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CMS Method Statement - Remaining Works from Feburary 2019

Project Title:

Caithness – Moray – Shetland HVDC Link

ABB Project No: G14006

Contractor:		**Employer:**
NKT	**NKT HV Cables AB**	Scottish & Southern Electricity Networks

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CMS Method Statement - Remaining Works from Feburary 2019

Updated method statement for revised backfilling methods CMS

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1 Non-Technical Summary

1.1 Project Background

Scottish Hydro Electric Transmission Plc (SHE Transmission), a part of the Scottish and Southern Energy Plc (SSE) group of companies has developed a High Voltage Direct Current (HVDC) transmission link between Shetland (Weisdale Voe), Caithness (Noss Head) and Moray (Portgordon), collectively known as the Caithness-Moray-Shetland (CMS) project.

In order to achieve the necessary electricity transmission system reinforcement currently required in the north of Scotland, the CMS project has been split into two distinct offshore circuits: The Caithness-Moray (LT21) circuit and the Caithness Shetland (LT09) circuit.

Additional onshore transmission links are also proposed, including HVDC land cable circuits between Noss Head and Spittal, as well as Portgordon and Blackhillock. A HVDC convertor and substation is also planned at Spittal.

This report relates solely to the Caithness-Moray (LT21) offshore HVDC cable circuit, between Noss Head and Portgordon respectively.

- Current status of project (in use)
- Backfill Methodology
- Currently licensed methodology discounted
- Proposed methods
- Other Remaining works
- Summary of Outcome of Environmental Appraisal

1.2 Project Status

The Caithness-Moray HVDC Link is now laid along the entire route between Portgordon, Moray, and Noss Head, Caithness.

It is required that the cable is buried to a depth of at least 0.6 m for adequate protection. A PanGeo depth of cover survey conducted September 2018 confirmed sufficient depth of cover over (c. 76 km) of the (c. 111km) sea-cable route. This has been achieved through a combination of mechanical backfill (SCAR plough), jet trenching, controlled flow excavation (CFE), rock placement, and natural backfill.

No further intervention is planned where the acceptable cover has been achieved, however, additional backfilling is required over the c — 35 km of the cable route where depth of cover is less than 0.6 m.

The originally planned backfill method 'SCAR' mechanical backfill plough, was suspended from operations in March 2018 after concerns regarding positioning control. Following a series of trials in September and October 2018 where a number of modifications were tested, it was confirmed that the SCAR plough remained unable to maintain its operational tolerances, it was discounted from further works on the C-M Project.

With the SCAR mechanical backfill plough now discounted from the project, a series of optioneering studies and in-field trials have been undertaken in order to identify suitable alternatives to mechanical backfill over the remaining 35 km. Through this process, NKT and SHE Transmission have identified the following as suitable alternative backfill methodologies:

- Primary: Controlled Flow Excavator (CFE);
- Secondary: Rock Placement. in areas where sufficient cover cannot be achieved by CFE rock material will be placed within the trench to meet required levels of protection.

It should be noted that although natural backfill has resulted in sufficient depth of cover in some locations, it is not considered a suitable alternative over the majority of the route as it is estimated that full backfill of the trench via natural means would take in excess of 5 years, and this is not considered acceptable without an intervention campaign to achieve full protection of the cable.

All other options for an alternative backfill have been ruled out due to technical, environmental, permitting and other constraints.

Due to these changes in methodology, Licence variation is sought under the following Marine Licences for the use of CFE tool and additional rock placement:

- Licence Number 06043: Cable installation, outside 12nm;
- Licence Number 04368: Cable installation, Noss, Caithness to north of Smith Bank;
- Licence Number 04878: Cable installation, Portgordon to 12nm; and
- Licence Number 06600: Rock placement, Portgordon and Noss to 12nm.

Further information on the history and methods of the two proposed approaches is outlined below.

1.2.1 Controlled Flow Excavator

CFE will be the primary means undertaken to bury the cable in those sections where depth of cover is not yet sufficient.

The CFE tool will be used to displace the excavated soil berms located either side of the main trench back into the trench in order to achieve the required protection. To do this, the tool will be moved along the line of each berm (i.e. to either side of the trench) where it will mobilise the sediment and direct it over the cable. As the material settles, it will provide additional cover and protection to the cable. Through a number of trials, the settings on the tool have been optimised in order to ensure that secondary trenches either side of the main trench are minimised as far as practicable.

Pre and post burial surveys will be used to record seabed status before & after works

1.2.2 Rock Placement

Where CFE is unable to bury the cable, rock placement will be used to infill the trench and to achieve sufficient depth of burial.

Rock infill will be undertaken using a Dynamic Positioning Fall-Pipe Vessel (DPFPV), such as the DPFPV Seahorse, or a shallow draft vessel in shallower water. The progress of rock placement will be monitored via intermediate surveys using multibeam echo sounders, and compared to pre-rock placement surveys. Rock placement will be followed up by post-rock placement surveys to record as-built situation

As contingency a worst-case scenario where CFE provides no additional cable protection has been considered, 90,000Te & 25000Te has been applied to cover offshore (outside 12NM) and nearshore zones respectively. Further detail provided with section 5.

1.3 Environmental Summary

MarineSpace Ltd has been commissioned by NKT to prepare an environmental appraisal that has considered and assessed the potential environmental effect of the additional methods. Therefore, the appraisal represents the environmental appraisal of proposed Mass Flow Excavation or rock placement on potentially sensitive receptors in the vicinity of the Caithness-Moray High Voltage Direct Current subsea cable. The same methodology is used for assessing environmental impacts as in the original Environmental Impact Assessment, as well as previous environmental appraisals prepared by MarineSpace, to ensure consistency.

The potential impacts of the main cable burial were fully assessed within both the marine Environmental Statement produced for the project and the Shetland HVDC Connection Marine Environmental Appraisal (SHET, 2009). The proposed works assessed here, namely burial of the remaining exposed cable by either Mass Flow Excavation or rock placement are similar to the already assessed (and consented) burial works.

In summary, the majority of impacts predicted via Controlled Flow Excavation were assessed to result in no more than minor impacts. A moderate impact on marine mammals was predicted via the combined works, but with mitigation, this was reduced to a minor. Increased placement of rock, including a limited length of Cable Protection System was judged to result in no more than minor impacts. Construction and emplacement of a rock berm were assessed to result in no more than minor impacts for the majority of receptors. A moderate impact on commercial fisheries was predicted, reduced to minor with the implementation of well-established mitigation measures.

The detailed MPA assessment identified associated pressures and footprints and screened the potential exposure of these footprints with MPAs in the vicinity of the cable repair works and their designated features within the study area:

- Annex I and MPA designated benthic habitats;
- Annex II marine mammals and migratory fish species designated within SACs;
- Annex I bird species classified within SPAs; and
- Where appropriate, Ramsar sites.

