Marine Licence Application for Construction Projects

Havfrue Cable System

Attachment I: Post-Installation Survey and Decommissioning Plan

1 INTRODUCTION

The Havfrue Cable System ("the Project") is a planned subsea communication cable in the Atlantic and North Sea that will link the US, Denmark, Ireland and Norway, providing additional connectivity across the Atlantic Ocean and North Sea.

This document describes the post-survey installation and decommissioning plan for the Havfrue Cable System in the Scottish Territorial Sea (TS) and UK Exclusive Economic Zone (EEZ). The document summarizes the following information as requested by Marine Scotland:

- Post-Installation Survey Programme
- Routing Inspection /Repairs
- Decommissioning

2 POST-LAY SURVEY PROGRAMME

2.1 AS-LAID DATA COLLECTION

Vessels will use a DGPS (Differential Global Positioning System) navigation system during cable installation. During the main lay operation, the accuracy of the as laid position of the cable will be derived as follows:

- For buried cable, the cable position will be derived from the burial tool position, which in turn will be derived via a Hydroacoustic Position Reference (HPR) system. The HPR is a Super Short Baseline (SSBL) positioning and tracking system that provides burial tool positioning relative to the host vessel. The HPR is integrated with the ship's DGPS navigation system. The absolute accuracy of the buried cable is achieved by combining the HPR error with the maximum DGPS error. Typically, the navigational accuracy for the buried cable will not exceed +/-10 m and will be typically defined to within +/-5 m.

- For surface laid cable, the cable/hardware position is recorded at the point where the cable leaves the stern of the laying vessel. The positioning accuracy of this point will not exceed +/-10 m and will typically be defined as +/-3 m.

As-laid information will be provided to all applicable / required agencies upon completion of work.

2.2 POST-LAY INSPECTION AND BURIAL

The post-lay inspection operation shall be performed in order to inspect the proper laying and proper burial of part of the submerged plant. The operation shall be carried out along a maximum of 10% of the areas where burial was planned as indicated in the burial plan.

The post-lay burial operation shall be performed to Reasonable Endeavors, in order to bury all lengths of the submerged plant that were not buried according to the agreed burial plan during the laying operations, including but not limited to:

- initial, final or intermediate splices,
- crossings of in-service power and telecommunication cables and pipelines,
- where sea bed conditions are more conducive to ROV jet burial than plough burial
- plough skips,
- between the low water mark and start of plough burial, if applicable,
- any other lengths of the submerged plant that was not properly buried according to the burial plan.

The areas to be inspected and buried during the PLIB operations shall be discussed and determined by Supplier's and Purchasers' representatives onboard the cableships during the laying operations. The information shall be passed to Supplier and the Purchasers ashore for further discussions and final agreement. The PLIB operations shall not start before such agreement has been reached.

Subject to agreement between the Supplier and Purchasers' representatives, and according to data and/or information acquired during the course of the PLIB operations, the scope of work of the PLIB operations shall be modified in order to achieve the requirements of the agreed burial plan. The Main Lay Vessel's on-board Purchaser representative shall have the authority to approve the PLIB Matrix (locations for planned remedial burial operations), and also the Purchaser representative(s) on board the PLIB vessel(s) shall have the authority to approve remedial burial locations prior to the vessel departing the work site. The PLIB scope of work may only be modified as mutually agreed by both parties.

The Post-Lay Inspection and Burial (PLIB) programme is undertaken by a Remotely Operated Vehicle (ROV) equipped with a video camera and single beam OA sonar. PLIB operations may be performed in order to supplement the burial operations at the following locations:

- Planned recoveries of the burial tool, e.g. ploughshare change locations
- Initial and final splice positions within the buried sections
- Crossings of other cables and pipelines within the buried sections
- Unplanned recoveries due to burial breakdown, weather delay etc.
- Surface laid sections due to sea plough malfunction where the plough is not recovered
- Water depths or seabed types that exceed the operational limited of the sea plough

The ROV will be deployed and operated from a cable ship or support vessel via a controlled umbilical. The ROV typically uses a jetting tool to bury the cable to the target depth, depending on seabed conditions. The jets are directed onto the seabed by the burial tool. The seabed is emulsified in the region of the burial and a trench is formed. The ROV jetting system slowly moves along the seabed along the cable track forming this trench into which the cable is placed. The ROV uses the surrounding seawater for the jetting system, and no seabed materials are introduced or removed from the area.

