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INTERNATIONAL Ocean Systems

May/June 2019

The Magazine for Ocean Professionals

CONNECTORS/CABLES/WINCHES; OFFSHORE RENEWABLES/OFFSHORE TECHNOLOGY

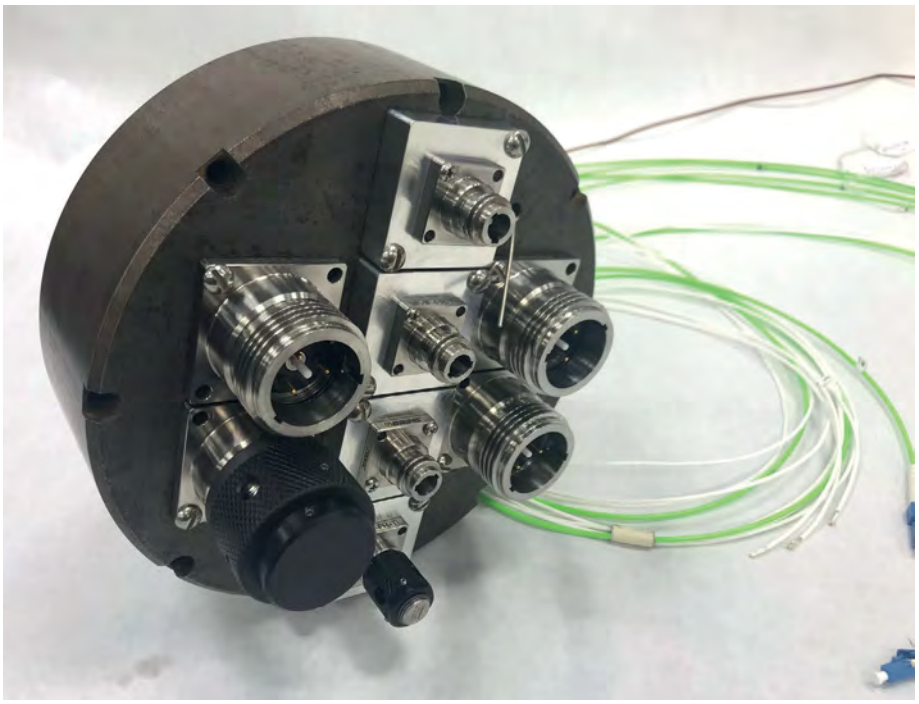
Staying cool

By Amy Brown, chief marketing officer, BIRNS, Inc., California, USA

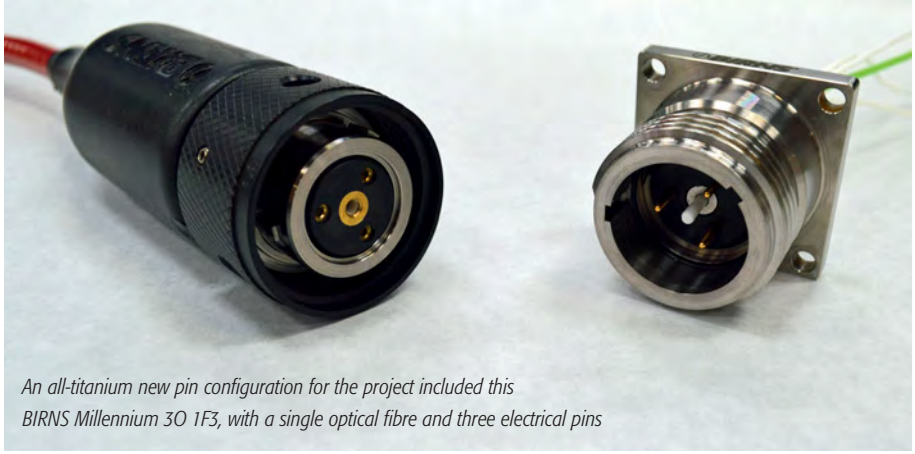
BIRNS develops new custom cable assemblies for extreme cold, ultra-depth rated AUV

When exploring the ocean at great depth, pressure is a primary design focus for subsea vehicles, and for the critical equipment within them. When those great depths are in the six-kilometre range, as necessitated by many of today's extreme depth vehicles, pressure increases dramatically, and equipment must be carefully designed in such a way as to survive it. The average ocean depth is approximately 3800 metres and since pressure is often referenced in atmospheres (about 14.6 PSI) the pressure increases at approximately one atmosphere for every 10 metres of depth. There are a range of different zones and aspects that affect the temperature in each; however, it is difficult to assess a true overall average temperature of the ocean due to dissimilar surface waters and global warming.

