THE CHALLENGES OF COMPLETING AN OIL & GAS CABLE SYSTEM ORDER

Jerry Brown, Rendong Xu, Guilin Sun, Lei Zhang, Changji Hao, Xiong Wang, Hongli Qu, Di Wu, Fu Feng, Yin Jiang (Hengtong Marine Cable Systems)
Email: jerry@htgd.com.cn

Hengtong Marine Cable Systems,
No 8 Tongda Road, Changshu Economic Development Zone,
Jiangsu Provence, China 215537

Abstract: This paper details some of the opportunities & challenges Hengtong Marine Cable Systems (HMCS) encountered when working with a client from the oil & gas industry. The equipment design, solutions and documentation requirements are discussed and lessons learned presented. The project budget created many opportunities for novel innovative solutions for the cable accessories supplied. The end client however required only field proven equipment, which could not always be supplied due to existing restrictions and so a number of technical concessions were granted. Some examples are provided to show how all parties worked together to ensure products were delivered on time.

1. INTRODUCTION - SCOPE OF SUPPLY

'Standard' Submarine Cable System projects (if there is such a norm) use relatively standard cables, components, joints, repeaters and Beach Man Hole (BMH) accessories. The interfaces are generally well known and understood. Planning and control of work, normally does not affect or involve other operations and is fully under the control of a marine installer.

Oil & Gas submarine cable system orders on the other hand are customized to meet the client requirements. The cable & accessories are designed to meet specific client requirements, to interface with platform structures, to cope with dimensional restrictions and to function in a special working environment.

Hengtong Marine Cable Systems signed a contract on 30th July 2014 for the supply of a un-repeatered submarine cable to connect an offshore platform with the onshore communications centre of an Oil & Gas Company. The un-repeatered cable was designed to meet the client specifications and contained 24 Single Mode Fibre Cores in compliance with ITU-T G.652D. The contract required that the system and spare submarine cable was to be manufactured in a single length without joints and comprised of 6.0 km Double Armoured (DA) System Cable (for the Shore End Landing & Beach Man Hole) and an inline transition to 77.0 km Single Armour (SA) System Cable (for the Platform J-Tube) with a length of Spare Single Armour (SA) Cable included at the end.

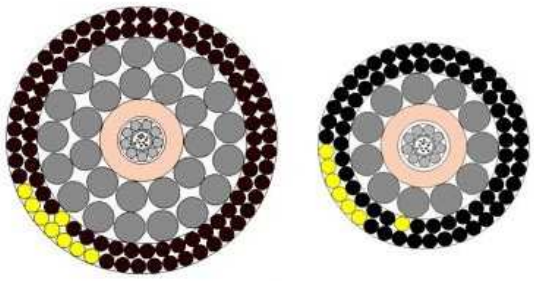


Figure 1: Cross Section DA & SA Cables

A 0.8 km length of Land Cable was also supplied.

On 25th February 2015 an additional contract was signed for the supply of cable accessories which included the following

- BMH Armour Cable Anchorage
- Elastomeric Cable Protection
- Beach Joint
- Land Cable Joints
- Platform J-Tube Cable Hang Off
- Diver-less J-Tube Seal
- Cable Head Pull-in Equipment
- Topside Cable Jointing Cabinet
- Topside Cable (Fire resistant)
- Selected spares

The contracts were signed with the selected Telecommunications System Vendor, not the final Oil & Gas Client. There were 3 company entities in the communication chain between HMCS and the final Oil & Gas Customer.

- Submarine Cable and Cable Accessories Supplier
- Telecommunication System Vendor
- Contractor
- Consultant
- Client

All Technical Queries and Clarifications had to be routed through all companies in this contractual chain, which ultimately lengthened & complicated communications

Lesson Learnt #1: Be prepared to deal with multiple companies between the Supplier and the end Client

2. PROJECT SPECIFICATIONS

HMCS was provided over 500 pages of Technical Specifications relating to the supply of the submarine cable and accessories. In addition to the top level project specific Technical Specification for the Submarine Cable System, all the other top level specifications originated from the end Client and were generic in nature covering the requirements for

- Quality
- Offshore Telecommunications
- Spare Parts
- Electromagnetic Compatibility
- Preservation of Equipment
- Protective coatings and Linings

The project specifications included several interesting requirements –

- ***All equipment supplied should be field proven***, with no prototypes of any kind permitted.
- A Functional Design Specification was required for each item of equipment, providing a description of the equipment supplied, the equipment functions/specifications, layouts, dimensions and interfaces. (within 3 weeks of contract award)
- Detailed documentation was required to cover many items including Test Procedures, FAT documentation, Inspection Reports, Material Certificates, As-Built drawings and documents, Final Data Book, Material Safety and Product Data Sheets, Design Calculations, Procedures covering Transportation, Storage, Installation, Operation and Maintenance, Spares and Spare Parts Lists.

