINIMUM – 1200 PSI.
ELONGATION AT RUPTURE, MINIMUM % – 150.
AFTER AGING IN AIR 168 HOURS AT 121 ± 1°C.
TENSILE STRENGTH, MINIMUM % OF UN-AGED VALUE – 75.
ELONGATION AT RUPTURE, MINIMUM % OF UN-AGED VALUE – 75.
LONG TERM INSULATION RESISTANCE IN 75°C WATER SHALL BE IN ACCORDANCE WITH UL 44.

CONDUCTOR JACKET (ENHANCED PLUS ONLY) – CPE OR HYPALON – COMPOSITE, TYPE RHH/RHW-2.
ABRASION RESISTANCE IN ACCORDANCE WITH ISO 4649 – INDEX OF 100 MAXIMUM.
PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381.
TEAR RESISTANCE, MINIMUM, 30 LB/IN.
UN-AGED VALUES.
TENSILE STRENGTH, MINIMUM – 2000 PSI.
ELONGATION AT RUPTURE, MINIMUM % – 400.

OVERALL JACKET – MOLD CURED, TWO LAYER REINFORCED JACKET FILLING THE CABLE INTERSTICES.
INNER WALL – HEAVY DUTY CPE.
PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381.
UN-AGED VALUES.
TENSILE STRENGTH, MINIMUM – 1800 PSI.
ELONGATION AT RUPTURE, MINIMUM % – 300.
AFTER AGING IN AIR 168 HOURS AT 100 ± 1°C.
TENSILE STRENGTH, MINIMUM % OF UN-AGED VALUE – 85.
ELONGATION AT RUPTURE, MINIMUM % OF UN-AGED VALUE – 55.
OUTER WALL– EXTRA HEAVY DUTY CPE.
ABRASION RESISTANCE IN ACCORDANCE WITH ISO 4649 – INDEX OF 75 MAXIMUM.
PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381.
TEAR RESISTANCE, MINIMUM, 50 LB/IN.
UN-AGED VALUES.
TENSILE STRENGTH, MINIMUM – 2400 PSI.
ELONGATION AT RUPTURE, MINIMUM % – 300.
AFTER AGING IN AIR 168 HOURS AT 100 ± 1°C.
TENSILE STRENGTH, MINIMUM % OF UN-AGED VALUE – 70.
ELONGATION AT RUPTURE, MINIMUM % OF UN-AGED VALUE – 55.

ENHANCED & ENHANCED PLUS THOF SPECIFICATION

REVISED: CIEE	JANUARY 31, 2006	ATTACHMENT 2-1.3

ASSEMBLY

ENHANCED THOF CABLE SHALL HAVE INSULATED CONDUCTORS.
ENHANCED PLUS THOF CABLE SHALL HAVE INSULATED AND JACKETED CONDUCTORS.
SEE DRAWINGS FOR DIMENSIONS AND SUPPLEMENTAL INFORMATION.

THREE CONDUCTORS SHALL BE CABLED WITH A MAXIMUM LAY LENGTH OF 26 INCHES. EXCEPT FOR A CENTER EXTRUDED RUBBER ROD FILLER, NO OTHER FILLERS ARE PERMITTED. NO ASSEMBLY BINDER TAPE IS TO BE USED. MOLD RELEASE AGENTS, IF USED SHALL NOT CONTAIN SILICONE OR WAX.

