

MOOS BENTHIC OPTICAL CABLE SPECIFICATION

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MBARI, 7700 Sandholdt Road

Moss Landing, CA 95039

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Rev. 1.1 – 08FEB01

Rev. 2.0 – 08AUG05 Added mechanical values. Minor revisions and reformatting. mrc

Rev. 2.5 – 19AUG05 Minor revisions on mechanical specification. mrc

Rev 3.0 – 24JUL06 Added details about torque balancing. jah

1.0 Introduction

The Monterey Aquarium Research Institute (MBARI) has developed a deep ocean underwater science observatory. Data communication and power are supplied to the seafloor by an oceanographic buoy system. Individual instrument installations on the seafloor are connected together with an electro-optical cable to be laid on the seafloor by ROV referred to as the **Benthic Optical Cable**. Currently this system is installed in 3200m, but all components are designed for a maximum depth of 4000 meters.

An existing benthic optical cable design has proven successful in depths down to 1400 meters. At 3200 meter depths, the existing design develops an internal torque that causes the cable to twist up significantly after spooling off of the drum on the ROV. A video of this problem can be downloaded from www.mbari.org/staff/hamilton/pub/cable_sled.mpeg. It is believed that this twisting is caused by the hydrostatic pressure squeezing the copper wire helix, imparting a torque that the torsional stiffness of the cable can not resist. The existing cable consists of 5 #20 copper conductors arranged at a 28 degree helix angle. To eliminate this problem, a new design is sought that will have a minimal torque imbalance at high pressure.

All information supplied by cable vendors to MBARI in connection with this cable purchase, including proposed designs, estimated performance and cost will be held in strict confidence by MBARI. Non-disclosure agreements can be executed if necessary. For final evaluation of the cable, if necessary, design specific permission may be requested from the vendor to submit to third party test and evaluation consultants assisting MBARI with the cable purchase.

2.0 Cable Proposal Requirements.

Prospective vendors are invited to submit proposed cable designs and must include the following information:

- 2.1 Design and estimated performance documentation.
 - 2.1.1 Description of the cable construction materials, approximate sectional dimensions and illustration for both armor protected and non-protected cable cross-sections.
 - 2.1.2 Cable weight per meter in air and seawater for both armor protected and non-protected cable cross-sections.

- 2.1.3 Estimated safe working load and ultimate breaking strength of the proposed design.
- 2.1.4 Estimated strain induced rotation of the proposed design.
- 2.1.5 Estimated pressure induced rotation of the proposed design.
- 2.2 Cable cost.
- 2.3 Cable delivery time ARO.

3.0 General and Environmental.

- 3.1 The cable must be water blocked with all interstitial voids filled with suitable filler material.
- 3.2 Temperature. The cable must meet the optical and electrical performance specifications and remain flexible enough to spool and un-spool from the specified minimum diameter storage drum from –2 degrees Centigrade to +25 degrees Centigrade.
- 3.3 Pressure. The cable must meet the optical, electrical and mechanical performance specifications while continuously submerged in 4000 meters of seawater.
- 3.4 Materials Compatibility. The cable jacket construction materials must be compatible with 5 years of seawater emersion. The individual copper conductor insulation must be compatible with silicone oil OR food grade mineral oil.
- 3.5 Storage Conditions. The cable must not be damaged by storage for five years on a storage reel meeting the minimum radius specifications.
- 3.6 Service Life. The cable shall provide a minimum of five years of service while continuously submerged.

4.0 Mechanical Specifications.

- 4.1 Length. Lengths up to 4000 meters will be required.
- 4.2 Diameter. The completed cable shall have a maximum diameter of 0.320 inches.
- 4.3 Weights. The cable weight in seawater shall not be less than 20 lbs per 1000 feet or greater than 25 lbs per 1000 feet. In air, the cable shall not be greater than 55 lbs per 1000 feet.
- 4.4 Working Strength. The cable working load shall be a minimum of 250 lbs..
- 4.5 Minimum Bend Diameter. The cable minimum bend diameter shall not be greater than 14 inches.
- 4.6 Armoring: 25 meters of each end of the cable shall be steel armored and not exceed 0.500 inches in diameter. The weight of the armored section must not exceed 270 lbs per 1000 feet in air or 210 lbs per 1000 feet in water.
- 4.7 Markings: The cable shall be a high visibility yellow color, dark contrasting bands and/or numeric meter markings every 1 to 5 meters on the cable are desirable.