The documentation requirements were clearly very detailed and reflect the importance placed on high quality products used offshore in a potential hazardous environment by the Client.

Lesson Learnt #2: Prepare a comprehensive documentation system to capture all documentation received from the client and all the required documentation deliverables.

Having received detailed documentation specification requirements, HMCS issued to the Client over 40 documents for approval (including FAT, Data Books, Procedures) amounting to over 250 pages of documentation and technical drawings.

3. PROJECT TIMELINE

The cable specification and design was approved and manufacture of the 83km of submarine cable as required by the project specifications was completed within 3 months without incident. The cable FAT was completed on 3rd November 2014 with no Client comments or concessions.
The cable was shipped from the factory quayside (in a custom designed cable pan) on 12 April 2015, over 8 months after contract signature and 5 months after the FAT.

Figure 2: Product Delivery in Cable Pan

Unlike standard telecommunication system projects where the client usually requires the cable system to be manufactured and installed as soon as possible, perhaps to take the commercial advantage of being the first service provider in a certain area, Oil and Gas Clients do not operate under the same commercial constraints.

It is clear that the Oil and Gas Client ordered the submarine cable system well in advance of required timescales. With hindsight, this was to allow for a complete re-manufacture of the cable should there be any incidents or problems during manufacture or any non-conformances identified during the FAT of the submarine cable.

Lesson Learnt #3: Oil & Gas Clients build lots of contingency into plans and schedules, to allow for a complete cable remake.

This probably stems from the Oil & Gas Clients experience when purchasing custom designed and manufactured umbilical cables, where they plan for contingency to allow for a complete umbilical remake, to ensure no slippage to the overall project schedule.

During the cable manufacturing phase discussions on the cable accessories continued. Three rounds of Technical Clarifications took place with the following response cycle times.

TQ1 – 18 days
TQ2 – 23 days
TQ3 – 28 days

Average Response time 23 days.

***Lesson Learnt #4*:** Be prepared for protracted response times to Technical Queries as these have to be reviewed sequentially by all parties.

Clearly there is considerable scope for improving the response cycle time for Technical Queries. One solution could be to transmit the Technical Query to all parties simultaneously.

4. ENGINEERING THE CABLE ACCESSORIES

The design of the submarine cable accessories and critical interfaces with the offshore platform were progressed in parallel with the engineering design of the platform. This meant that information requested in the form of 'as-built' drawings could not be supplied, only 'approved for construction' drawings were available and the design was progressed on this basis.

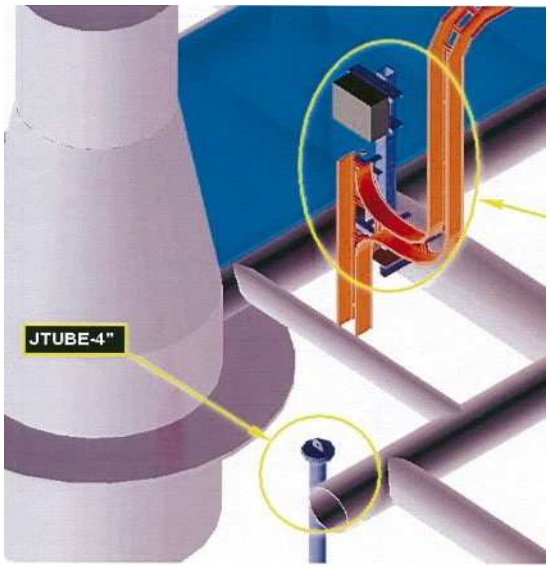


Figure 3: J-Tube (4") for Cable Hang-Off

Lesson Learnt #5: Be prepared for concurrent engineering and design with other companies and disciplines. Good communication is key to success.

One of the most challenging cable accessories to design and supply was the Diver-less J-Tube seal.
As the cable design had already been approved with an outer layer of Polypropylene yarns, the Client did not want to modify the cable design to provide a sheathed outer surface which would have been a more suitable interface to create a reliable J-Tube seal. The additional complication of having a length of Spare cable included at the platform end of the cable system, meant that the length of cable to be placed in the J-Tube could not be confirmed until Marine Operations were underway and the cable to be pulled onto the platform was cut to length.