FUNCTIONAL TESTS

THE GOVERNMENT RESERVES THE RIGHT TO WITNESS ANY OR ALL CABLE TESTS. ONCE FUNCTIONAL TESTING HAS BEGUN, ALL TESTS MUST BE COMPLETED IN NO MORE THAN 36 HOURS. FUNCTIONAL TESTS ARE REQUIRED USING A TEST CABLE AS DESCRIBED BELOW. TESTS SHALL BE CONDUCTED AFTER THE CABLE HAS BEEN EXPOSED TO THE SPECIFIED TEST TEMPERATURE FOR AT LEAST 8 HOURS. THE FUNCTIONAL TESTS SHALL BE PERFORMED IN THE FOLLOWING ORDER USING THE SAME PIECE OF CABLE:

1. DIELECTRIC PRE-FLEX TEST.
2. SUMMER FLEXIBILITY WITH NATURAL BEND.
3. SUMMER FLEXIBILITY AGAINST NATURAL BEND.
4. WINTER FLEXIBILITY WITH NATURAL BEND.
5. WINTER FLEXIBILITY AGAINST NATURAL BEND.
6. CUT-BACK.
7. DIELECTRIC POST-FLEX TEST.

TEST CABLE DESCRIPTION

THE TEST CABLE WILL BE 12 FEET IN LENGTH CUT FROM A CABLE WITH A MINIMUM LENGTH OF 100 FEET, ROLLED ONTO A CABLE REEL FOR AT LEAST 168 HOURS WHOSE SPOOL DIAMETER DOES NOT EXCEED 3 FEET. THE TEST CABLE WILL BE CUT FROM THE LAYER OF CABLE IN CONTACT WITH THE SPOOL. AFTER THE DIELECTRIC PRE-TEST EACH END WILL BE SEALED TO PREVENT MOISTURE INFILTRATION.

ENHANCED & ENHANCED PLUS THOF SPECIFICATION (CONT'D)

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FLEXIBILITY TEST

ALL FLEXIBILITY TESTS WILL BE PERFORMED BY LAYING THE TEST CABLE ON A 20 INCH DIAMETER SHEAVE OR DRUM (IE WHEEL) AND LIFTING IT VERTICALLY UNTIL THE CABLE HANGS FREE IN AIR. THE PLACEMENT OF THE CABLE ONTO THE WHEEL WILL ALLOW APPROXIMATELY ONE-HALF OF THE CABLE TO HANG DOWN ON EACH SIDE. AS THE CABLE HANGS FREE, ATTACH 80 POUNDS TO EACH END AND MEASURE TANGENTIALLY (IE PERPENDICULAR TO VERTICAL) THE SHORTEST DISTANCE BETWEEN THE CABLE MEASURED AT THE BOTTOM OF THE WHEEL. THE CABLE SHALL HANG FOR NO MORE THAN 30 SECONDS BEFORE THE MEASUREMENT IS TAKEN. NO FORCE TENDING TO BRING THE CABLE ON EACH SIDE OF THE WHEEL CLOSER TOGETHER WILL BE PERMITTED. ONLY THE WEIGHT OF THE CABLE AND THE TEST WEIGHTS WILL BEND IT AROUND THE TOP OF THE WHEEL.

DIMENSIONS BETWEEN CABLE AT BOTTOM OF WHEEL.
SUMMER: 25 INCHES MAXIMUM AT 25°C, ± 2°C.
WINTER: 28 INCHES MAXIMUM AT 5°C, ± 2°C.

CUT-BACK TEST

NOT LESS THAN 24 INCHES OF THE CABLE JACKET WILL BE REMOVED FROM BOTH ENDS OF THE TEST CABLE USING A KNIFE, 10 INCH CHANNEL LOCK OR VICE GRIP TYPE PLIERS, AND 8 INCH NEEDLE NOSE PLIERS. REMOVAL OF THE JACKET SHALL BE ACCOMPLISHED WITHOUT THE APPLICATION OF HEAT TO THE JACKET AT ROOM TEMPERATURE OF 20°C ±2°C. VERIFY THE FOLLOWING:

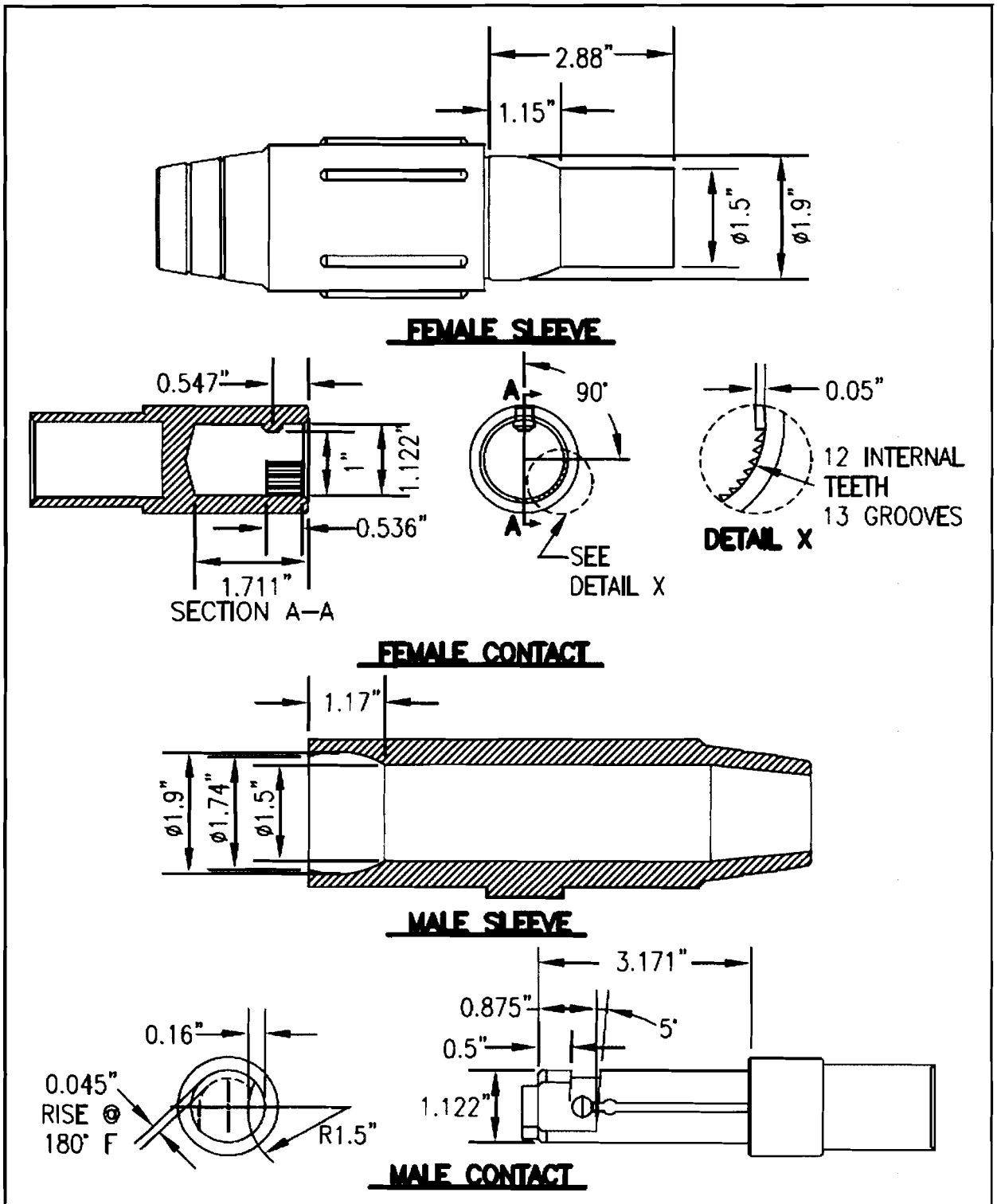
NO BONDING OF CONDUCTOR INSULATION (OR CONDUCTOR JACKET) TO CABLE JACKET
NO REMOVAL OF CONDUCTOR INSULATION (OR CONDUCTOR JACKET) BY TEARING
BOND BETWEEN INNER WALL AND OUTER WALL OF OVERALL JACKET SHALL BE STOCK TEARING.