2.3 PROPOSED SURVEY SCHEDULE

PLIB can take place any time after the initial marine installation is completed. The Post-Lay Burial operation shall be performed in order to bury all lengths of the submerged Plant that was not buried according to the burial plan during the laying operations, such as:

- Initial, final or intermediate splices

- Crossings of in-service power and telecommunication cables and pipelines
- Unplanned plow recoveries due to malfunction of the vessel plow
- Between the low water mark and start of plow burial, if applicable
- Operations that materially deviated from the intended lay plan as detailed in the SLLI
- Locations where burial data reported from the plow is suspect.

Where PLIB is needed in the UK EEZ, for example at infrastructure crossings, it is currently planned for August 2019. Duration of the activity will be 4-6 days. There is no PLIB planned within the TS at this time.

2.4 *Mitigation Measures for Spans Or Movements*

The use of detailed and precise submarine cable laying software (Makai) means that cable spans and areas of potential movement will be maintained to a minimum. Makai constantly monitors external forces on the cable laying operations and adjusts cable laying parameters to ensure that a proper cable installation is achieved. In areas where cable burial is not achievable and where spans may develop Makai is able to adjust cable laying parameters to ensure that the minimum achievable span.

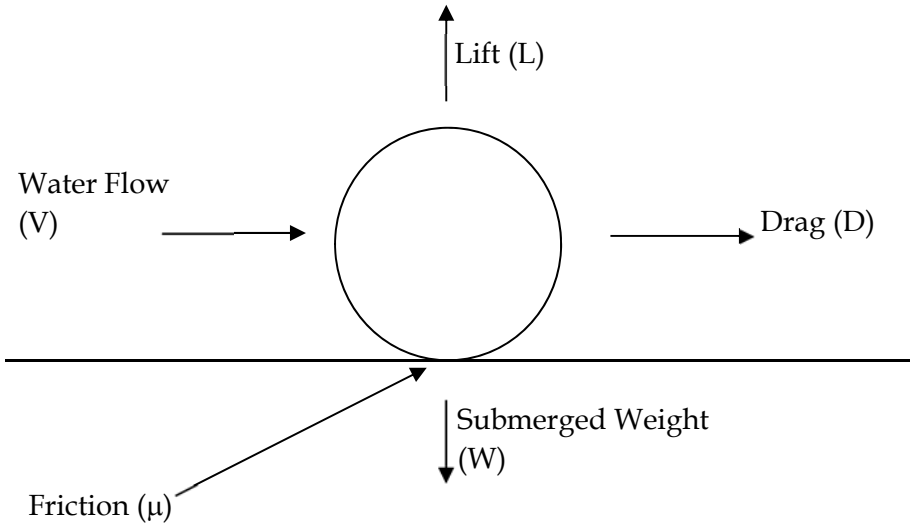
In addition to the precision cable laying software, TE SubCom will be ensuring that where spans are anticipated, the cable in these areas is double armored. The inclusion of the double armoring will add greater weight to the cable thus ensuring that it adheres to the seafloor as much as possible. The addition of the double armour also means that the cable will be more rigid, thereby reducing the bend radius of the cable and making cable breaks less likely.
The location of all areas of span will be included in as laid data which is then provided to the relevant authorities. The locations will also be relayed to the fisheries organisations.

2.4.1 *Surface Laid Cable Stability on Seafloor*

The cable will be laid onto the seabed from a cable ship in a controlled manner such that the cable will lie on the seabed under a residual tension of between 3 and 5 kilonewtons.

In practice, once installed cables do not move on the seafloor due to tension and the overall weight of the cable, as explained below and depicted in Figure 2.1 (*Figure 2.1*). In special circumstances the cable can be secured to the seabed within safe diving limits, but this is typically not necessary.

Figure 2.1 Forces Acting on the Cable on the Seafloor



The water velocity required to move a cable on the seabed can be calculated using the formula below, where V is the water velocity required to initiate movement (m/s).

$$V = \sqrt{\frac{2gw}{d\rho\left(\frac{C_D}{\mu} + C_L\right)}}$$

g is gravity (m/s^2)

w is the cable weight in water (kg/m)

d is the cable diameter (m)

ρ is the density of sea water ($1020 kg/m^3$)

C_D is the transverse drag coefficient = 1.2

μ is the coefficient of friction of cable / seabed = 0.3

C_L is the transverse lift coefficient = 1.2

The assumptions associated with this equation are that the water flow is perpendicular to the cable (worst case), that the coefficient of friction between cable and seabed is 0.3 (minimum expected) and the cable is free to move (no residual tension). Substituting the values for an example cable (d = 28 mm and w = 1.5 kg/m), the resulting value of V is 0.45 m/s.