Lesson Learnt #6: Relatively minor decisions made early in the project can have significant knock on effects to accessory equipment designs.

To comply with the Client requirement of using only Field Proven equipment designs a number of recognized suppliers of Diver-less J-Tube seals were approached for solutions of sealing a 26.8mm diameter Single Armour (SA) Cable to a small 4 inch Schedule 80 J-Tube Pipe. Of the 6 suppliers approached, 5 responded that the J-Tube internal diameter was too small and the cable outside diameter was too small and the cable too light and flexible for use with their standard Diver-less J-Tube Seal designs (which had only been developed and used with larger diameter, stiffer and heavier umbilical cables) and all 6 suppliers confirmed that the cable outer surface of polypropylene yarns would not allow an acceptable seal to be formed.

Lesson Learnt #7: Size does matter. Standard equipment design principles on larger umbilical cables, are not always scalable for use on smaller fiber optic cables.

Through the exchange of Technical Queries, the Client confirmed that the size of the J-Tube could not be increased as manufacture was already underway. In order to avoid delays and increased costs, the client accepted a non-field proven proposal to install a length of thick walled Heat Shrink Tubing over the cable in the J-Tube to allow a seal to be created which

could meet the 1 bar pressure differential sealing specification.

Lesson Learnt #8: Be creative and prepared to offer novel, innovative solutions to the Client, if it is low risk and ultimately saves the Clients time & money they will consider it.

As the J-Tube bell mouth was designed to be 1.6m above the seabed there was an additional requirement to provide dropped object impact protection by applying an Elastomeric Cable Protection Sleeve over the length of cable in suspension and continuing for several meters along the cable on the seabed. Only one supplier was able to modify their standard field proven Diverless J-Tube seal design to suit the small J-Tube size and to incorporate the required Elastomeric Cable Protection.

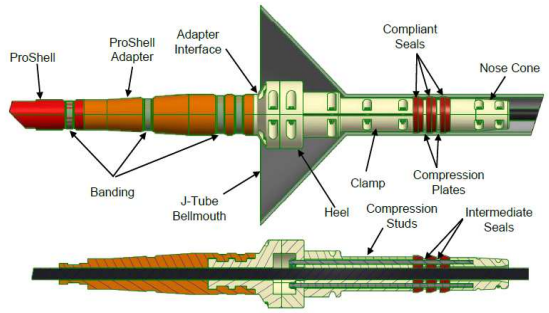


Figure 4: J-Tube Seal & Elastomeric Cable Protection

Lesson Learnt #9: Do not rely on a single supplier, always discuss requirements with as many reputable suppliers as possible, to ensure the best technical solution and price are realized.

The Diver-less J-Tube seal successfully passed the FAT, being assembled onto a length of Single Armoured Cable (with Heat Shrink Jacket), the force monitored during pull-in to a replica of the J-Tube geometry, and a 1 Bar pressure differential held for 1 hour, with no observed leakage.

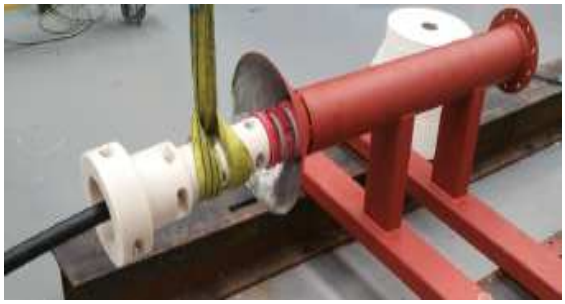
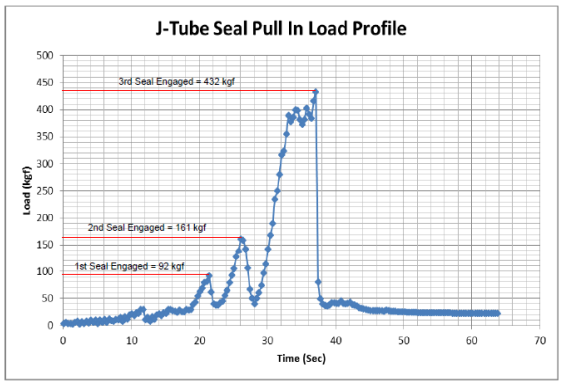


Figure 5 : Diverless J-Tube Seal FAT



Graph 1 : J-Tube Seal Pull-In Load

The measured Pull-In loads agreed well with design calculations.

