OWNERS BEWARE – ENGINEERING OIL & GAS PIPELINE CROSSINGS AND THE DEVELOPING REQUIREMENTS OF THE CLIENT

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Abstract: The oil & gas and telecoms industries interact at pipeline and cable crossing locations via crossing agreements. The traditional solution for the crossing location is to apply protective material for managing abrasion, but little focus has been spent analysing the risks for the owners, associated with surface laid cable at these crossing locations. Risks such as suspensions, interaction with fishing equipment and difficulties in maintenance repairs from using these traditional methods are becoming less acceptable to all parties.

This paper covers how changes in pipeline and cable owner requirements for pipeline crossings has impacted the design and implementation of fibre optic cable crossing methodologies, along with the risks of continuing to use the methodologies of old.

1. HISTORICAL PIPELINE CROSSING REQUIREMENTS & METHODS

The regularity of pipelines and telecoms communications cables interacting on the seabed has increased due to the introduction of new assets within congested seabed areas. Indeed, with platform owners now looking for increased communications for their assets, the market for fibre optic cable installations within the oil & gas market has been growing for a number of years.

The traditional method of managing the installation of a fibre optic cable crossing over a pipeline is via a 'Crossing Agreement' between the two asset owners. This agreement helps to clarify areas such as liabilities, indemnities, notices as well as agreement on the operational procedures during construction operations.

Historically, agreements formalised a crossing methodology, for the fibre optic installer to surface lay the cable across the traditional 1,000m plough exclusion zone and for Uraduct®, or a similar anti-abrasion material to be placed for one times the water depth over the pipeline being crossed. The installation vessel would then use their trenching Remotely Operated Vehicle (ROV) to bury the cable within the plough exclusion zone to give the fibre optic cable maximum protection from external aggression.

2. RECENT CHANGES IN CROSSING AGREEMENTS

Whilst the methodology previously mentioned was the norm for Crossing Agreements, in cases where the pipeline was exposed on the seabed it became apparent that the fibre optic cable had suspensions either side of the pipeline, due to the minimum bending radius of the fibre optic. This approach inevitably led to potential risks for both asset owners.

Figure 1.1: Cable Suspension

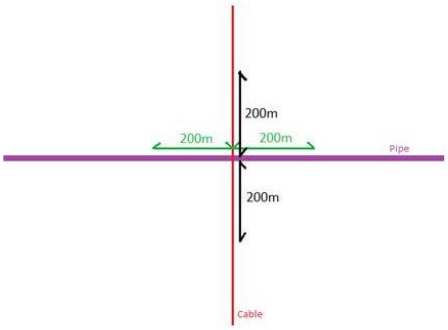

Figure 1.2: Survey Requirements

The suspended cable meant that the risk of fishing equipment becoming entangled with the fibre optic cable was significantly increased, which also led to the potential of discarded fishing gear being left over the pipeline.

Whilst discarded fishing equipment was highly unlikely to cause damage to any pipelines, the asset owner became more conscious of this occurrence; on occasion, assets have been sold to other operators, and providing ROV survey evidence of the pipeline with issues such as this was deemed undesirable. Equally, the fibre optic cable owner was concerned that fishermen making contact with the cable could not only damage the cable and interrupt system traffic but potentially submit claims for compensation relating to damage incurred to their equipment.

As a pre-curser to any construction works, many of the Crossing Agreements now have requirements for the contractor to conduct a pre-operations ROV survey of the crossing location, giving visual representation 200m along both the fibre optic and pipeline routes.

The purpose of this survey is to demonstrate that no obstructions exist before construction activities begin. One issue that has become prevalent in a number of Crossing Agreements is that the asset owner states this survey activity needs to occur at least four weeks prior to the crossing construction. This requirement can be at a great cost to the cable owner, as the install vessel may need to mobilise early at additional cost or a separate vessel may be required to undertake this task. In our experience, this issue has been negated through the main lay vessel conducting this requirement whilst in transit to the cable loading port, hence additional costs have been kept to a minimum. However, this approach is purely based on the location of the loading port in relation to the operational field and may not always be an available option.

