

OFFICE OF CIVIL ENGINEERING  
UNITED STATES COAST GUARD  
WASHINGTON, D.C.

APRIL 1996

MARINE CABLE,  
POWER AND CONTROL  
SPECIFICATION NO. G-SEC-390E

## 1. SCOPE

1.1 Purpose. This specification establishes the basic requirements for the construction and testing of power and control cable suitable for installation in the marine environment and intended for underwater use.

1.2 Equipment. This specification sets forth the requirements for the following types of marine cable:

- a. Type I - Power, three No. 6 AWG conductors, 5000 volt, No. 8 BWG armor;
- \* b. Type IA - Same as Type I, but double armor;
- c. Type II - Control, four No. 10 AWG conductors, 600 volt, No. 12 BWG armor;
- d. Type III - Heavy duty power/control, four No. 8 AWG conductors, 5000 volt, No. 8 BWG armor;
- \* e. Type IIIA - Same as Type III, but double armor.

1.3 Documentation. This specification sets forth the requirements for the following documentation:

- a. Test plan;
- b. Vendor submittals.

1.4 Precedence. Any ambiguity or conflict between this specification and applicable documents shall be resolved by utilizing the following documents in the precedence shown:

- a. This specification;
- b. Applicable documents.

\* 1.5 Changes From Previous Issue. Changes from the previous issue are identified by an asterisk in the margin of the specification.

## 2.0 APPLICABLE DOCUMENTS.

2.1 Applicability. The following documents form a part of this specification to the extent specified herein:

### 2.1.1 Military Standards.

MIL-STD-45662 Notice 3, Dec 84	Military Standard Calibration System Requirements
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### 2.1.2 NEMA Standards.

WC 8 1988	Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
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WC 7 1988	Cross-Linked-Thermosetting- Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
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2.2 Source of NEMA Standards. Standards are available from:

National Electric Manufacturers Association  
2101 L Street, N.W.  
Washington D.C. 20037

### 3. REQUIREMENTS.

3.1 General. The Contractor shall fabricate and test marine power and control cables in accordance with this specification.

3.2 Environment. The marine cable shall be designed and constructed to operate in the following environmental conditions:

3.2.1 Ambient Temperature. -20 to 125 degrees Fahrenheit

\* 3.2.2 Bottom Conditions. Sand, mud and rock.

3.2.3 Exposure. Fresh and salt water, salt air and sunlight.

3.3 Design and Construction. Cable construction, detailed in this specification, is specified from the conductors outward to the armor jacket.

3.3.1 Materials. The materials used for marine cables shall be as specified herein. Only virgin materials shall be used. Finished cable shall be negatively buoyant in sea water.

3.3.2 Copper Conductors. Each conductor strand shall meet all of the requirements of NEMA-WC7 or NEMA-WC8, Part 2.1 for soft or annealed copper wire.

\* 3.3.2.1 Conductor Coating. Cables using an EPR (see 3.3.4.1) based stress control layer shall have each conductor coated with tin or lead alloy in accordance with NEMA-WC8, part 2.1

3.3.2.2 Stranding. All conductors shall be concentric lay, Class B, compressed or compact stranded in accordance with NEMA-WC7 or NEMA-WC8, Part 2.3.

3.3.2.3 Conductor Splices. Conductor splices shall be butt brazed. The splice shall be made so that all parts affected in the process be as strong and durable, electrically and mechanically as the remainder of the cable. Splices shall not exceed 1 for each 5000 foot length with 1 splice permitted for each additional 5000 feet or fraction thereof, provided no two splices are less than 1000 feet apart.

3.3.3 Stress Control Layer. A stress control layer shall be provided on conductors of types I and III power cable in accordance with NEMA-WC7 or NEMA WC-8, Part 2.7. The extruded compound shall be free of any voids larger than 5 mils. The number of voids larger than 3 mils shall not exceed 30 per cubic inch of stress control layer. The stress control layer shall be easily and completely removable from the conductor using

conventional stripping methods. The stress control layer shall have an average minimum wall thickness of 15 mils.

