UNDERWATER HARDWARE DESIGN CHALLENGES FOR THE OFFSHORE PLATFORM MARKET

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Abstract: This paper presents a trunk & branch suite of undersea hardware developed for optical fiber communications between terrestrial landings and offshore oil & gas floating platforms. The trunk connects the two ends of the system, while the branches connect the platforms to the trunk. The branches consist of dynamic risers that terminate on one end at the platforms, and on the other end at an SL Wet Mate Fiber Distribution Canister (SL FDC), before reaching an SL Optical Add/Drop Multiplexing Branching Unit (SL OADM BU) that ties it to the trunk. This riser cable system uses the latest technology of undersea optical fiber cable, along with the FDC's which allow the network to be expanded to tie in additional platforms, without cutting into the cable system, but through the use of an undersea wet mate. It also uses the latest OADM Branching Units to provide the ability to optically control the powering configuration of the undersea network. The termination and joint for the riser cable are designed to maintain strength, optical, and electrical continuity.

1. INTRODUCTION

Advances in remote sensing, offshore structures, and deep water drill technologies have allowed the oil and gas industry to locate offshore platforms further away from shore. Accordingly, the need to communicate real-time with such platforms, and exchange data with shore stations and between platforms, has given rise to the development of special telecommunication hardware including riser cables, special branching units and other undersea equipment. Through the Campos Basin project, and the Gulf of Mexico project, Tyco has developed a suite of hardware to support such extensive and elaborate networks. These consist of a trunk & branch architecture where the trunk connects the two ends of the system, while the branches connect the platforms to the trunk. Figure 1 depicts the main trunk going through a Branching Unit (BU), while the other branch of the BU connects an offshore platform to the trunk.

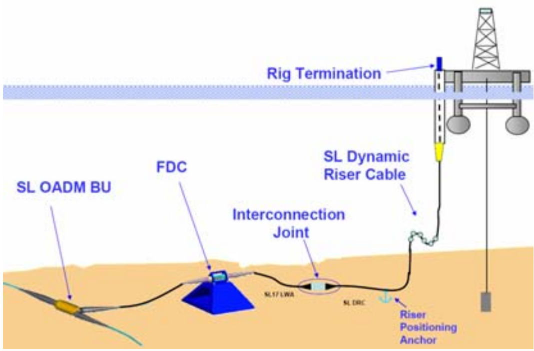

Figure 1. Diagram of a riser system

A closer examination of Figure 1 shows the main riser cable system which includes the dynamic riser cable (DRC), the dynamic rig termination, the interconnecting joint, a fiber distribution canister (FDC), and a branching unit. A detailed description of each of these elements is presented in the subsequent sections. The FDC allows future platforms to be easily integrated into the network without cutting into the system, but through a wet-mateable connection made into the trunk cable.

2. UNDERSEA HARDWARE COMPONENTS OF A RISER SYSTEM

2.1 SL Dynamic Riser Cable, Rig Termination, and Interconnecting Joint

The DRC is a high strength, torque balanced cable that is specifically designed for the dynamic environment of a floating platform and meeting the cyclic fatigue and deep water requirements. The structure of the cable is shown in Figure 2.

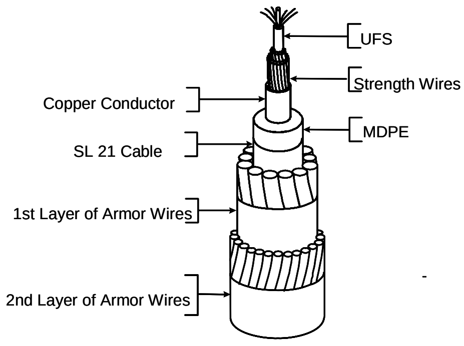

Figure 2. Tyco SL Dynamic Riser Cable Structure

The inner and outer layer armor wires have been laid on the core cable in opposing directions to torque-balance the cable. The core is a Unit Fiber Structure (UFS) which contains the fibers in an elastomer as a tight-buffer design, or in a loose-tube design.

The top end of DRC is terminated at the platform through the rig termination, as shown in Figure 3, which locks both armor and strength wires to secure the DRC onto the platform through a hang-off device or at the bottom of an I-tube. In addition, platform cable is joined to the DRC through the top end of the rig termination to connect the platform to the network.