3 CABLE INSPECTION AND REPAIRS

3.1 INSPECTION AND REPAIR

No routine inspection programme is required or planned for the cable within the Scottish TS and UK EEZ. Routine inspections are unnecessary due to the stability of the seafloor environment, and the proposed burial to a depth of 2 m, where seafloor conditions allow. Should the cable be damaged by anchors or fishing gear, the location of the interruption can typically be pinpointed electronically by the cable terminal station and on site by the repair vessel through the use of low-frequency electroding. Cable repair is typically conducted by a cable ship similar to the one used for installation; impacts are similar to cable installation but limited to the immediate area of the repair.

The Project's life expectancy is approximately 25 years. In accordance with the Initial Decommissioning Plan (to be submitted to Crown Estate Scotland [CES]), the Applicant will advise Marine Scotland and the CES of the status and disposal of the inactive cable.

A cable survey is typically undertaken to verify the condition and burial status of the cable in advance of decommissioning. The method of abandonment and/or removal and final disposal option will be evaluated by Marine Scotland and the CES at the end of the Project's life expectancy. In the event that cable recovery is required by UK agencies, the following is a typical cable recovery programme:

Cable Recovery

Before cable recovery operations commence a cable crossing detailed plan will be drawn up through working with industry specialists to enable the latest cable crossing data to be included. ICPC will also be notified of the pending recovery plan areas so that this can be promulgated to the entire industry of cables owners.

Recovery Operation

The maximum recovery speed is mostly depending on the depth of the sea at the specific position, the size and weight (in water) of the cable and the minimum breaking strength of the cable. To estimate the maximum recovery speed at certain depths please see the below calculations for the different type of cable at different depths.

Depth/max speed at max 6 ton tension for the LW& LWS cable

Depth (m)	Speed (m/s)	Tension(mt)
1000	1	1.56
1500	1	2.41
2000	1	3.25
2500	1	4.09
3000	1	4.94
3500	1	5.78
4000	0.9	6.0
4500	0.8	5.9
5000	0.7	5.9
5500	0.6	5.9

The Havfrue cable will cross or be crossed by numerous other cables. These include:

- In-service cables
- Out of service cables (coax or fibre optic)
- Out of service telegraph cables

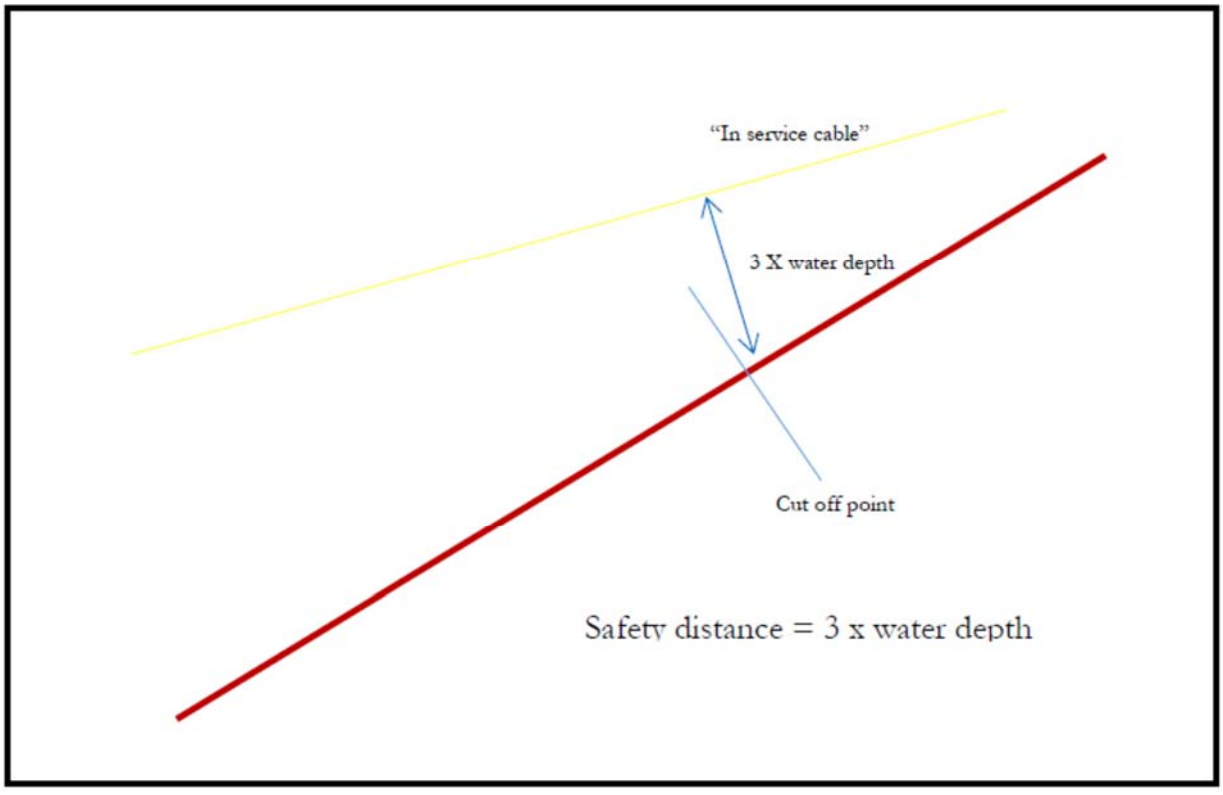
To avoid damage to other cables we utilize safe working distances as follows:

- Recovery in the vicinity of an **In-service cable**
- Recovery towards a crossing of an **In-service cable**
- Recovery towards or in the vicinity of an **Out-of-service cable**
- Performing of grapnel runs in the vicinity of any cable (HR&CR)

These safe distances will be considered during the project preparation and during the actual operation. Which safety distance to be used is on the basis "whatever comes first".

Recovery in the vicinity of an In-service cable

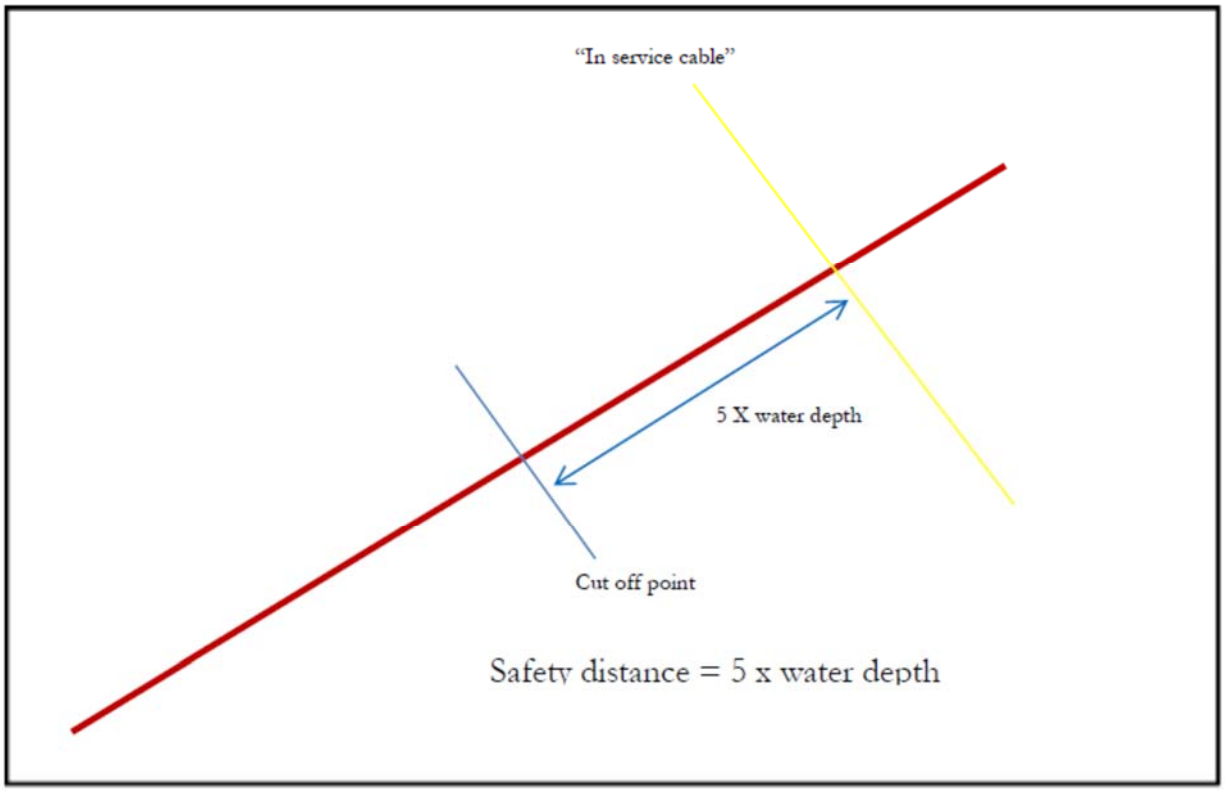
During recovery operations a safety distance of 3 times the water depth will be maintained at any time between the recoverable cable and any in-service cable in the vicinity.



