ON THE OPTIMUM BURIAL DEPTH OF SUBMARINE POWER CABLES

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ABSTRACT

Submarine cables are usually protected by trenching into the seabed. Since the trenching process has a substantial impact on cost of a subsea cable project the trenching depth must be designed carefully. The investment related to the trenching depth must be compared to the benefit of better protection in terms of reduced repair costs and reduced loss of income in outage times.

This paper describes the key factors for the analysis of the damage risk in different waterways, the correlation between burial depth and protection level, and the influence of seabed warming criteria on the burial depth.

KEYWORDS

Submarine power cables, trenching, burial depth, protection, sea bed warming, 2K criterion.

INTRODUCTION

The trenching of submarine power cables into the sea bed is one of the most efficient methods to protect the submarine cable from external violence. Before submarine cables were buried to a larger extent in the 1980s many cables were damaged by fishing gear, anchors or other external impacts. Today, the burial of submarine power cables is common place except for the largest depths. Since the burial depth of the cable under the sea bed may have a sizeable impact on cost and schedule for a submarine power cable project, the issue is often discussed between cable installers, owners, authorities and other groups. Deep burial may provide better protection than shallow burial but inflicts higher costs, slower installation progress, reduced accessibility for repair, reduced cooling and the need for larger cable size [1]. Different interests stand against each other and need to be evaluated for each part of the cable route.

PROFITABILITY OF CABLE PROTECTION

The high asset value of submarine cables calls for efficient mechanical protection to keep external hazards away from the cable.

Repair costs for submarine power cables are usually high since repair vessels, equipment and crew must be mobilized, and waiting for suitable weather condition may add more costs. The loss of revenues can be substantial for the cable owner. Therefore a reasonable cable protection is a good investment.

However, cable protection is associated with costs. The additional protection costs include more powerful equipment, a possible slow-down of the installation process, and even higher costs for preparatory deburying in case of future damage repair.

A cost/benefit calculation can be performed by comparing the incremental ΔCost of increased burial depth with the incremental risk reduction ΔRisk achieved by this increased burial depth. If the cost-benefit value CBV is less than unity, the measure is cost-efficient [2].

$$CBV = \frac{\Delta Cost}{\Delta Risk} \qquad (1)$$

with

$$CBV = \frac{C_M}{\sum_y \frac{\Delta C_R + \Delta C_P}{(1+r)^y} \cdot PoF} \qquad (2)$$

where
C_m = cost of risk reducing measure
ΔC_R = reduction in repair cost
ΔC_p =reduction in revenue loss
PoF = probability of failure/failure frequency
r = interest rate
y = number of years

This calculus has been formulated for submarine pipelines but can be used as well for the assessment of increased burial depth for submarine cables. ΔC_R denotes the anticipated reduction in repair costs as a consequence of increased burial depth but it should be noted that the actual repair costs in general increase with increased burial depth because the necessary deburial efforts increase, resulting in a negative ΔC_R . The reduction in revenue loss ΔC_P is clearly very different for a 20 MVA turbine cable than for a 800 MW interconnector. The costs consist of initial cost for the burial itself including possible slow-down of the installation process, and maintenance costs in case of preparatory deburying in case of later damage repair. The cost/benefit analysis shows which incremental protection measures do make economic sense. Beside this, the cable operator might have additional rules on acceptable availability or outage limits for the cable system. Stated acceptable risk levels in combination with a detailed risk assessment of the cable route helps defining the required degree of protection.

RISK ASSESSMENT

The risk assessment is based on a statistic analysis of the cable route. The occurrence of damages is a statistical matter which can be resolved with a classical risk matrix. Index values related to the probability of a specific event, and the consequence of the event, can be assigned to each risk category (e.g. hit by dropped cargo or dropped anchors, dragging of anchors, construction works, fishing activities etc). Due to the small number of submarine power cable faults there is no accurate open-source statistic about the share of different causes. The latest Cigré evaluation counts only a few such incidents without