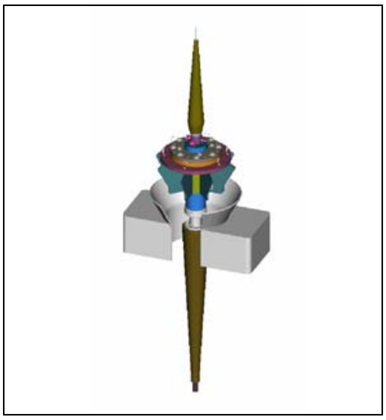

Figure 3. Dynamic Rig Termination and Hang Off Device

The vertical movement of a platform, especially a floating one, could put the DRC in compression at the touchdown point, which would buckle and bend the cable beyond its minimum bending requirement. In order to avoid this occurrence, buoyancy and/or ballast are installed on the bottom of the riser to create a “Lazy Wave” profile. A typical Lazy Wave profile of a DRC is shown in Figure 4. For the SPAR platform, with limited vertical movement, it is unlikely to need buoyancy and/or ballast, and usually a simple catenary of the riser would suffice.

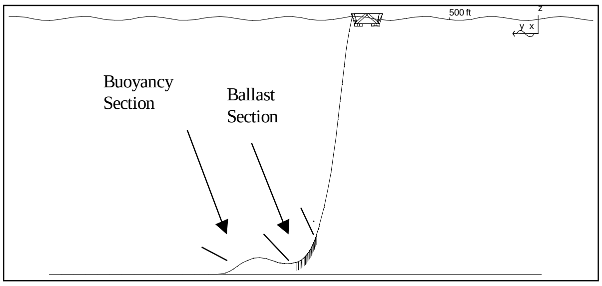

Figure 4. DRC Lazy Wave Profile

The bottom of the riser is positively secured to the bottom through anchors, which are preceded by wear protection to protect against lateral sliding and the lift-up-and-down of the riser close to the touchdown point.

The DRC is then joined to the rest of the network cable through an interconnecting joint.

2.2 Fiber Distribution Canister (FDC)

The FDC’s function is to pass through some number of fibers from the platform to the network, while others are terminated locally for plug-in accessibility.

Physically, the FDC is a canister that allows one to plug a wetmate connector into it, for fiber connectivity, without having to cut into the cable after the system is installed. It is pre-spliced in-line with the submarine cable in anticipation of future plug-ins and contains a number of bulkhead connectors. SL couplings are installed on either end of the FDC to allow the cable that connects it to the rest of the network to move freely during handling and deployment.

The FDC can contain up to four (4) wetmate connectors (WMCs), each spliced to the platform through a single fiber pair within the dynamic riser cable. For future expansion and connectivity, up to four (4) WMCs (receptacles) on flying leads may be readily hooked up using an ROV. Figure 5 illustrates an FDC design, while Figure 6 depicts the fiber configuration.

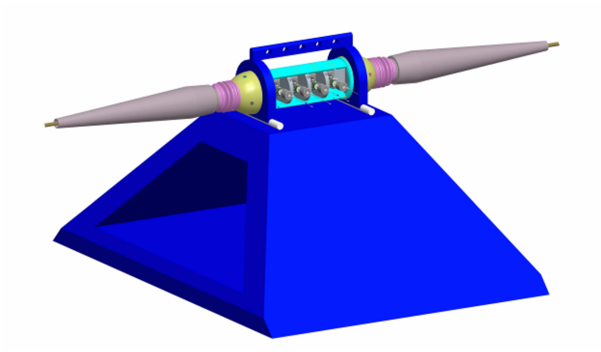

Figure 5. Fiber Distribution Canister with Couplings and Bottom Standing Frame

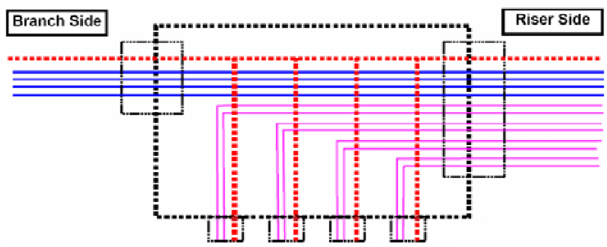

Figure 6. FDC Optical Fiber Configuration

A key feature of this approach is that the wetmate connectors with their pressure-balanced manifold components are isolated, from the deployment and handling loads. This is accomplished by mounting them inside the strength bypass & connector box. The

Lifting Bar and cable loads are transferred mechanically through the outer mounting box while protecting the manifold and bulkhead connectors. Figure 7 shows the WMCs, Connector Manifold and cable couplings without the bottom standing frame.