At six kilometres, in the Abyssal Zone the pressure is 596 atm. Vehicles designed for these parts of the ocean must withstand extreme pressure and still operate efficiently. But what about temperature at that depth? Below the thermoclines, the water temperature of most oceans is approximately 0 to 3°C (32–37.5°F). The environmental conditions of the Abyssal Zone are quite uniform – continually dark and extremely cold, averaging near freezing: 2°C at 4000 metres. Ocean water with an average salinity of 35 psu (practical salinity unit) freezes at -1.94°C/28.5°F.



BIRNS electro-optical and optical flanged receptacles are mounted to the pressure vessel fixture



An all-titanium new pin configuration for the project included this BIRNS Millennium 3O 1F3, with a single optical fibre and three electrical pins

CUSTOMISING CABLE ASSEMBLIES

BIRNS, Inc. was recently asked to develop new custom titanium cable assemblies for temperatures close to the freezing range of seawater, for signal and power supply for an extreme cold, ultra-depth rated AUV designed for survey and inspection. In addition to the new connector development, the project required BIRNS to develop a new extreme cold/hydrostatic test system that successfully allowed 48-

under pressure

hour-plus continuous testing of connectors and cable assemblies at six kilometres in a highly controlled 2°C (±1°C) environment. BIRNS developed the new system in concert with the development of a brand new pin configuration (3O-1F3) in its BIRNS Millennium series. The new connector was a small electro-optical hybrid with a single optical fibre, along with three electrical contacts.

The custom cable assemblies for the project, integrating the new pin configuration, included flanged titanium receptacle assemblies terminated with LC/PC (Lucent Connector/Physical Contact) connectors, as well as double-ended 3O-1F3 cable assemblies with all-titanium cable plugs (CPs) terminated and moulded on both ends of 52V cable at lengths of approximately 10 feet (three metres). The project also included miniature BIRNS single fibre connectors and cable assemblies, in this case, the BIRNS Millennium 3F-1F – all featuring titanium CPs and flanged receptacles (FRs), as the application required no stainless steel or non-titanium metallic materials outboard. The 3F-1F is an ultra-compact connector size, with a diameter (the outside diameter (OD) of the coupling ring) of less than three quarters of an inch (19 millimetres), which provides high bandwidth connectivity in a low profile package. The BIRNS 3F-1F is also widely used for small remote operated vehicles with telemetry capabilities, towed or untowed data acquisition devices or high definition underwater visual applications. It is very robust, is resistant to mechanical damage and delivers high bandwidth data with negligible signal degradation. It is also specially engineered for applications requiring long cables, thanks to its precision optical alignment and sophisticated cable termination. This particular project had cables that terminated to the LC/PC connectors at far end, with lengths of 165 feet (50 metres) on a deployable spool.

WITHSTANDING THE TEST OF TIME ... AND TEMPERATURE

The BIRNS team needed to develop a completely new testing capability to fulfill the requirements of the customer's project. The company already had extensive and sophisticated hydrostatic pressure testing capabilities, along with electrical and optical test systems. The team assessed the new requirements and started by upgrading an existing hydro test vessel suitable for use to 20,000 PSI (138 MPa). The technicians created temperature control by installing a secondary, external chamber wall in order to surround the test chamber with ice, kept cold using a copper tube heat exchanger with water/ethylene glycol from a nearby chiller. Next they developed a new software program to provide real-time test data throughout the continuous 48 hours of the required testing, monitoring both the pressure and the temperature – which had to be kept at six kilometres in a controlled 2°C (±1°C) environment the entire time. In addition, the team developed a separate software program which controlled the hydrostatic pressure, allowing them to ramp up and down at any pre-programmed dp/dt, with any dwell times, for any number of test cycles, all entirely automated and unattended. They also developed an alert system which sent alerts to their smart phones if the test pressure (or any other test parameters) were to go out of tolerance. Included in the testing protocols were the use of BIRNS's Kikusui electrical test system and CAMI Research 829A HVX-21 High-Voltage test system, as well as an Opto-Test OP940-SM-13/15 Singlemode Return Loss Meter.