A further recent development in asset owner requirements has been the insistence on separation between the pipeline and fibre optic cable. Whilst this has been the case in many instances already, a new requirement has been noted through the insistence that some form of separation material, such as a mattress, is placed between the asset and fibre optic cable even if the asset being crossed is buried. The premise of this new requirement is that the asset owner desires confirmation that some form of separation will remain between the two crossing parties should seabed movement occur and the

current material is removed from between the asset and the fibre optic cable.

3. METHODOLOGIES UTILISED TO MEET REQUIREMENTS

The first area to review in terms of new Crossing Agreement requirements is the separation necessary between the asset and the fibre optic cable. This has been managed via a number of different solutions. The reason we have varied solutions is that asset owners had different values in the amount of separation they required between the two products. The majority of asset owners wanted to ensure a minimum of 300mm was in existence whilst a few of the owners insisted on 500mm separation.

In cases where the pipeline was buried, then the 300mm requirement was a simple solution, as this was the depth of a mattress. This meant a 6m x 3m mattress could be placed directly over the crossing location in preparation for the fibre optic installation as shown in Figure 1.3.

Figure 1.3: 300m Mattress (buried pipeline)

Where the 500mm separation was required a combination of the 300mm depth mattress and a layer of tyres was installed to reach the 500mm requirement. In order to make the deployment of the 500mm mattress more practical, the tyres were connected to the mattress prior to deployment so that only one operation was required to get the tyres and mattress deployed in situation.

Figure 1.4: 500m Mattress

Where the pipeline was surface laid or partially buried, the same solutions mentioned above were utilised based upon separation requirements.

Figure 1.5: 300m Mattress (exposed pipeline)

Whilst the use of the mattress addressed the separation issue, the management of the fibre optic cable's suspension over surface laid pipelines remained. It was clear that the construction of the fibre optic cable could not change significantly enough to allow the minimum bend radius to conform to assets it crossed, so alternative protection methods were required.

The first challenge to be addressed was how to support the cable that was in suspension and remove the risk of fishing equipment becoming entrapped, whilst also making the support mechanism over-trawlable so that

neither fibre optic or fishing gear were endangered. A number of options were available to manage this risk but the key driver to the two most practical solutions was influenced by the fibre optic cable owners' need to manage future cable maintenance. One solution was to encase the crossing point and associated cable suspension via rock placement.

This methodology allowed for the aforementioned mattress to be placed over the pipeline thus meeting the separation requirements with the second phase of operations undertaking the installation of the fibre optic cable.

As our examples demonstrate the installation vessel concluded the fibre optic cable installation over the pipeline. Figure 1.6 illustrates, a Double Armoured cable with Uraduct® installed over a 20" pipeline gave a cable suspension distance of 39.3m.

It is at this phase of a project such as this that the cable owner needs to be aware of another potential issue. All recent projects that Global Marine has undertaken have utilised a DP2 vessel for the operations, this is not always the case for marine operators. Within the Crossing Agreements, the pipeline owner requests all vessel assurance documentation is provided and approved by their vessel assurance team prior to any vessel gaining permission to enter the pipeline 1,000m exclusion zone. Most rock placement and mattressing vessels are now DP2 as standard. It is important to be aware of the stipulated requirement of the pipeline owner for works on and around their asset. These requirements' can affect the choice of works vessel and equipment you need to plan for and this needs to be covered in your contract and risk management processes.

With the fibre optic cable installed a rock placement vessel was then needed to place a filter layer of rock on the base in order for the cable suspension to be supported. The protective layer of rock is then placed on top of the cable with the berm being designed to have a 1:3 ratio to ensure stability and over-trawlability.

Figure 1.6: Rock Placement

Whilst this is the most robust of protective designs, it would mean that in the event of a fault, the cable would need to be cut and abandoned at the present crossing location. A new section of cable would need to be installed along with the requisite cable protection and rock placement plus the potential requirement of a new Crossing Agreement. Some customers prefer to have the rock placement solution and undertake the potential fault risk, whilst others are deterred by any repeat costs of the rock placement should this cable replacement event occur. As such, a solution which offered protection to the pipeline and fibre optic cable, whilst allowing for ease of cable recovery and replacement was investigated.