In case the distance becomes smaller than the above mentioned safe distance, the recovery operation will be suspended. The cable will be cut and lowered to the seabed by means of a dead-mans-weight.

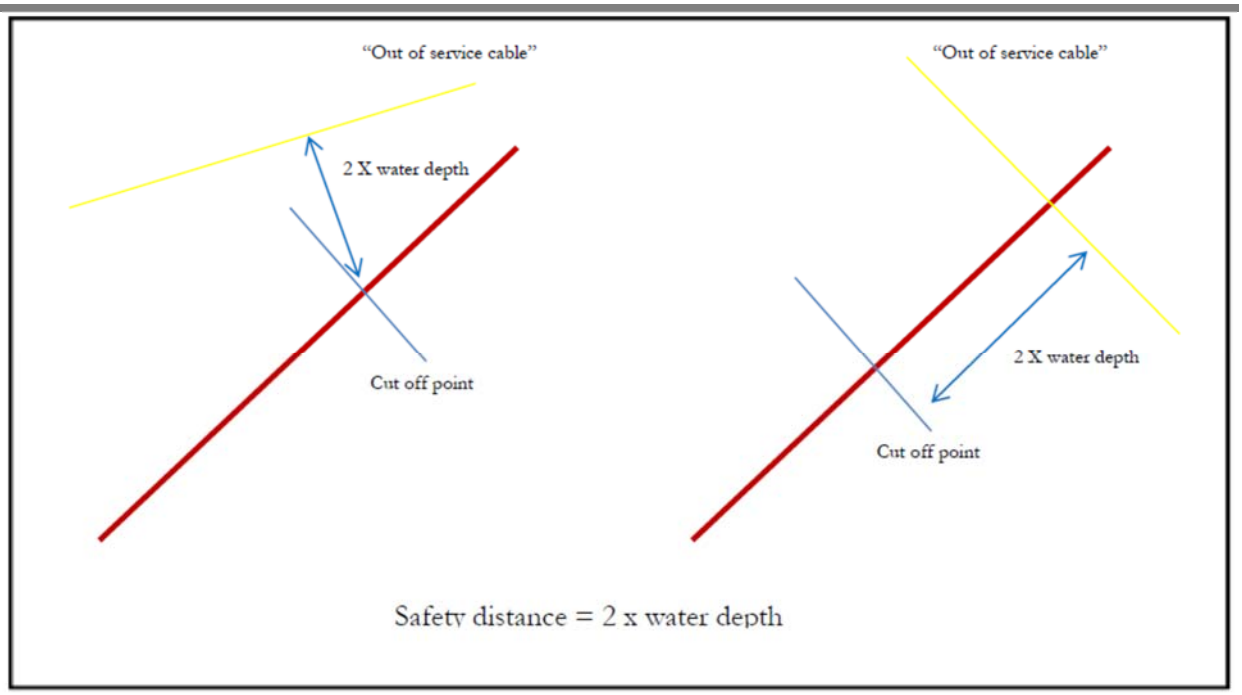
Recovery towards a crossing of an In-service cable

During recovery towards a crossing of an in-service cable the recovery operation will be suspended at a distance of 5 times the water depth of the crossing.



Recovery towards or in vicinity of an Out-of-service cable

During recovery towards a crossing with, or in the vicinity of, an out-of-service cable, the recovery operation will in principal be suspended at a distance of 2 times the water depth of the crossing or of the cable in the vicinity.