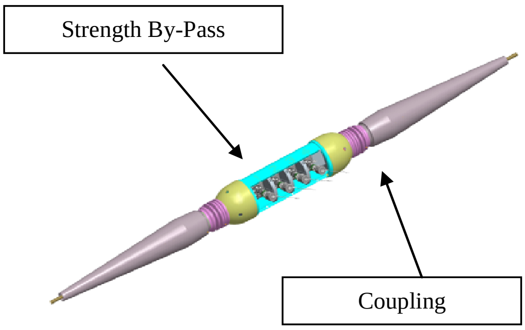

Figure 7. FDC Top and Side Views

2.3 Branching Unit

The function of the BU is to connect each of the platforms to the network cable, while providing the ability to isolate each of the branches in case of a repair. The Optical Add/Drop Multiplexing Power Switched Branching Unit (OADM-PSBU) is designed to allow optical connections between three cables terminating at the Branching Unit. It provides controllable electrical connections among the terminated cables and a local Sea Ground built into the Branching Unit. The OADM-PSBU can support direct routing of optical signals between two fibers and shared optical routing needed for Optical Add/Drop features in the system.

The OADM PSBU housing utilizes reliable and proven high pressure vessel design which protects the optical and electrical elements of the OADM-PSBU from the ocean environment. It also provides a high-strength connection among the three cable terminations. This housing, made of a beryllium-copper alloy, consists of a cylindrical body, the trunk cover assembly, and the branch cover assemblies. Figure 8 depicts a BU with cable couplings on its ends.

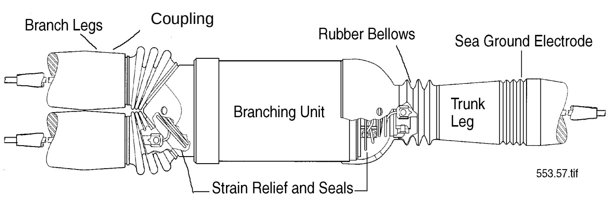

Figure 8. OADM-PS Branching Unit

The high-pressure housing assembly also provides voltage isolation between sea ground and system potential. Within the housing, the OADM-PSBU internal components are mounted. The vessel cover assemblies are equipped with feed-through penetrations for optical fibers and power conductors. The internal hardware design incorporates a modular network which includes proven and qualified optical component placement, reliable fiber splicing and fiber path routing. The network consists primarily of a Power Switching module which contains high voltage relays and power switching circuitry and OADM modules which house the optical components and fiber paths.

The design incorporates fiber pairs that are connected directly between the primary trunk cable and a secondary branch leg, and fiber pairs supporting Add/Drop multiplexing from one trunk fiber pair to the other branch cable. Additional direct connections (pass-through) between fiber pairs can be provided, up to a total of six fiber pair connections per cable in a one OADM Module product.

Electrical connectivity within the BU is controlled by means of an optical signal delivered to the Branching Unit through the same optical fibers used to carry traffic. The electrical switching features support a system design in which the system's main cable (trunk) can be grounded to Sea Ground at any branching point.

In the event of a system cable fault, this feature allows any segment of the trunk to be grounded at both ends during repair operations, while maintaining traffic to the rest of the platforms still connected to the system. The OADM-PSBU is designed robustly to withstand the worst case current and voltage transients caused by a cable fault.

The BU has undergone extensive qualification, including thermal cycling and shock & vibration. It is qualified to operate in 6000m water depth, and can accommodate system voltages up to 5 kV. The OADM PSBU is designed to meet or exceed typical installation and storage environments.

3. SUMMARY

This paper provides an overview of the telecommunication hardware developed and used to provide real-time communication to and between offshore oil & gas platforms. Special attention was given to the hardware associated with connecting the branches to the main cable trunk. This included a dynamic riser cable, a rig termination, a fiber distribution canister, and an Optical Add/Drop branching unit. All hardware has been qualified through rigorous testing as well as field applications.

4. ACKNOWLEDGEMENT

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