Where likely significant effects/risks could not be screened out, detailed assessment and determinations of any adverse effects/risk (or where no adverse effect/risk cannot be determined) are presented. Overall, no adverse effects on the integrity of any of the MPAs were determined.

2 Introduction

This document includes outline method statements and plans for the Caithness – Moray HVDC Link remaining alternative method backfilling works that have resulted from the disqualification of the originally consented installation method (SCAR Backfilling plough). These works are planned to commence once license variation has been granted and to be complete by latest 31 August 2019, This document is intended to support an application to extend the licence to enable alternative backfill method (CFE) to be utilised.

2.1 Alternative Backfill Methodologies

Following the failure of the Oceaneering backfill plough trial (see Section 3.1), NKT and SHET together with a suite of environmental and technical consultants performed concept and front-end engineering level studies to identify suitable alternatives. These can be broadly categorised as follows:

Proposed Solution	Result
Alternative Backfill Plough	Discounted
Dredging / Sand Placement	Discounted
Mass Flow / Controlled Flow Excavations	Pursued
Rock Placement	Pursued
Natural Backfill (as an exclusive solution)	Discounted

2.2 Surveys - General

Each campaign will typically utilise existing survey data from previous campaigns. If such survey data does not exist or is considered outdated, an As-Found Survey will be carried out prior to undertaking the task. A Multibeam Echosounder (MBES) survey is the typical method for mapping the current seabed conditions. Each campaign will also record the As-Left conditions by carrying out another MBES survey at the end of the task.

MBES surveys may also be supplemented by Depth of Lowering (DoL) / Depth of Cover (DoC) surveys for example where trenching / backfill activities are undertaken.

USBL will be used for work where ROV or other tooling is utilised that requires a live positioning record. Frequencies and noise levels depend on the vessels USBL system and will be part of the actual engineering documents for each campaign. Specifications of all equipment are provided and assessed in an Environmental Assessment 'Caithness-Moray HVDC Link - Additional Cable Replacement and Remediation Works Environmental Appraisal Report. Project Number J/7/19/18. July 2018' – NKT Document 1JND14006D006546 carried out by NKT allocated Environmental Consultants. Requirements for MMO's and PAM equipment will be fulfilled during all offshore operations as per in force EPS licence.

2.3 Site and Works Location

Figure 1-1 presents the Caithness Moray cable route including repaired sections and joints, a chart defining CFE / Rock placement areas is included in section 3 (CFE Scope of work)

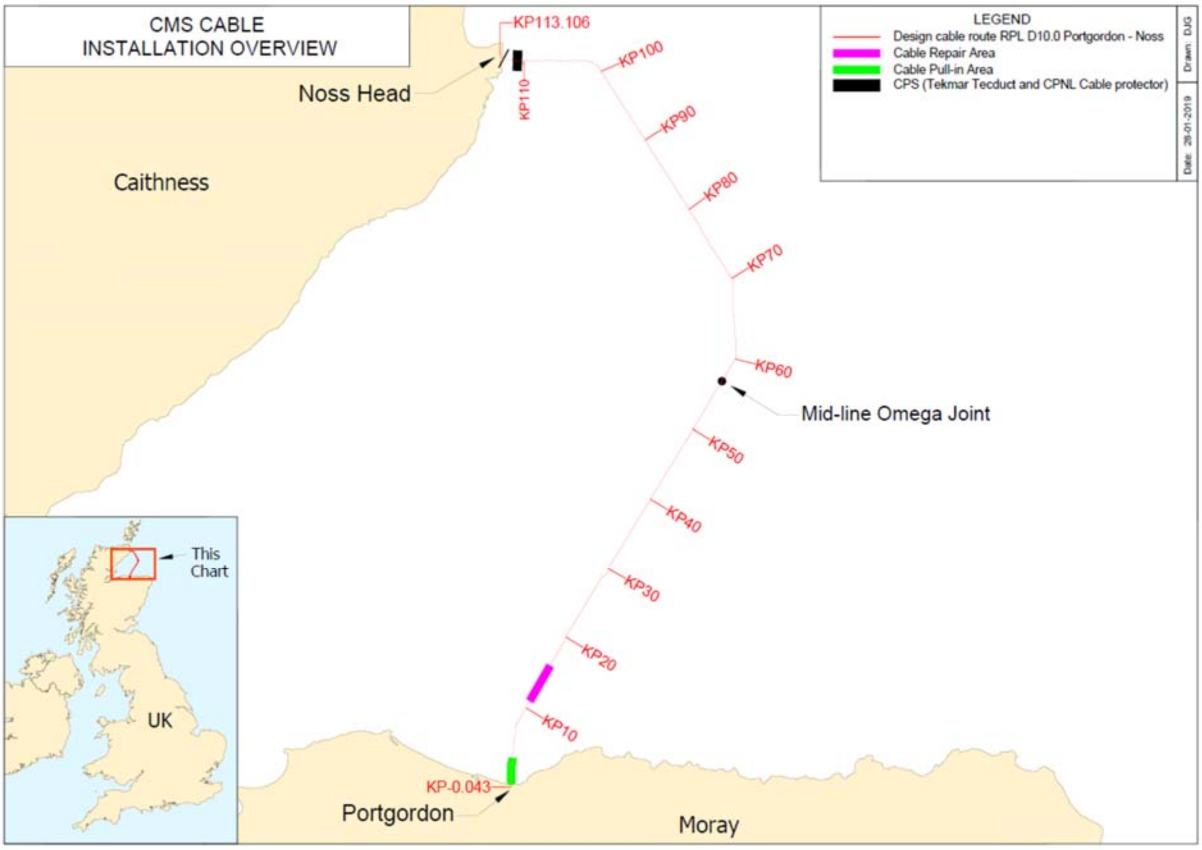


Figure 2-1 Topographical Map

2.4 Terms and Abbreviations

Abbreviation	Description
CFE	Controlled Flow Excavation also known as Mass Flow Excavation
CMS	Caithness – Moray – Shetland
CPS	Cable Protection System
DC	Direct Current
DPFPV	Dynamic Positioning Fall-Pipe Vessel
DoC	Depth of Cover
DoL	Depth of Lowering
DTM	Digital Terrain Model
HDD	Horizontal Directional Drilling

KP	Kilometre Point
HVDC	High Voltage Direct Current
JFSE	James Fisher Subsea Excavation
LP	Low Pressure
MBES	Multibeam Echosounder
MMO	Marine Mammal Observer
MSBL	Mean Seabed Level
ND	Normal Density (Rock)
nm	Nautical Mile
PAM	Passive Acoustic Monitoring
ROV	Remotely Operated Vehicle
SCAR	Subsea Trenching and Backfill System
TSHD	Trailing Suction Hopper Dredger
USBL	Ultra Short Baseline

3 Installation Progress and Programme overview

The various Marine Licences are valid until 31st August 2019, . The replacement cable section will be installed in February-March 2019 for “cut in” to the existing cable bundle with all protection works completed by 31 August 2019 latest. An overall schedule of works is included in Appendix C.