DIELECTRIC TESTS

DIELECTRIC TESTS (BOTH PRE AND POST FLEXIBILITY TESTING), PER ICEA T-27-581.
AC HI POT; 9.5 KV FOR 5 MINUTES.
INSULATION RESISTANCE: NOT LESS THAN 100 MEG-OHMS.

ENHANCED & ENHANCED PLUS THOF SPECIFICATION (CONT'D)

REVISED: CIEE	JANUARY 31, 2006	ATTACHMENT 2-1.5



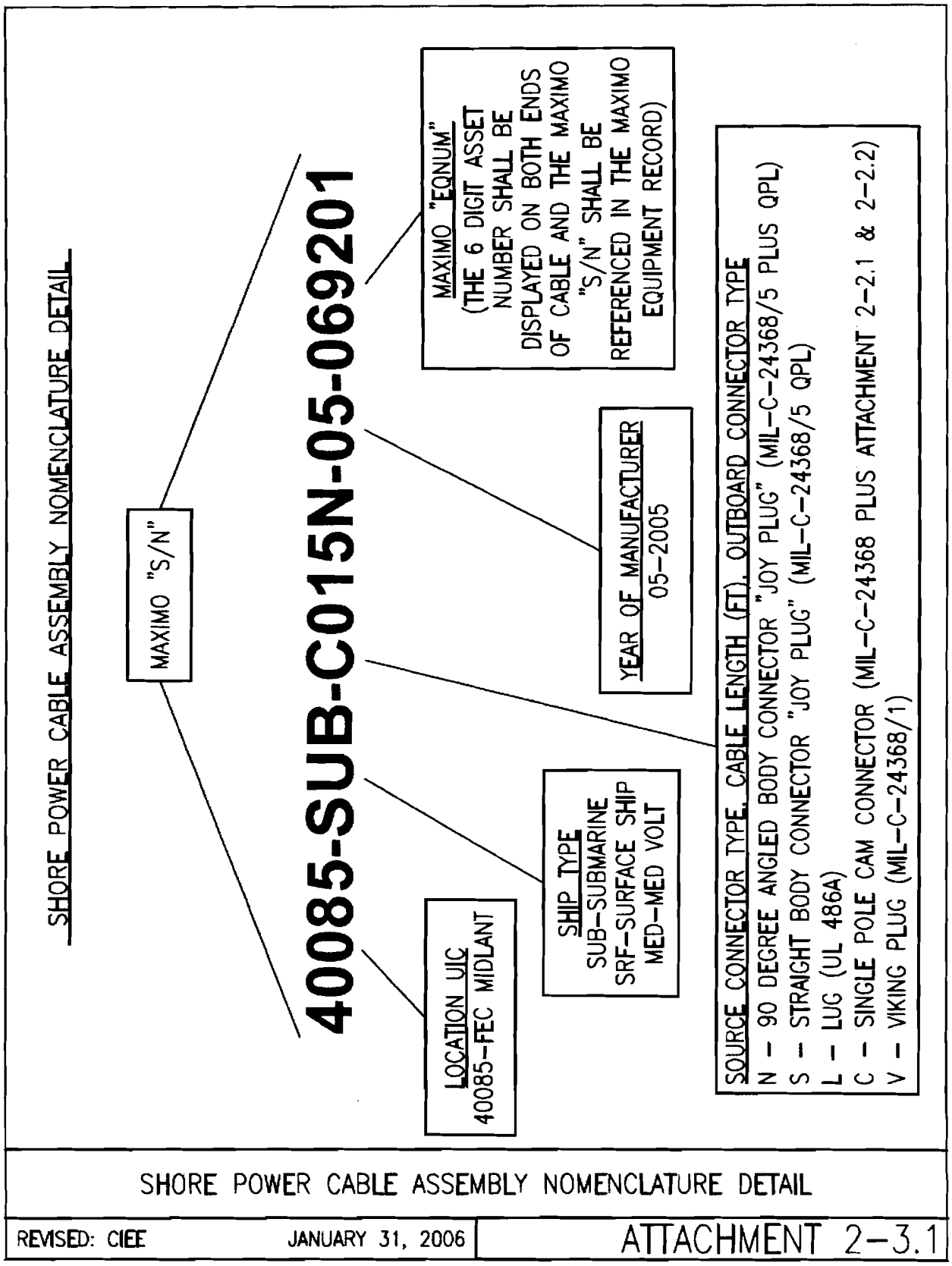
SINGLE POLE CONNECTOR DETAILS

REVISED: CIEE	JANUARY 31, 2006	ATTACHMENT 2–2.1

1. RATED FOR 600 VOLTS, 690 AMPERE MAX, 60 HERTZ, SINGLE POLE CAM, CONTINUOUS DUTY OPERATION.
2. INLINE CONNECTORS SHALL LOCK TOGETHER SO THAT THEY CAN NOT TWIST OR TURN LOOSE UNLESS A PUSH-BUTTON RELEASE MECHANISM IS ENGAGED.
3. POWER CABLE TERMINATION TO THE CONNECTOR CONTACTS SHALL BE VIA A CRIMP CONNECTOR.
4. THE INSULATED SLEEVES SHALL BE MECHANICALLY SECURED TO THE CONNECTOR CONTACTS TO GIVE A MINIMUM OF 700 LBS SHEAR FORCE.
5. BALL NOSE INSULATED SLEEVES SHALL BE MOLDED OF AN ETHYLENE PROPYLENE THERMOPLASTIC RUBBER (EPTR) COLORED BLACK PHASE A, WHITE PHASE B, AND RED PHASE C.
6. THE EPTR SLEEVES SHALL HAVE THE FOLLOWING MINIMUM REQUIREMENTS:

   - CONSTANT SERVICE TEMPERATURE RANGE: -60°C TO +135°C (-81°F TO +275°F)
   - FLAMMABILITY: UL 94 HB RATED
   - ELECTRICAL: UL RELATIVE THERMAL INDEX (RTI): 100°C (212°F)
   - DUROMETER HARDNESS: ASTM D 2240, 55 - 65A

SINGLE POLE CONNECTOR SPECIFICATION		
REVISED: CIEE	April 12, 2006	ATTACHMENT 2-2.2


SHORE POWER CABLE ASSEMBLY NOMENCLATURE DETAIL
40085-SUB-C015N-05-069201
MAXIMO "S/N"
MAXIMO "EQNUM"
(THE 6 DIGIT ASSET NUMBER SHALL BE DISPLAYED ON BOTH ENDS OF CABLE AND THE MAXIMO "S/N" SHALL BE REFERENCED IN THE MAXIMO EQUIPMENT RECORD)
YEAR OF MANUFACTURER
05-2005
LOCATION UIC
40085-FEC MIDLANT
SHIP TYPE
SUB-SUBMARINE
SRF-SURFACE SHIP
MED-MED VOLT
SOURCE CONNECTOR TYPE, CABLE LENGTH (FT), OUTBOARD CONNECTOR TYPE
N - 90 DEGREE ANGLED BODY CONNECTOR "JOY PLUG" (MIL-C-24368/5 PLUS QPL)
S - STRAIGHT BODY CONNECTOR "JOY PLUG" (MIL-C-24368/5 QPL)
L - LUG (UL 486A)
C - SINGLE POLE CAM CONNECTOR (MIL-C-24368 PLUS ATTACHMENT 2-2.1 & 2-2.2)
V - VIKING PLUG (MIL-C-24368/1)
SHORE POWER CABLE ASSEMBLY NOMENCLATURE DETAIL
REVISED: CIEE
JANUARY 31, 2006
ATTACHMENT 2-3.1