Another challenging cable accessory to be supplied was the Platform Cable J-Tube Flange Hang-Off. The Static Riser Hang-Off was designed, manufactured and tested by HMCS.
The Functional Design Specification was extremely useful in defining all the required interfaces and functional requirements. In addition to securing the cable outer armour wires, the Hang-off also had to provide a seal to the cable (heat shrink) jacket and to electrically isolate the armour wires from the J-Tube.
It is necessary to electrically isolate the submarine cable outer armour wires from the J-tube, to ensure no adverse effects on the platform corrosion protection system. The weight of the system DA & SA submarine cable was 140 Tonnes in air. The protective outer armour wires alone

contribute over 113 Tonnes of steel to this weight. When these steel armour wires are connected to the platform jacket structure the connection detail has to be designed to ensure the armour wire hang-off is isolated from the J-Tube flange, therefore avoiding any adverse effects on the platform corrosion protection system. The submarine cable system weight of outer armour was over 4% of the weight of the platform jacket structure and therefore not insignificant.

Lesson Learnt #10: The devil is in the detail. It is always the small details which count. Always double check the cable system interfaces to ensure all conditions, load cases & eventualities are considered and accounted for.

Figure 6: HMCS Platform Hang-Off

The Static Riser Cable Hang-Off shown in Figure 5 was designed to meet operational and extreme load cases, to ensure a reliable cable anchorage.
All the cable accessories were designed, tested, FAT witnessed & completed and documentation provided to the Client specification within 6 months. The items were shipped from the company quayside port on 27th August 2015 to meet the client project schedule.

5. ON-GOING PROJECT SUPPORT

A third purchase order from the Client was received for the supply of Submarine Cable Repair Joints and for the provision of Offshore Service Technicians. The HMCS factory joint was modified for use with the cable manufactured for the Client. The customised cable joint was designed and manufactured within 3 weeks.

Lesson Learnt #11: Clients are Kings. Building a good relationship with all the parties in the purchasing chain can result in an enlarged scope of supply for equipment and offshore engineering personnel.

HMCS continues support to the project as it moves from the design, engineering and procurement phases into the construction and operational phases. Offshore Service Engineers all hold UK Oil & Gas Medical Certificates and Basic Offshore Safety and Survival Certificates.

Lesson Learnt #12: The project requirements for technical support and offshore engineering are never really complete.

As the Oil and Gas Client operates, expands and develops the platform and Field, there are many more opportunities to provide support to the end Client

6. CONCLUSIONS

This objective of this paper was to share some of the challenges, experiences and lessons learnt from working on the supply

of a submarine fibre optic cable for an Oil & Gas Client.
The initial cable supply contract was fulfilled and completed, and lead onto an enlarged scope of supply for customised cable accessories.

Several of the ***Lessons Learnt*** from this project are summarised again here –

Lesson Learnt #1: Be prepared to deal with multiple companies between the Supplier and the end Client.

Lesson Learnt #2: Prepare a comprehensive documentation system to capture all documentation received from the client and all the required documentation deliverables.

Lesson Learnt #3: Oil & Gas Clients build in lots of contingency into plans and schedules, to allow for a complete cable remake.

Lesson Learnt #4: Be prepared for protracted response times to Technical Queries as these have to be reviewed sequentially by all parties.

Lesson Learnt #5: Be prepared for concurrent engineering and design with other companies and disciplines. Good communication is key to success.

Lesson Learnt #6: Relatively minor decisions made early in the project can have significant knock on effects to accessory equipment designs.

Lesson Learnt #7: Size does matter. Standard equipment design principles on larger umbilical cables, are not always scalable for use on smaller fiber optic cables.

Lesson Learnt #8: Be creative and prepared to offer novel, innovative solutions to the Client, if it is low risk and ultimately saves the Clients time & money they will consider it.

Lesson Learnt #9: Do not rely on a single supplier, always discuss requirements with as many reputable suppliers as possible, to ensure the best technical solution and price are realized.

Lesson Learnt #10: The devil is in the detail. It is always the small details which count. Always double check the cable system interfaces to ensure all conditions & eventualities are considered and accounted for.

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Lesson Learnt #12: The project requirements for technical support and offshore engineering are never really complete.

Offshore engineering and technical support for the project continues.