3.1 SCAR Backfill Plough - trials outcome

The SCAR mechanical backfill plough was temporarily suspended from operations in March 2018 due main contractor concern that losses of positional control may have led to damage to the installed cables. Between March and September 2018 modifications to the SCAR plough and control systems were made with the goal of improving performance, an agreement was made for an offshore backfilling trial to demonstrate the improvement. The modified SCAR backfill plough trials were held between 24 September and 15 October 2018 using the AHTS *Siem Ruby* over an agreed trail route of around 2km. During trials, the modified SCAR backfill plough remained unable to maintain operational tolerances and was judged by main contractor unsuitable for further works on the CM Project

During the above period, it was confirmed via inspections that the installed cable had been damaged at some of the locations SCAR plough had been operated outside its operational tolerances, a replacement of a 5 km cable section between KP 11-16 would be required.

3.2 Pangeo Results and remaining Backfill SoW

In areas which were programmed to be backfill, a full PanGeo Depth of Cover survey was performed in September 2018. In addition to the rock which was already placed within the pre-cut trench, a certain level of natural backfilling has occurred, leaving approximately 35km of the route where further backfill is required, i.e., where the Depth of Cover (DoC) remains less than 0.6m. Remaining areas that require backfill are shown in Figure 3-1 below. Further description of the backfill methods is found under Section 0.

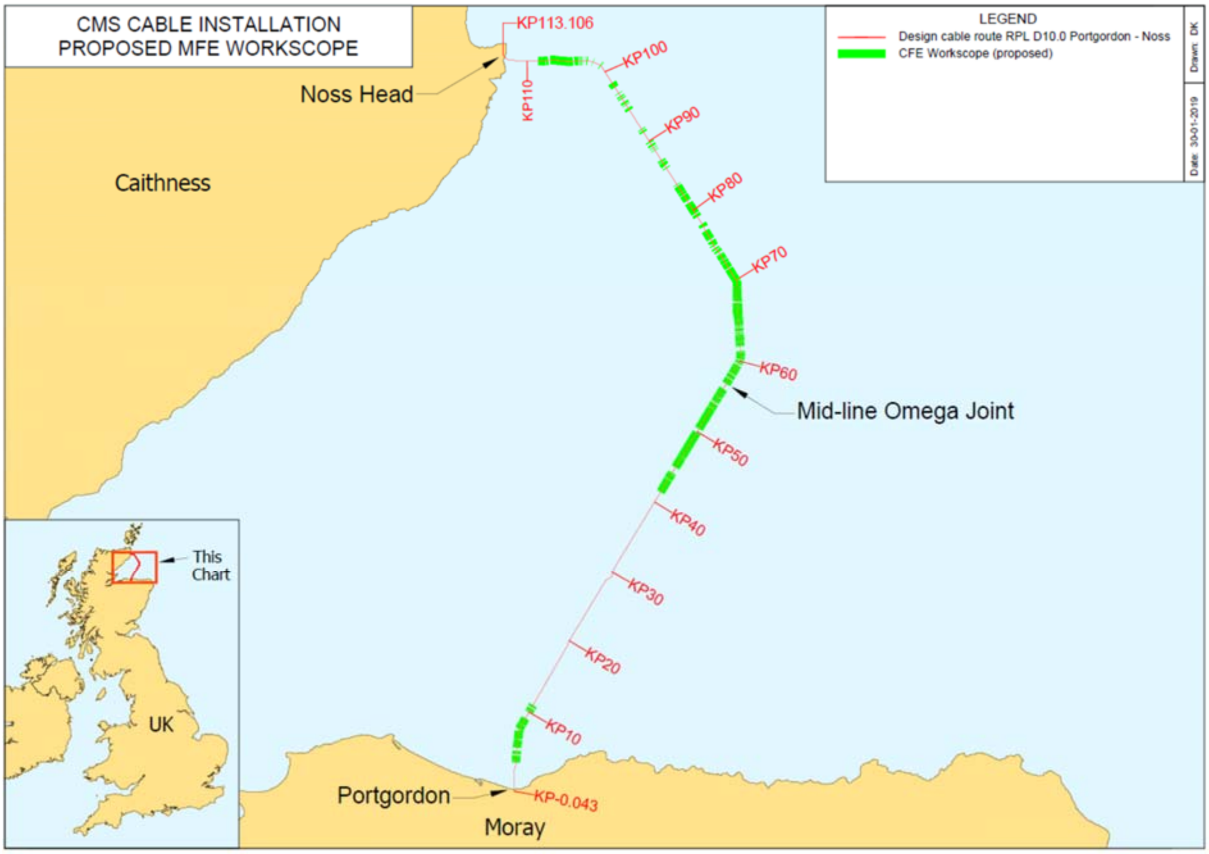


Figure 3-1 CFE Backfill Scope of Work

3.3 Excavations and Inspections KP 11-16 and KP 83-86

Excavations and cable inspections at specifically identified locations between the backfilled sections KP11-KP16 and KP 83 - KP86 have now been completed by CFE and Dredging methods as planned.

- **<u>KP 11-16:</u>** Areas of cable damage were found intermittently between KP11.150 – 14.610. This section is to be replaced.

- **<u>KP 83-86:</u>** The cable bundle was found to be intact - no replacement required. Section 8 in the previous method statement described this potential replacement but is now not required.

Reference is made to Section 4 in the previous Method Statement which covered the background and plan for inspection works at these areas. For clarification; these areas were identified as potentially damaged cable sections and was inspected to verify whether the backfill plough had been in contact with the cable.

Figure 3-2 and Figure 3-3 below show the inspected cable that was found intact and will remain part of the final HVDC link following reinstatement on the depth of cover via rock placement

Figure 3-2 Cable Excavation and Inspection KP 10.929 (left), KP 14.866 (right)

Figure 3-3 Cable Excavation and Inspection, KP 86.

3.3.1 Preparations for Replacement - Cable deburial

De-burial at each end of the cable bundle section to be cut and replaced has been performed by the NKT Victoria during Nov-Dec 2018 as part of the excavation and inspection works using a subsea dredger.

Reference is made to previous Method Statement, Section 7 where the initial plan was described.