3.3.4 Conductor Insulation. The conductor insulation shall be one of the following types:

\* 3.3.4.1 EPR Conductor Insulation. The insulating compound shall be a vulcanized Ethylene-Propylene-Rubber (ASTM Standard Symbol EPR). The insulation shall meet or exceed the requirements set forth in NEMA-WC8, Part 3. The average wall thickness, as defined in Part 3.2 of NEMA-WC8, shall be not less than 120 mils for types I and III cable and 60 mils for type II cable.

\* 3.3.4.2 XLP Conductor Insulation. The insulating compound shall be Tree-Retardant-Cross-Linked-Thermosetting-Polyethylene (ASTM Standard Symbol XLP). The insulation shall meet or exceed the requirements set forth in NEMA-WC7, Part 3. The average wall thickness, as defined in Part 3.2 of NEMA-WC7, shall be not less than 120 mils for types I and III cable and 60 mils for type II cable.

3.3.4.3 Contaminants. The manufacturing process shall provide for the screening and removal of contaminants from the insulation compound prior to their entrance into the extruder.

3.3.5 Conductor Color Coding. Each conductor shall be color coded by the application of colored synthetic rubber, rubber filled fabric tape, mylar tape, electrically inert paint, or printed color coding. Solid colored insulation is acceptable for type II cable. Color coding tape or printed tape shall be color fast under conditions encountered during manufacture and over the life of the cable. If tape is used, it shall be applied to the insulated conductor after completion of preliminary electrical tests. The tape shall be applied with a suitable lay and overlap and shall not be less than 0.001 inch. If printed color coding is used, the color name and color number shall be printed on the conductor insulation at 6 inch intervals maximum. The colors used shall be in accordance with the following:

- a. Type I - Three conductor - Red, White and Blue;
- b. Type II - Four conductor - Red, White, Green and Blue;
- c. Type III - Four conductor - Red, White, Green and Blue.

3.3.6 Fillers and Core Binders. Fillers and core binders shall consist of a waterproof jute, polypropylene or fiberglass material compatible with the cable insulation system.

3.3.7 Core Assembly. The required number of conductors shall be laid up spirally with fillers to achieve a round cross section. Type I cable shall have direction and length of lay in accordance with NEMA-WC7 or NEMA WC-8, Part 5. Type II and III cables shall have a left hand lay with the blue and white coded conductors directly opposite and nonadjacent to each other in a spiral-four or star-quad configuration.

\* 3.3.8 Marker Tape. A marker tape consisting of a

nonconducting, thin, waterproof and corrosion resistant material shall be installed along the entire production run of the cable and shall be printed with the following information approximately every two (2) feet. Printing inks shall be durable and water resistant.

- a. Name of manufacturer;
- b. Year of manufacture;
- c. Cable type;
- d. Contract number;
- e. Sequential footage (for entire production run)

For example: ABC Co. 1996 Type I DTCG36-96-C-00000 21050 FT

3.3.9 Thermoplastic Jacket. A moisture resisting thermoplastic jacket shall be applied over the group of insulated conductors. The jacket shall meet the requirements of NEMA WC-7 or NEMA WC-8, Part 4.4. The thickness shall be in accordance with Table 4-7 of NEMA WC-7 or Table 4-5 of NEMA WC-8. The jacket may be used as armor bedding as long as the thickness meets the requirements of paragraph 3.3.11 and if a marine borer barrier (3.3.10) is not required.

3.3.10 Marine Borer Barrier. When specified in the contract, a metallic sheath shall be applied over the thermoplastic jacket. The sheath shall consist of one layer of non-magnetic 0.005 inch thick uncoated copper tape applied helically with a 12.5 percent minimum overlap.

3.3.11 Armor Bedding. A jute, PVC or other non-hygroscopic bedding material shall be applied over the copper tape when a marine borer barrier is specified. The thickness of the material, regardless of type, shall be in accordance with Table 4-21 of NEMA-WC7 or Table 4-19 of NEMA-WC8.