5.0 Optical Specifications.

- 5.1 Fiber Count. There shall be **four** single-mode optical fibers. Fibers shall be Corning “SMF-28”. Substitution of alternate fiber shall only be by written agreement between vendor and MBARI. The optical specifications below must be

met over the specified cable service life during continuous operation at ocean depths to 4000 meters.

- 5.2 Optical Attenuation. Attenuation in each fiber shall not exceed the following values under cable working conditions (see mechanical specifications for working condition values):
 - 5.2.1 0.7 dB per kilometer at 1310 nm wavelength
 - 5.2.2 0.7 dB per kilometer at 1550 nm wavelength
- 5.3 Optical Attenuation Uniformity. No single point attenuation discontinuity in any fiber in the finished cable shall be greater than 0.15 dB at either 1310nm or 1550nm wavelengths, as measured with an OTDR.
- 5.4 Optical Dispersion. Individual fiber specifications for optical dispersion in the completed cable shall meet the pre-cabled fiber manufacturer's specifications for the fiber used, as measured by EIA/TIA 455-175.
- 5.5 Fiber Proof Test. Individual fibers will be proof tested at the time of manufacture to a minimum of 100kpsi.
- 5.6 Fiber Identification. Fibers or their over-jacketing shall be color coded or otherwise indelibly marked at least every meter for identification.

6.0 **Electrical Specifications.**

- 6.1 General. The cable will be used for electrical power transmission while submerged in the marine environment. The cable shall provide a minimum of two electrical conductors insulated from one another, and from seawater.
- 6.2 Working Voltage. The cable will be used at a working voltage between conductors, or between conductors and seawater, of up to 425 Volts DC. At this voltage, the maximum electrical stress present at any point in the cable insulation system shall be less than or equal to 2.0 kV/mm (51 volts/mil). The insulation system used must be suitable for continuous high DC electric field stress.
- 6.3 Insulation Resistance. The Insulation Resistance of each conductor in the as-built cable shall be a minimum of 3,000 Megohms per kilometer, measured at the working voltage of Section 6.1 above. The resistance shall be measured between the test conductor, and the other conductor(s) plus the cable armor plus any other metallic cable elements, tied together.
- 6.4 Conductor Resistance. The cable will be used at a working current of up to one ampere per conductor. The maximum as-built, as-cabled, round trip (two way) resistance of the two cable conductors in series shall be a maximum of 52 ohms per kilometer (nominally 26 ohms per kilometer per conductor, although equal resistances are not required), measured at a conductor temperature of 20 degrees C. The as-built conductor resistance shall have a tolerance of +/- 5%.
- 6.5 Production Testing. Each individually insulated conductor shall be tested for insulation resistance, before cable assembly, in a water bath or bead curtain test line. The test conditions and criteria for acceptance shall be as specified in Section 6.2 above. The completed cable shall be evaluated for Partial Discharge at the working voltage of Section 6.1 above. No detectable discharge is permitted, within the detection limits of the test equipment employed.

6.6 Conductor Identification. The individual conductors shall be color coded or otherwise made visually distinguishable from one another, either throughout their length, or at regular increments not to exceed 0.33 meter.

7.0 DELIVERY.

Delivery shall be quoted FOB destination, Moss Landing, California, 95039. Cable shall be delivered suitably packaged for transportation and storage.

Cable shall be delivered in a continuous length of 4000 meters (+5%-0%). A minimum of five meters shall be accessible at both ends of the cable to allow for testing on the shipping drum without re-spooling. A three flange reel is preferred.