Backfilling proposals (Previously Section 4.6)

3.4 Locations

3.4.1 Main Route 35km

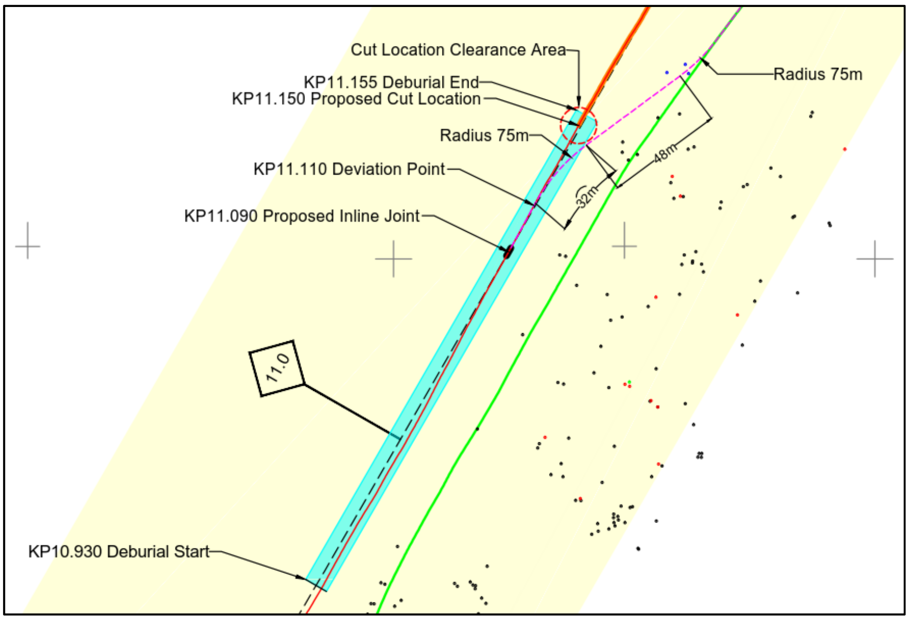
After failing operational trials, the modified SCAR backfill plough has been discounted from the CM Project, alternative methods to achieve the required 600mm of cover have been investigated. Whilst natural backfilling is likely to continue in advance of commencement of backfill works, in order to achieve the required cover within an acceptable period active backfill methods are considered necessary. To substitute the now discounted SCAR backfill plough it is proposed to first utilise CFE over as much of the backfill SOW as possible. This method has the advantage of mobilising original material to reinstate the seabed and has been shown in trials to have a high success rate in providing 600mm of cover. Areas that prove unsuccessful via CFE will be backfilled using a suitably graded rock infill via a DPFPV.

The purpose of this backfill work is to provide the required depth of cover protection to the cable bundle and also to return the seabed to its original profile or as close as reasonably practicable.

3.4.2 Excavated Inspection locations – 160m

Rock infill via a DPFPV is planned to reinstate the seabed and the required DoC at locally excavated and inspected sections; KP11-16 and KP83 - 86 (volumes specified in section 4).

Backfilling alternatives for the main route are described below.



3.5 Backfill Alternative Methods

3.5.1 Solution 1: CFE backfill

A CFE tool is planned to be used to backfill the trench by jetting the spoil berms toward the trench; the selected tool is the TWIN R2000 provided by JFSE. A similar tool may be substituted if required.

This tool is a low pressure / high flow tool which is the most suitable to displace the spoil with minimum loss of sediment. After review of the Pre- Backfill multibeam survey data on site the TWIN R2000 tool will be configured in backfill mode (see figure below). Jetting runs will commence with the TWIN R2000 running parallel to the berm and utilising low power to direct the berm materials back into the trench, in more consolidated soil additional CFE passes may be required. The displacement of soil in the berms will be monitored using sonar systems. An Altimeter and Octans will be used to measure height above the seabed and heading/pitch/roll in real time.

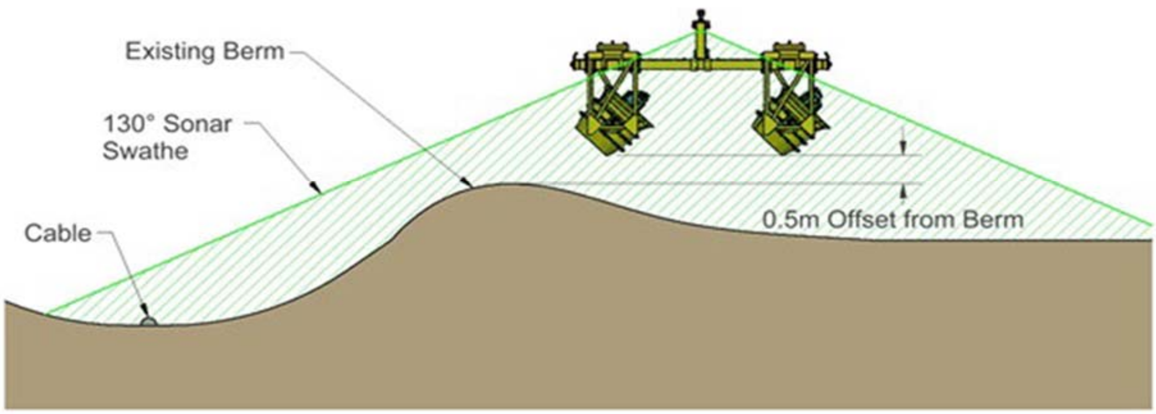


Figure 4-4 – Schematic demonstrating Backfill by CFE

A number of backfill trials have been completed and surveyed over short sections of the cable route to verify that the flow settings are effective. In this way, the residual berms can be minimised, and the trench will be partially or wholly backfilled. An example of the CFE backfill trial results is shown below:

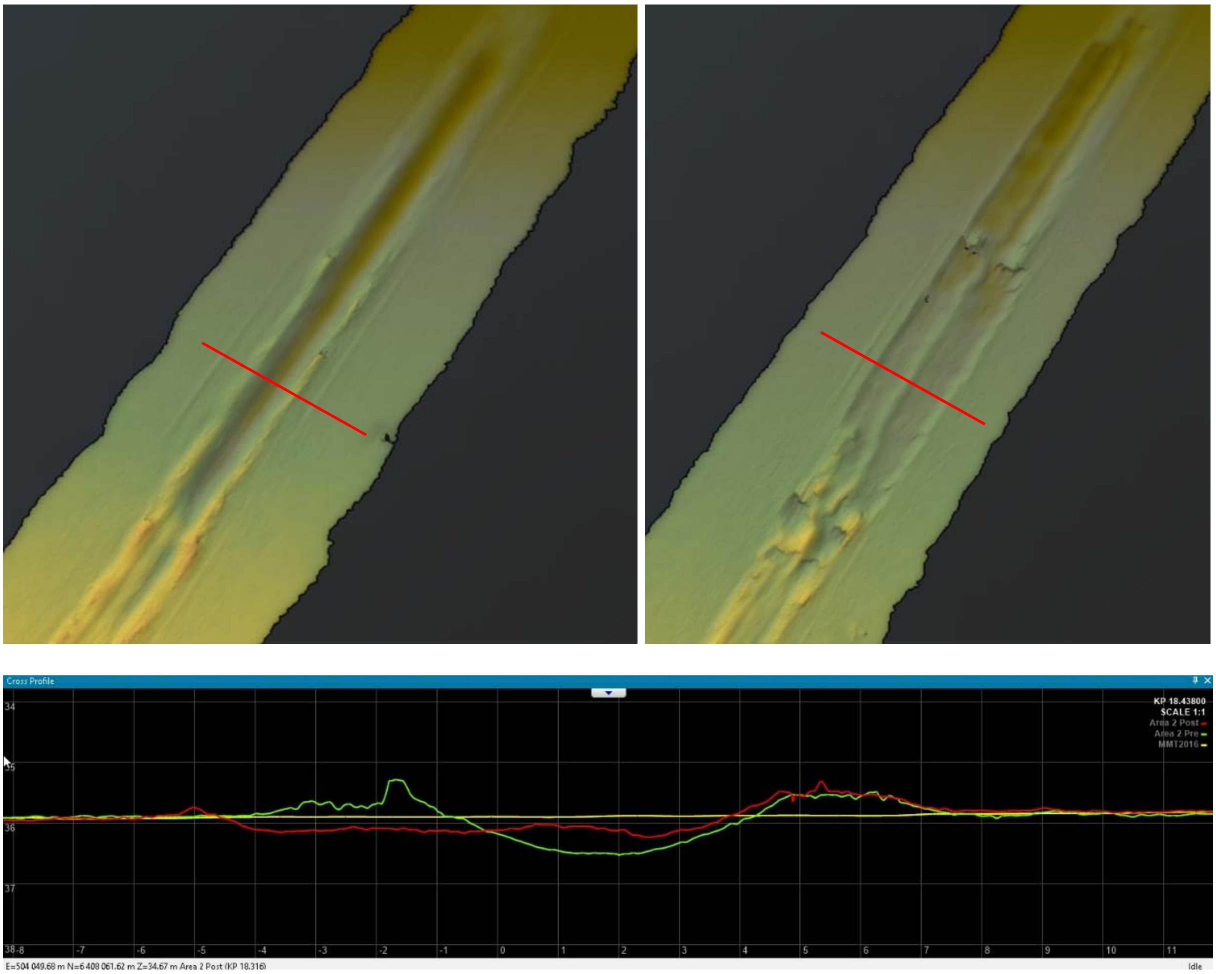


Figure 4-5 Result from CFE backfill trials, before (left), after (right), X-Section below.

In the above images it can be seen that the CFE backfill process has largely removed the soil berms and the provided the required depth of cover.

3.5.2 Backfill Alternative Solution 2: Rock Berm

While the intended method is to first complete the maximum possible backfill by CFE a contingency plan of 100% rock placement to replace planned CFE backfill is applied for; this would only be implemented if CFE was discounted or proved ineffective. In such case a suitably graded crushed rock would be placed in the trench below MSBL, limited lengths of the rock backfill would extend partly above MSBL. The method of rock placement is as previously permitted and described in Section 4 in this document. To support this option, a variation to the existing rock licence is applied for to allow up to an additional 90,000t within the offshore zone and 25,000t within the nearshore Portgordon zone, revised rock volumes are further detailed within section 5.

3.5.3 Backfill Alternative Solution 3: Natural Backfill

Seabed currents have caused natural backfilling of the trench in some areas; no further intervention is planned where an acceptable level of cover has already been achieved. Spoil berms created during pre-cut trenching are also eroding, it is however estimated that full backfill of the trench via natural backfill would take in excess of 5 years, this is considered excessive. An intervention campaign to achieve full protection of the cable is considered necessary.

3.6 CFE Backfill Equipment

It is planned to utilize James Fisher's Twin R2000 CFE tool for backfilling of the trench to increase DoC. A full specification of the tool is found in Appendix A.

Figure 4-6 James Fisher Twin R2000

3.7 Example CFE Support vessels

3.7.1 EDT Hercules

Example of a suitable CFE support vessel provided below, as an alternative the Cable Lay Vessel NKT Victoria may be used as a support vessel for the CFE campaign.

3.7.1.1 Overall Specifications

Figure 3-7 Example North Sea Construction Support Vessel EDT Hercules

Description	Information
Vessel Name	EDT Hercules
Vessel Operator	EDT Shipmanagement Ltd
Year Built	2014
DP Class	II
Length Overall	88.8 m
Beam	19 m
Design Draft	6.6 m
Working Deck Area	~609 m2
Tugger Winch	10Te
Provision Crane	2T e
Offshore Crane	70 Te AHC
Accommodation	71 bunks

Table 3-1 - EDT Hercules Overall Specifications

3.7.1.2 Vessel Crane

A 70tm AHC McGregor Crane is installed on the EDT Hercules

3.7.1.3 ROV

On board of the EDT Hercules 2 work class Schilling HD ROVs are installed.

3.7.2 NKT Victoria

NKT Victoria is an alternative CFE platform

Figure 3-8 - NKT Victoria

3.7.3 Overall Specifications

Description	Information
Vessel Name	NKT Victoria
Vessel Operator	NKT
Year Built	2017
DP Class	III
Length Overall	140 m
Beam	29.6 m
Design Draft	7.2 m
Working Deck Area	~1,600 m2
Carousels	1 x 7000Te Above Deck / 1 x 4500Te Below Deck
Tensioners	2 x 45Te
A & R Winches	3 x 45Te
Deck Crane	10Te Auxiliary crane, port side

Description	Information
Offshore Crane	25Te Heave Compensated knuckle boom crane, port side
Telescopic Crane	5Te Telescopic knuckle boom crane, starboard
Chute	2 x Integrated aft chutes
ROVs	2 x WROV

4 Rock Methodology & Program (Previous Section 6)

This section outlines the methodology and planning for remaining rock placement. The overall scenarios have not changed since the previous license. The current status of rock placement is shown in the table below.

4.1 Rock Volumes, Installed, Planned and Licensed

Table 5-1 shows the rock volumes available in the four different licenses. The table also shows what has been installed until December 1st, 2018 in the different sections. The planned volumes to be installed comes from the latest update of the Scope of Work for Rock Installation.

