RISK ASSESSMENT METHODOLOGY AND OPTIMISATION OF CABLE PROTECTION FOR EXISTING AND FUTURE PROJECTS

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ABSTRACT

The current economic climate in the submarine telecoms cable industry dictates that a cable must be installed in the most cost efficient way. This includes not only the capital cost of the subsea equipment and installation but also the whole life costs associated with maintenance and repair. Burial has historically been adopted as the most cost effective means of protecting a cable, with increased levels of armour commonly used where good burial cannot be achieved. Less than ten years ago, a burial depth of 0.6m was considered adequate to provide protection against most hazards. Over recent years, with concerns over system security and reliability, the tendency has been to specify deeper and deeper burial. However, this had the effect of increasing installation costs and also making recovery and repair more difficult.

The burial protection index provides a quantifiable figure tying the level of protection achieved by burial in different seabed sediments. A specification based on this concept would aim to maintain the burial protection index constant for areas of similar threats, but not necessarily the burial depth, which would vary with the strength of the seabed soils. However such a methodology does not allow for the possibility of enhanced armour. An alternative, and more rigorous approach is to develop a risk matrix as used for offshore pipelines. The methodology comprises hazard identification and evaluation of the frequency and consequence in a risk matrix. Within the matrix, the ALARP (As Low As Reasonably Practicable) region identifies an area where the risk is acceptable. Further reduction of risk would be subject to cost benefit evaluation. This paper illustrates this methodology and shows how it can be applied to both existing and proposed cable systems to quantify the whole life cost. The application of such a method clearly has significant economic advantages to investors and carriers, demonstrating that the lowest whole life cost will be achieved.

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1. INTRODUCTION

Cable burial has historically been adopted to protect submarine cables from potential threats, primarily fishing and anchoring. The deeper the depth of burial achieved, the greater the level of protection. Whilst the financial consequences of damage to a cable system in terms of both lost revenue and cost of repair are significant, deep cable burial can be a slow and expensive operation. Given the current economic climate, new cables must be installed in the most cost efficient way whilst maintaining a sufficient level of protection against damage.

The burial protection index (BPI), developed in the late 1990s (Allan, 1999), provided a framework for tying the level of protection achieved by burial in different seabed soils. A specification based on the BPI concept aimed to maintain the burial index constant for areas of similar threats, but not necessarily the burial depth, which would vary with strength of the seabed soils. The BPI concept went some way towards optimised cable burial and protection. However, in the majority of cases, the BPI assessment is quantitative and the methodology did not allow for the additional protection provided by cable armour or the possibility of enhanced protection, for example by rock dump.

An alternative and more rigorous approach is to use the risk assessment methodology developed for offshore pipelines. Here, quantitative techniques can be developed for assessing risk and a range of protection measures compared and incorporated within the risk assessment.

2. RISK MATRIX

2.1 METHODOLOGY

A methodology for carrying out a risk assessment of pipelines and umbilical protection has been published by DnV (DnV, 2001). It is a risk based approach for providing protection against accidental external loads and uses a risk matrix to assess damage frequency and consequence.

Prior to undertaking any risk assessment, the safety objectives and the acceptance criteria need to be defined. In the case of submarine telecoms cables, the aim of any protection measures adopted should be to avoid the risk of damage from potential hazards or reduce the risk to a level that is as low as reasonably practicable (ALARP). The description of the risk assessment process is shown in Figure 1.

In general, the risk assessment consists of an estimation of the frequency of occurrence of hazard events and an evaluation of the consequence of the event.

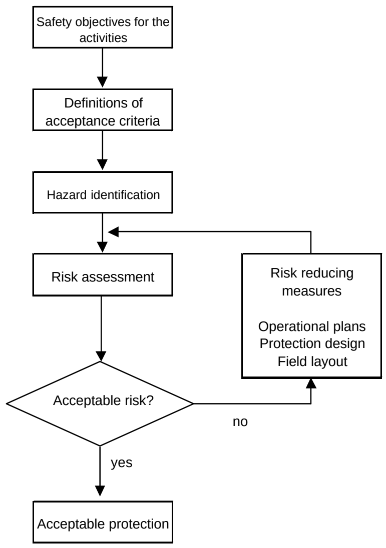

Figure 1: Risk Assessment Process

The frequency of occurrence is given a ranking from 1 (low) to 5 (high). Similarly, the consequence is either calculated or estimated, then ranked from 1 (low, non critical consequence) to 5 (high, severe consequence). The risk is then evaluated within a risk matrix, Figure 2.