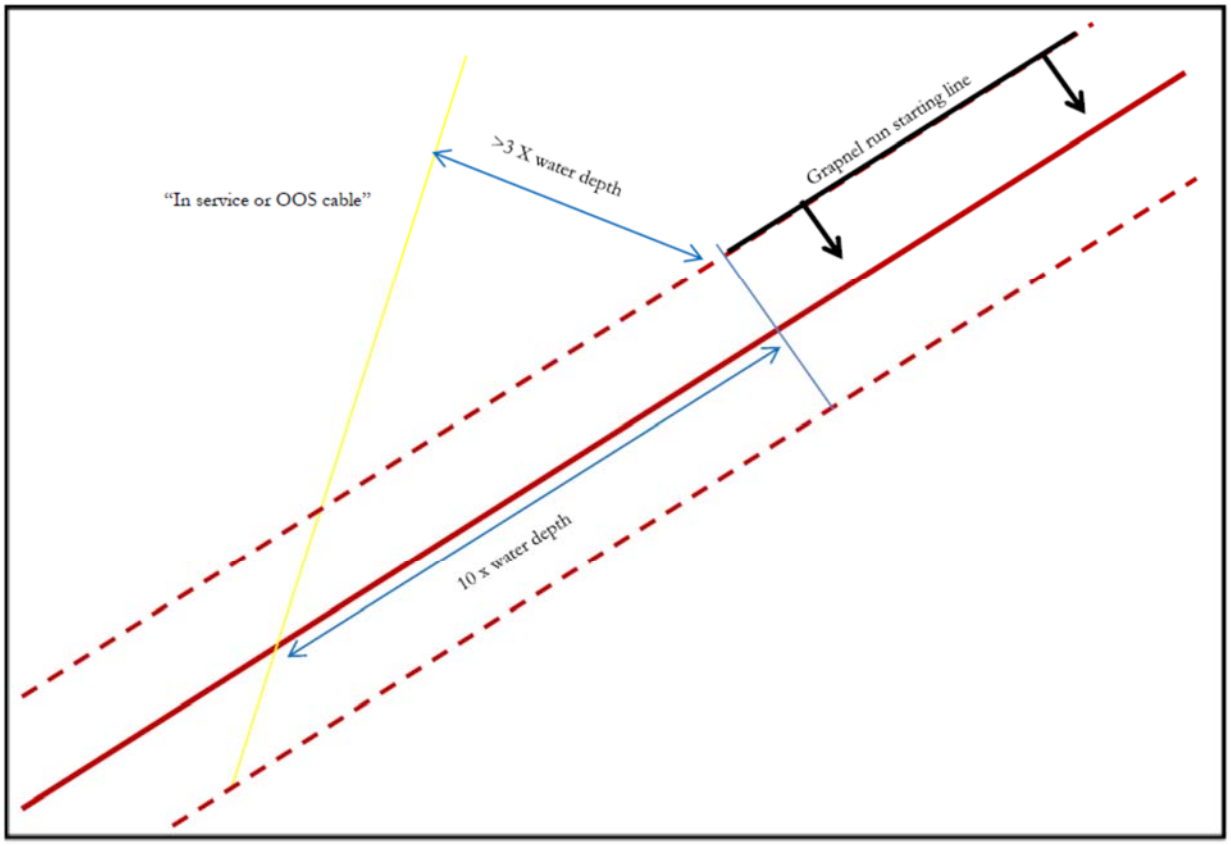


In consultation with the owner of the OOS cable a deviating safety distance or procedure might be used. If this is the case this deviating safety distance or procedure will be described in the working details.

Performing of grapnel runs in the vicinity of any cable (HR&CR)

By performing a grapnel run in the vicinity of any other cable the following precautions will be taken:

- Grapnel runs starting point at a minimum of 10 times the water depth from any crossing.
- Any grapnel activity not closer than 3 times the water depth from any cable
- The direction of the grapnel run is always away from the cable in the vicinity.



In consultation with the owner of an OOS cable a deviating safety distance or procedure might be used. If this is the case this deviating safety distance or procedure will be described in the working details.

Weather Information

Cable recovery can be achieved up to 7-8 Bft and wave heights up to 6 meter. Grapnel runs however are limited to maximum 6 Bft and a wave height of 4 meters. Because increased ship acceleration forces can make it difficult to determine the tension readings.
Please note these are theoretical figures and the master has always the right and duty to ensure a safe working place for crew and vessel.