From the installed volumes, the planned volumes and the licensed volumes, the remaining volumes within the license have been calculated. The total remaining available volume within the existing licenses is approx. 118 000 Te

Rock Placement Summary Status December 1st, 2018					
Area	Portgordon to 12 Nm*	Noss to 12Nm	12Nm to 12Nm*	Noss Head TZ1*	Total*
Licence ID	(a) 06600 (b) 04878	06600	06043	04368	
Licence Amounts	(a) 44190 (b) 67260 (total) 111 450	109187	122 369	20 500	361 756
Installed by Seahorse	*30 075*	*77 260*	*71 855*	*6 485*	*185 675*
Installed by Atlantis				*11 506*	*11 506*
Installed by EEMS Dublin				*2 211*	*2 211*
Installed Total	30 075		71 855	20 202	199 392
Remaining in License:	81 375	31 927	50 514	-	163 816
Planned installation (SOW B12)	35 000	10 000	500		45 500

Jet trenching Provisional sum	25 000				
Remaining in licence after Base scope	**21 375**	**21 927**	**50 014**	**-**	**118 316**
Required if CFE campaign 100% ineffective	**24 000**	**17 500**	**110 000**	**-**	
Variation request for additional tonnages inc. contingency	**25 000** **(Licence ID 06600)**	**0**	**90 000** **(Licence ID 06043)**	**0**	**115 000**

Table 5-1 Rock Placed and Planned within the existing licence, *all numbers are in Metric Tonne

The rock tonnages presented in Table 5-1 have been developed to include the following rock tonnages which are, and which may be, required to be installed, these include:

- The rock which has been designed is licenced and is ready to install, e.g. Portgordon pop-outs, other unfinished areas
- Rock which is expected to be required in order to complete the cable protection of the KP11 to KP16 repair, i.e. following completion of jet trenching activities
- Rock which may be required to be placed within the pre-cut trench in the event that CFE backfill is unsuccessful or not deployed at a specific section for operation / technical reasons

Estimating rock tonnages is challenging however NKT together with the rock installation contractor have used their previous experiences on Caithness-Moray and other similar projects to estimate the required tonnages. In general rock consumption for 1-5" rock has been 10—15% less than predicted, however, very little rock armour has been installed on the project to date and hence the design tonnages have less validation from experience. In order to complete the scope within the remaining licence period pessimistic estimates together with reasonable contingencies applied have been made for each of the rock berm types to suit the various geological settings along the route.

To estimate the rock volume needed for trench backfill is difficult at this time as there is not yet any results from the CFE backfill. Therefore an estimate was made based on historical data from trench fill and a worst-case scenario is the basis for the estimate as rock has already been placed in the trench. On average, a trench fill with a depth of cover of 60cm has resulted in a rock consumption of 4.5Te/m. The absolute worst case scenario is that there is a requirement to rock place over the entire 35km section. This would result in a rock tonnage of

157,500Te, the available volume within the license after the known planned rock placement is 118,316Te. This means that the overall licensed volume is approximately 40,000Te short, without any contingency.

Note that the distribution of available license volumes between the Nearshore sections and the 12nm-12nm section is not balanced (as shown in Table 5-1) to reflect the remaining cable protection required. Hence for the 12nm-12nm section, the licensed volume is approximately 60,000Te short and hence 90,000Te additional rock applied for.

As such, the Table 5-1 includes all installed and planned rock from the base scope together with additional masses applied for to cover backfill worst case scenario situations. The approx. 1200Te rock required for reinstatement work at KP83-KP86 & KP16 (inspection locations) is contained within the tonnages defined within the above table. The masses defined in table 5-1 as ‘Remaining in license after base scope’ & ‘New application for additional volumes’ totals all rock that is required to deliver a 100% rock based backfill campaign, should this be necessary.

Table 5-1 is based on a conservative scenario where CFE backfill provides very limited additional depth of cover cable protection.

4.2 KP 11-16 Protection of new Cable

It is intended to replace a section of cable from KP11-16 which has been damaged, the replacement section to be jet trenched as licensed in connection with the earlier application. Due to challenging ground conditions an estimate of 30% success for the jet trenching campaign has been made. 25,000t rock has been estimated as a worst case scenario for KP 11-16 post jet trenching protection; this volume is split 25% filter rock / 75% armour rock.

4.3 Rock Placement Vessels

The primary vessel to be used for rock placement operations is DPFPV Seahorse. For nearshore, shallow water rock placement at Portgordon, it is planned to utilise a shallow draft vessel e.g. Atlantis (or another similar vessel). Vessel specification sheets for Seahorse & Atlantis are attached in Appendix B.

Fig 5-1 Seahorse – Rock Placement Vessel

Figure 5-1 Rock Placement Vessel Tideway Atlantis

4.4 Rock Placement works

4.4.1 Rock Loading

Rock loading of the vessel is planned to be done in west coast Norway and is done by means of onshore based conveyor belts or hydraulic cranes. The loaded material is graded crushed rock with sizes required for the works.

4.4.2 Rock Placement Operation

Inside each hold, a hydraulic excavator, placed on pedestal, unloads the rock onto longitudinal conveyor belts. The rock is transported to a central buffer hopper of approx. 70 m3 and from there the rock is fed into the Fall Pipe by means of the vibratory feeder and Transverse Conveyor Belt. Adjusting the vibratory feeder controls the flow; this is controlled from the bridge.

A belt weighing system is incorporated in this conveyor belt to measure the dumped quantities. In this stage, the ROV will be positioned at working depth, i.e. approx. 3 - 8 meters above the seabed.

Figure 5-2 Excavator onboard the vessel

The amount of rock placed per linear metre is a function of the rock flow rate and the tracking speed. The rate can be controlled by adjusting the outflow of the hopper, whereas the tracking speed can be adjusted using the DP system. In this manner, the rock volume placed per linear metre is controlled.

When sailing a track, the MBE screen (online cross profiles) and the Navigation screen give the operator information about the Fall Pipe position relative to the dump area. The MBE cross profiles will be compared (at regular intervals) with the theoretical profiles extracted from the pre-survey. This allows the operator to monitor the progress and build-up of the rock material.

Intermediate surveys will be carried out at regular intervals to monitor the progress as well as for quality check purposes.

4.4.3 Fall-Pipe System

The fall pipe is launched through a moon pool in the centre of the vessel. Steel pipe sections of about 8 metre length (and a few pipes of approx. 4m and 6m length) are stacked on a suspended section at the lower end until the desired depth. A telescopic section at the top end of the Fall Pipe system allows for adjustments in length.

Characteristics of this closed Fall Pipe system are:

- No losses of fine material due to a closed system
- High production without generating uncontrolled high flow rates at the discharge end of Fall Pipe

With the classic fall pipe system, it is possible to place rock up to a maximum size of 400mm in all directions.

The ROV is located at the lower end of the Fall Pipe and is suspended separately from the Fall Pipe on three wires. The wires are also used for power supply and data communication at the same time.