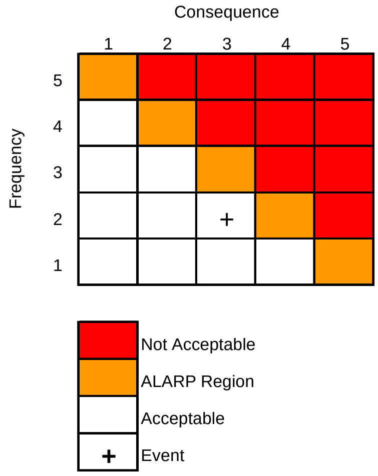

Figure 2: Risk Matrix

In Figure 2, the ALARP region identifies an area where the risk is acceptable. Cost benefit analysis can be used to assess the benefits of a further reduction in risk. Risk reduction can be achieved by reducing the frequency or consequence of the event, or a combination of both. Typical measures include:

- Restricted zones (reducing frequency)
- Change layout / routing (reducing frequency)
- Increase depth of burial (reducing frequency)
- Increase mechanical protection (reducing consequence)

3. APPLICATION

The application of a rigorous risk assessment methodology for assessing cable protection clearly has significant economic advantages to investors and carriers. For future projects, the methodology can be used to optimise cable burial and armour protection along the route and demonstrate to investors that maintenance and repair costs will be minimised. For existing cables, the assessment can be used as part of an integrated asset management strategy identifying sections of cable where the risk of damage may be unacceptable and to allow targeting of additional protection measures.

The first stage of the assessment is to define the safety objective which in the majority of cases will be to ensure that the cable is not damaged during its design life and therefore that network disruption is minimised. The next stage is to identify the potential hazards to the cable and to undertake a risk assessment. The main sources of hazard to cables can be classified as either human or natural. The primary human hazards are from fishing or anchoring, while sediment mobility and submarine slides are the primary natural hazards.

The assessment of all potential hazards cannot be discussed fully here, however, a methodology for assessing the risk from fishing or anchoring is presented. In the case of fishing, it is necessary to determine the nature and distribution of the fishing activity. The different types of fishing operations have particular characteristics which affect the level of risk posed to a cable. Bottom (demersal) trawling is one of the main types of fishing that is associated with damage to cables. The net is held open by trawl doors that are designed to skim across the seabed. The doors vary significantly in size and weight. The distribution and frequency of fishing activity can also vary significantly along a cable route and is dependant upon a wide range of factors including water depth, distance to shore, seabed type and national or local restrictions.

In order to assess the consequence of the trawl doors hitting the cable, it is necessary to estimate the impact loads based on the size and weight of the trawl gear and the speed of the vessel. Without cable armour or burial, the consequence of a trawl impact is likely to be failure of the cable. Burial of the cable in most cases will result in no impacts and therefore meeting the safety criteria. In order to optimise the depth of burial whilst maintaining the level of protection to the cable, the depth of penetration can be estimated using published observations (for example, the Irish Marine Institute 2000), or by mathematical modeling.

The depth of penetration of fishing gear not only varies with the size and weight of the gear but also with the strength of the seabed soils. This is the underlying principle of the BPI. Figure 3 shows that for a particular trawl door configuration, a small increase in shear strength has a significant impact on the depth of penetration.

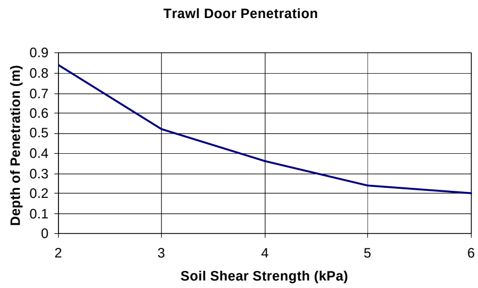

Figure 3: Trawl Door Penetration

In some cases however, the depth of burial required to meet the safety criteria may be significant and alternative protection solutions more cost effective. A combination of burial and armour protection could be used and the risk assessment procedure applied.

With regard to anchors, a similar approach to that of fishing activity is used. Anchoring is normally limited to clearly defined zones and is also limited by water depth. The size of anchors can be estimated from the type and size of vessels. For example, the selection of anchors for merchant vessels is governed by the Rules and Regulations for the Classification of Ships published by various organizations including Lloyd's Register of Shipping and Det Norske Veritas. The depth of penetration of different anchor types is normally assessed using semi empirical models based on field trials with appropriate charts, for example, in Figure 4.

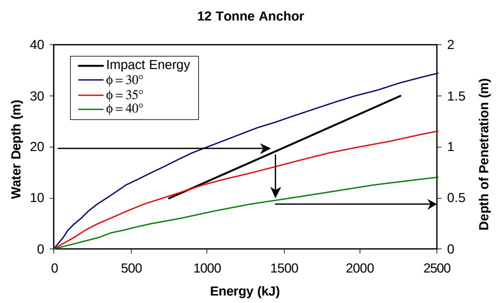

Figure 4: Anchor Penetration

Unlike, fishing gear, impact or hooking of an anchor is likely to result in failure of the cable irrespective of the level of cable armour. An alternative method of protection is to provide rock cover in areas of anchoring. The level of protection provided by rock dump can also be assessed using energy dissipation methods (DnV 2001). Finally, the risks and protection measures can be presented for different sections of the cable route.

4. CONCLUSIONS

The current economic climate in the submarine telecoms cable industry dictates that a cable must be installed in the most cost efficient way and that whole life costs associated with maintenance and repair are minimized. Traditional risk assessment techniques such as the BPI go some way towards optimizing cable burial and protection. However, use of quantitative techniques and a more rigorous risk assessment methodology allows the protection measures adopted to be easily verified by operators and investors and to form part of an integrated asset management plan.

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