\* 3.3.12 Armor. The armor shall consist of class B galvanized steel wire in accordance with NEMA-WC7 or NEMA-WC8, Part 4.5.8 except the ratio of the length of lay to pitch diameter shall be not less than eight nor more than ten, and the number of armor wires shall be such as to ensure not less than 95% coverage. The diameter of the armor wire is specified in paragraph 1.2 of this document. The wire shall be applied spirally with a right-hand lay. The wire shall be so preformed that it will remain in proper position. All joints in the armor shall be welded and no individual armor wire weld shall be within 3 feet of another weld as measured along the axis of the cable. All welds shall be thoroughly cleaned after welding and coated with zinc.

\* 3.3.12.1 Double Armor. When specified in the contract, a second layer of 10 BWG armor wire, conforming to paragraph 3.3.12, shall be installed over the 8 BWG armor wire. The 10 BWG armor shall have a left-hand lay.

3.3.13 Armor Jacket. An overall thermoplastic jacket shall be extruded over the armor core in accordance with NEMA-WC7 or NEMA-WC8, Part 4.5.16. The jacket may be extruded into the valleys of the armor.

3.3.14 Completed Cable Repair. The length of finished cable that fails to meet the tests outlined herein due to a localized fault or faults may be repaired and shall be retested at the original criteria. Repairs shall not exceed 1 for each 5000 foot length, with 1 repair or splice permitted for each additional 5000 feet or fraction thereof, provided that no two repairs are less than 1000 feet apart. Repaired lengths failing to meet tests outlined herein shall be rejected with no further repairs allowed.

3.3.14.1 Completed Cable Repair Procedures. Armor shall be laid back in its original position and electrically butt welded or brazed. The joints in the armor shall be staggered in accordance with the requirements of paragraph 3.3.12. The jacket shall be replaced in a manner to assure that it is mechanically and physically identical to the original jacket.

3.3.15 Cable Length. The length of cable on each reel furnished by the vendor shall be 1% greater than the length specified in the contract.

3.4 Documentation. The following documentation shall be provided:

3.4.1 Test Plan. The contractor shall submit to the Coast Guard Contracting Officer for approval a test plan, in English, for all factory testing to show compliance with the requirements of this specification. The test plan shall be submitted prior to the start of production. As a minimum, the test plan shall include:

- a. Location of test facility;
- b. Provisions for entering time and date of test;
- c. Contract number;
- d. A chronological list of tests to be performed;
- e. All information necessary to fully describe the tests so that the tests can be replicated independently;
- f. A complete listing of all equipment to be used including serial numbers, calibration due date and instrument calibration error;
- g. Samples of test data sheets used to collect data;
- h. Provisions for entering date and signatures of test personnel.

3.4.2 Vendor Submittals. The contractor shall submit to the Coast Guard Contracting Officer for approval vendor submittals, in English, prior to the start of production. The submittals shall contain the following information:

a. Proposed type of materials to be used in construction of cable:

1. Conductor coating;
2. Insulation;
3. Filler;
4. Thermoplastic jacket;
5. Armor bedding (omit if nonsheathed);
6. Armor jacket.

- b. Weight per foot of cable;
- c. Minimum installed bend radius of cable;
- d. Recommended DC hi-pot test voltage for field use;
- e. List of other recommended field tests;
- f. Special handling and field requirements;
- g. Current carrying capacity;
- h. Calculated capacitance of cable at 60 hertz between conductors and armor of completed cable assembly;
- i. Calculated dielectric constant of cable;
- j. Calculated insulation resistance;
- k. Calculated resistance of conductor.

#### 4. QUALITY ASSURANCE PROVISIONS.

4.1 Contractor's Calibration System. The contractor shall maintain a calibration and maintenance system to control the accuracy of measurement and test equipment used in the fulfillment of this specification.

4.2 Responsibility for Inspection. The contractor shall be responsible for the performance of all inspections and tests as required by NEMA-WC7 or NEMA-WC8.