The ROV is equipped with four thrusters, which allows for horizontal corrections of the Fall Pipe bottom end position and also enables the ROV to rotate around the Fall Pipe. In this manner, the ROV can obtain an independent heading from the vessel and the survey instruments can be orientated in the same heading as pipelines, reference lines, etc.

The ROV is actively heave compensated, which provides a stable survey platform essential for the quality of data gathered by the survey sensors installed on the ROV.

4.4.4 Dynamic Positioning System

The Dynamic Positioning (DP) system on board the vessel is the primary vessel position control during rock placement and surveying operations. The DP system works with input from two Differential Global Positioning Systems (DGPS) or an alternative system such as a reference transponder or laser. The DP system allows the vessel to hold position on a certain spot or to sail tracks along a pre-defined line with a certain speed and heading.

4.4.5 Navigation

Two DGPS systems will control the vessel's positioning; one shall be operated as primary and the other as a secondary system. This will serve as input for the navigation computer.

Furthermore, additional equipment is interfaced to this computer, e.g.:

- Ship’s gyro and motion sensor
- ROV gyro and motion sensor

The navigation computer is capable of calculating the actual position of the vessel and the Fallpipe to a high degree of accuracy. The data is also used as input for the DP system. The second DGPS system is serving as a back-up system.

4.5 Rock Placement Survey

During the construction of the rock berm, intermediate surveys will be carried out having as main objective the verification of the progress, i.e. build-up of the rock berm, and the quality of the work. All the surveys described below will be performed from the rock placement vessel using the permanently installed multibeam echosounder (MBES) survey spread.

The progress of the construction will be monitored ‘on-line’ by comparing the results of the intermediate survey with data from the corresponding pre-rock placement survey.

4.5.1 Pre Rock Placement Survey

The pre-rock placement survey includes all operations, which contribute to establishing the existing seabed conditions. Latest as-left survey data falls under this category.

The objectives of the pre-rock placement survey are:

- To determine the topography of the un-touched seabed
- To establish topography around the proposed rock placement location;
- To estimate the required quantity of rock

Installed reference heaps or any other clear seabed features might be used as benchmarks for later comparison between the pre-rock placement, intermediate and post-rock placement DTM surveys.

4.5.2 Post Rock Placement Survey

After completion of a part of the rock placement scope, a post-rock placement survey will be performed to record the as-built situation. The data gathered will be compared with the corresponding rock design data and pre-rock placement survey to ensure that the rock berm is built within specifications.

Since the post-rock placement survey will not discover the cable position but the rock berm profile and position, this survey in combination with the previously executed Post Mechanical Trench Back-fill Survey will define the final cable position with its Depth of Cover. As for every as-left or as-built survey, a final survey report will be issued.

4.5.3 Rock Placement in Shallow Waters

In event that the selected fall pipe vessel is unable to access shallow water areas, e.g. Portgordon landfall, rock placement will be performed using a shallow water vessel / barge, either Atlantis or similar. Installation engineering is ongoing to confirm the placement method, however, employed methods may include both side dumping and placement by grab, tolerances specified within the navigable depth reduction agreements with the Maritime and Coastguard Agency (MCA) on 30/01/19 will be maintained. The placement of rock in shallow waters will be measured and documented by multibeam surveys both pre and post-rock placement.

Rock placement is the primary protection method, however, if operations in shallow water are either locally or more generally restricted through vessel accessibility an alternative protection strategy of a cable protection system (CPS) such as cast iron shells may be utilised. This protection system would be installed as a maximum from HDD exits at circa. KP 1.622 - KP 2.0. The CPS would be installed from a point close to where cables exit the Portgordon HDDs, physical attachment to the HDD ducts may not be possible. An appropriate size of CPS would be utilised to address the bundled section, individual HVDC cable, and the fibre optic cable. The CPS installation may be made intermittently if rock protection has been possible in limited locations. To permit the installation of lower CPS halves limited excavation of seabed beneath the cables may be required, this would be carried out using diver manipulated airlift excavators.

Acceptance for an additional deposit of up to 1000m length of cast iron cable protection shells with diameters up to a maximum of 500mm is requested via this application.