BIRNS developed a new extreme cold, extreme depth pressure testing system that allows 48-hour-plus continuous testing of connectors and cable assemblies at six kilometres in a controlled 2°C (±1°C) environment

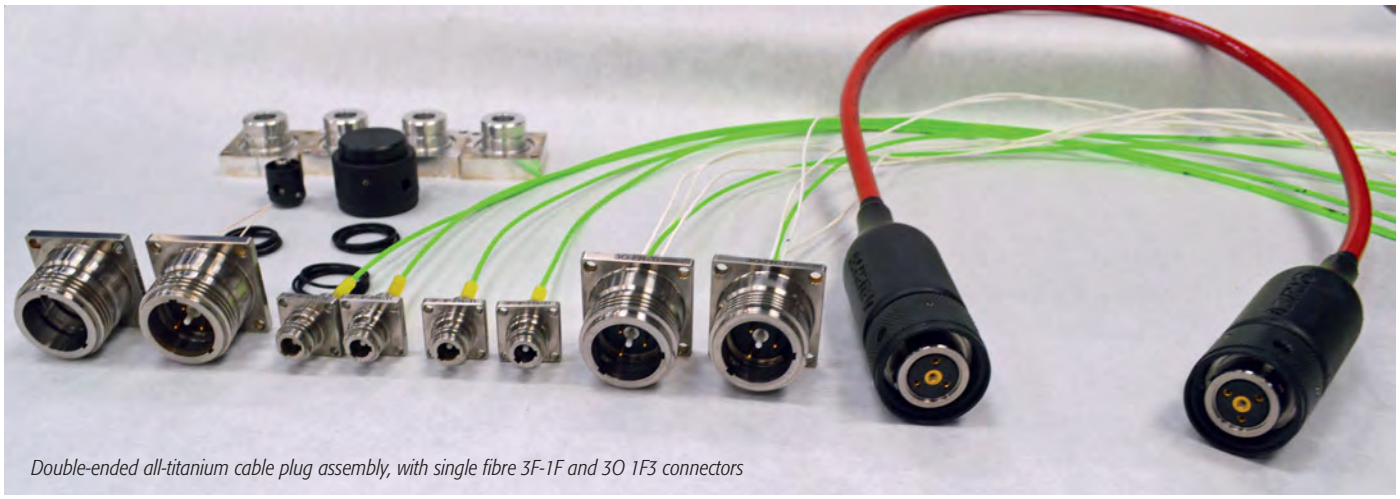
A Wi-Fi connected video inspection camera provides visual monitoring for moisture intrusion and condensation on the inboard side of the connectors, while under test pressure and temperature

During testing, the assemblies were mounted to a bulkhead to which the FRs were attached and loaded into an adaptor. Test cables were attached to test and qualify the performance in the mated condition, while pressure capped receptacles were provided for qualifying the integrity of the capped condition. Finally, open-faced receptacles were used to qualify the structural integrity of the open faced condition, and were tested to 625 bar/9065 PSIG (6km) in open face mode. Successful testing required dB loss held at <1dB, insulation resistance (IR) >2GΩ, and IR/continuity dielectric withstanding voltage (DWV) of 1200VDC between contacts and contacts-to-shell. At both 1310nm and 1550nm, the insertion loss of the 3O-1F3 over the entire 48-hour test was less than 0.12dB, far lower (less than an eighth) than the specification of 1.0dB.

Contact resistance was measured in accordance with MIL STD 202 Method 307. A mating pair (plug and receptacle) were used for this measurement. Connections were made to the solder pots and the test conducted at 1A and 1.5VDC. The 3O 1F3 dielectric strength was tested in situ using the Kikusui tester with all three lines and the shell connected at the same time.

The new pressure testing provided automated, programmable multiple pressure cycles with real-time data recording of electrical and optical testing, along with digital output of pressure and temperature data

The new pressure testing provided automated, programmable multiple pressure cycles with real-time data recording of electrical and optical testing, along with digital output of pressure and temperature data. The BIRNS team was pleased to successfully develop this complex new testing capability that combined extreme pressure, cold, and endurance, and for developing custom cable assemblies that could successfully pass such tests with tight tolerances in electrical and optical performance.



Double-ended all-titanium cable plug assembly, with single fibre 3F-1F and 3O 1F3 connectors