4.3 Shop Traveler. The contractor shall maintain with each reel offered for acceptance a shop traveler prepared during manufacture. Shop travelers shall not be attached but shall remain with the item during all phases of inspection and repair. As a minimum, each shop traveler shall include:

- a. Contract number;
- b. Date each fabrication step is completed;
- c. QC inspection hold points;
- d. Test data sheets;
- e. Date of all inspections;
- f. Provisions for entering signatures of test personnel.
- g. Space for additional remarks and entries.

\* 4.4 Factory Testing and Test Methods. Tests on samples of cable and completed cable lengths shall be in accordance with section 6 of NEMA-WC7 or NEMA-WC8. Tests shall be performed regardless of cable length ordered. The Partial-Discharge Test Procedure is not required.

4.5 Production Inspection Tests. The following tests will be witnessed by a Government inspector:

4.5.1 Documentation. The shop traveler shall be available for review by the Government inspector. The inspector shall ensure that appropriate tests, as outlined in the test plan (3.4.1), were performed.

\* 4.5.2 Visual Tests. A one foot length of cable shall be cut from the end of two reels of each type of cable offered. The interior of the cable shall be exposed such that each layer is visible for inspection. Measurements of the conductor size, stress control layer, insulation and armor shall be made.

4.5.3 Marking. Inspect the marker tape, reels and tags for correct markings as specified in paragraphs 3.3.8 and 5.2.

4.5.4 Acceptance/Rejection Criteria. Missing or incorrect documentation, failure of the visual tests, or incorrect markings shall constitute failure of the production inspection tests.

4.6 Failure Responsibility. If a type of cable fails to pass the production inspection, the Contractor shall take corrective action on the materials or process, or both as warranted, on all items or portions thereof which were similarly manufactured and which are subjected to the same cause of failure. Depending on the type and number of failures, the inspection may be discontinued at the option of the U.S. Coast Guard until all corrective action has been taken. Acceptance shall be withheld until reinspection has shown that the corrective action was successful and the cable satisfactorily passes all inspections.

## 5.0 PREPARATION FOR DELIVERY.

5.1 Packaging. Each length of cable shall be wound on an individual reel after factory testing. Reels shall be shipped with a wooden lagging cover. The reels shall be made of wood and shall be able to withstand handling during transit and not deteriorate if stored for 5 years uncovered, outside. The diameter of the drum shall be a minimum of 15 times the diameter of the cable. The head of the reel shall have a slot through which the inner end of the cable is accessible for testing. The outer end of the cable shall be securely fastened to the inner side of the cable head so that the cable will not come loose in transit. Cable ends shall be covered with an end cap to protect the cable end from entry of moisture. Cable reels shall be nonreturnable.

5.2 Marking. The reel shall be plainly marked to indicate the direction which it should be rolled so as not to loosen the cable on the reel. A corrosion resistant metal tag shall be securely attached to the flange of the reel with corrosion resistant screws or rivets on all corners. Identification on the corrosion resistant metal tag and reel shall be as follows:

- a. Manufacturer's name and address;
- b. Cable destination;
- c. Name and address of consignee;
- d. Date of manufacture;
- e. U.S. Coast Guard contract number;
- f. Length of cable on reel;
- g. Cable type;
- h. Net weight of cable;
- i. Gross weight of reel;
- j. U.S. Coast Guard stock number.

5.3 Characters. Characters on the metal tag shall be a minimum of 3/16" high.

5.4 Shipment. Reels shall be securely blocked in an upright position so that they will not shift during transit. All



shipment of cable shall be prepaid by the manufacturer who shall notify the consignee 48 hours prior to delivery and provide the following information:

- a. Method of shipment;
- b. Carrier;
- c. Total weight of each piece;
- d. Bill of lading number.

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Prepared by:

Reviewed by:

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Mr. Jon Grasson  
Signal & Power

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H. R. Cleveland  
Signal & Power Team Leader

Approved by:

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L. E. Jaeger, CDR, USCG                      Date  
Chief, Ocean Engineering Division