Through working closely with engineering companies, a number of designs were analysed with the most practical being a mattress which has a raised channel within the centre of the mattress. This allows the mattress to function for the requisite separation requirements whilst also providing protection to the cable as demonstrated in figure 1.7:

Figure 1.7: Channelled Mattress

At first glance the design looks like it could be challenging to install the cable within this channel. A recent project which required four mattress deployments and subsequent cable installation within the mattress channel, were all installed first time based on utilising a ROV to monitor the cable install at the crossing locations. The key benefit being that the cable is protected over the crossing from external aggression such as fishing equipment but it also allows ease of recovery and re-deployment should the need for maintenance ever be required.

The second challenge for this solution is to manage the cable suspensions over the pipeline and this was done through the development of tyre bridges. The primary purpose of this bridge was to remove any suspensions and the risk from fishing equipment but to also allow for the channelled mattress to be supported in a manner that the cable can be safely installed over the crossing location.

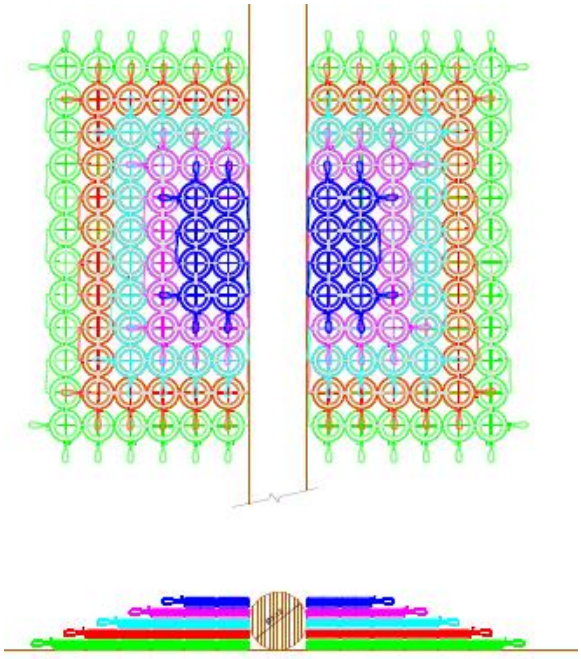

Figure 1.8: Tyre Bridges

As shown in figure 1.8 above, the tyre construction gives a pyramid formation so that any fishing equipment would be guided up and over the area without damage to either of the assets or endangering the fisherman's equipment.

Whilst this solution provides more flexibility in the maintenance potential for fibre optic cables over pipelines, the methodology for deployment in this solution is more weather sensitive. This is due to the accuracies required for installing multiple items next to a pipeline to fulfil the Crossing Agreement requirements, whilst also taking into account the needs of the fishing community.

As a final note, one area which came to light prior to any of the solutions above being contemplated, was a requirement from a pipeline owner who stated that no agreements would be signed unless they had a written agreement from the local fisheries representative for the proposed crossing methodologies. This requirement protects the asset owner against potential claims should fishing equipment become damaged or lost at the crossing location. As such, engagement of the local fisheries is now an important part of crossing agreement procedures.

4. CONCLUSIONS

It is now increasingly common for seabed users to develop infrastructure within multiple use areas, consequently the interaction between different industries is more prevalent. What used to be an unusual occurrence has now made the crossing of pipelines with fibre optic cables more commonplace. This is coupled with the need to understand the requirements and issues of local communities, such as fisheries.

This paper has examined the evolving requirements of pipeline owners through multiple lifetime ownership models, as well as fibre optic cable owners risk management of third party interactions has developed new requirements and methodologies to ensure Crossing Agreements are aligned before crossings occur.

Some pipeline owners may consider the traditional crossing methods mentioned as suitable with the fibre optic cable owner happy to take the risk on third party interaction and potential maintenance. However, our experience over the past five years within the North Sea, UK has noted that areas such as separation, suspension management and future maintenance allowance are becoming much more critical in the planning phase of the project to ensure an agreed solution with the customer and their clients.