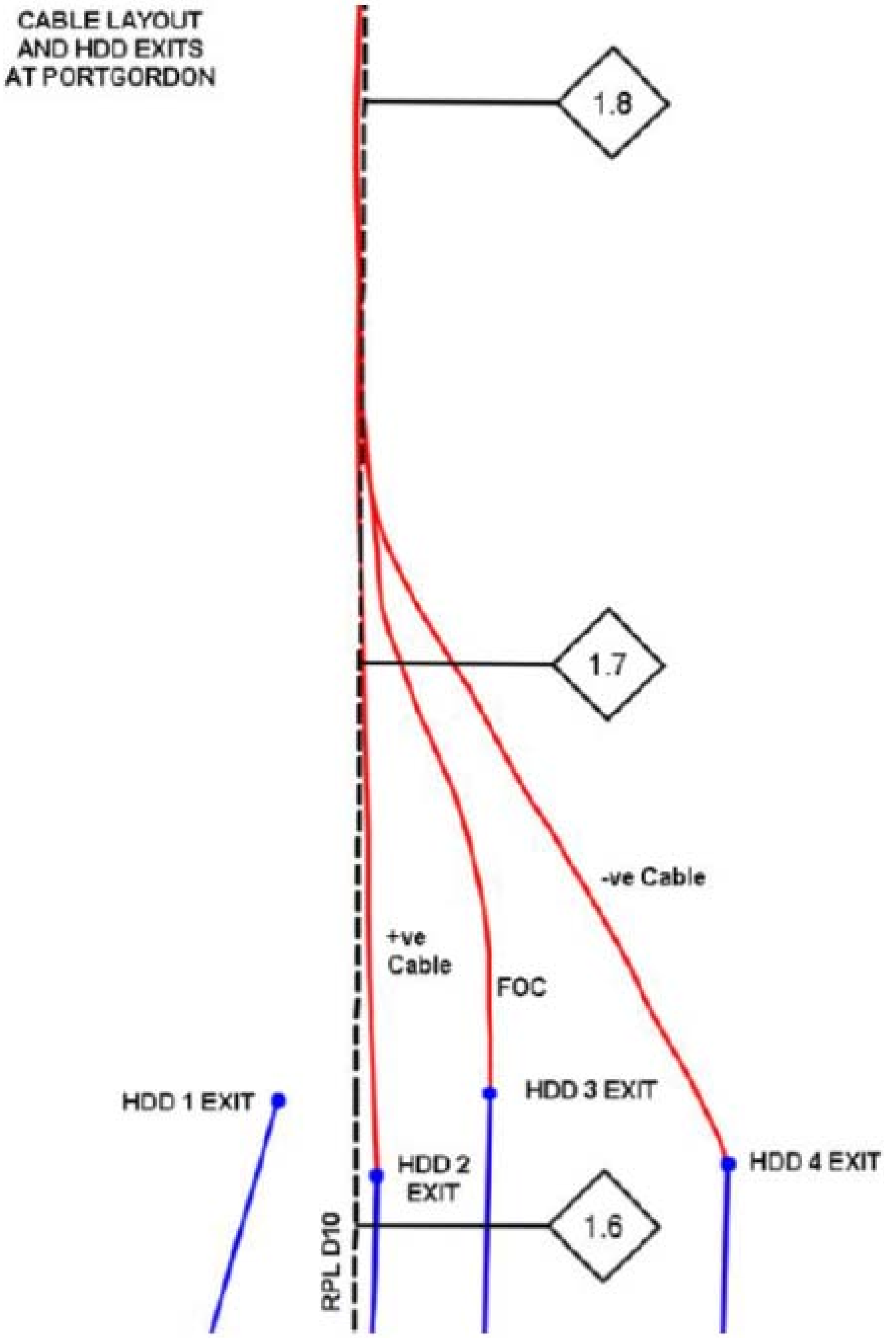


Figure 16 Overview HDD exits

Fig 5-4 HDD Exits and cable intersection point

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CP225333-4.5 (Cable Protection)

Specifications

Effective length	333,5 mm
Total length	396 mm
Inner diameter	225 mm
Max. outer diameter as set	326 mm
Max. cable diameter	205 mm
Wall thickness	9 mm
Bending angle	4,25 deg
Bend radius under tension (10% elongation)	4502 mm
Bending angle	3,82 deg
Bend radius without tension	5003 mm
One shell	12,50 kg
Weight per set	24,99 kg
Weight per meter	74,98 kg/m
Weight per meter in sea	64,42 kg/m
Material	EN-GJS-400-15
Material tensile strength	400 N/mm²
Elongation	15 %

DS - CP225333-4.5 V.02-Rev.1

Fig. 5-5 Example cable protection system

REVISION

Rev. ind.	Chapt (C)	Description	Date/Dept/Name
A		First Issue	2018/07/24 Installation Redacted
B	All	Updated as per SHET RRR	2018/07/26 Installation Redacted
C	All	Updated as per current status. Sections describing works now completed has been removed. An overview is provided in section 2.	2018/12/12 Installation Redacted
D	All	General re-writing of document, all sections.	2019/01/28 Installation Reda cted
E	All	Typoos corrected, errors removed	2019/02/05 AB

APPENDIX A Backfill CFE equipment

James Fisher and Sons plc
Marine Services Worldwide

James Fisher
Subsea Excavation

Twin R2000

Mass flow excavation tool

The Twin R2000 subsea excavation tool generates two controllable columns of seawater which travel vertically down towards the seabed at a velocity of up to 10m per second.

Working in water depths from 1.5m, this tool is ideally suited to shallow water projects on cables and large diameter pipelines.

Applications

- Pipeline & cable trenching
- Decommissioning & salvage
- Deburial for IRM works
- Rock dump dispersal
- Drill cuttings dispersal
- Free span rectifications
- Seabed clearance & preparation
- Shore approach

Soils

- Sand & gravel
- Rock dump
- Silt & mud
- Clays up to 50kPa shear strength
- Drill cuttings

Technical specification

Twin R2000	**Metric**
Max flow volume	4,000 L/S
Max flow velocity	10 m/s
Water depths	1.5m - 300m

Weights and dimensions	**Length (m)**	**Width (m)**	**Height (m)**	**Weight (kg)**
Twin R2000	3.8	1.9	2.3	6,000
Spares container	6.3	2.4	2.6	8,000
Hydraulic hose reel	2.4	2.1	2.6	7,000
Hydraulic Power Unit	3.8	1.9	2.3	6,000

T: Redacted   W: www.jfsubseaexcavation.com

APPENDIX B Rock Placement Vessels – Seahorse and Atlantis

main data	length o.a.	162.00 m
	width	38.00 m
	draught loaded	6.34 m
	loading capacity	17,500 ton
	main propellors	2 x 3,220 kW
	azimuth thrusters	4 x 1,000 kW (retractable)
	bow thruster	1 x 600 kW (tunnel)
	cruising speed	13 kts
dynamic positioning	Kongsberg Simrad, SDP 21 dynamic positioning system with auto track, auto heading and follow ROV mode	
fall pipe	steel pipe sections (8 m) with internal rubber lining deployed through moonpool	
	diameter	1,000 / 680 mm
	depth up to	1,500 / 2,000 m
ROV	active heave compensated on wires, controlling lower fall pipe end. equipped with	

	cameras, profilers, pipe tracker and other sensors as required	
	power	300 kW
classification	LR 100 AI - LMC - UMS - DP (AA)	
	rock dumping vessel	
	IMO / ISM-Code	

ATLANTIS

Self propelled marine working pontoon

Length ▶ 81.00 m
Breadth ▶ 22.00 m
Depth ▶ 3.80 m

CERTIFIED DP1

A copy of the DP1 trial report is available on request

Draught loaded	2.45 m
Carrying capacity	Deepsea 2,200 ton Coastal Waters 2,500 ton
Stone carrying capacity	Deepsea 1,520 ton Coastal Waters 1,850 ton
Working deck	22.0 x 57.0 m
Deck load	10 ton/m^2
Stone loading boxes	Dimensions 4 x 9.70 x 15.00 m
Propulsion	2 Azimuth Thrusters - 2 x 1000 HP 1 bowthruster 500HP 1 bowthruster 1000HP
Mooring system	4 x 500 m Max Pulling power 40 ton Max Holding power 75 ton
Dynamic positioning	Simrad Albatros ADP 701 MK 1
Classification	Lloyd's Register of Shipping ✠ 100 A1 Deep Sea UMS
Accommodation	10 single berths
Removable Forecastle deck	12.6 m
Spuds	2 spudguides 2 spud of 1,22 m - length 28 m

APPENDIX C Project 'Overview' Schedule

The below program gives indicative start and completion dates, offshore works are subject to vessel availability & weather impacts.

Task Name	Duration	Start	Finish	Task Calend	Predecesso
CFE Trials	30 days	Nov 20 08:00	Dec 20 08:00	24 Hours	
KP 11-16 excavation of ends	7 days	Nov 20 08:00	Nov 27 08:00	24 Hours	1SS
CFE Backfill / Additional rock License Application Docs.	63 days	Dec 03 08:00	Feb 04 08:00	24 Hours	
CFE Backfill / Additional rock License application	70 days	Feb 04 08:00	Apr 15 08:00	24 Hours	3
Early acceptance of CFE	1 day?	Mar 16 08:00	Mar 17 08:00	24 Hours	4SS+40 day
KP 11-16 Cable Replacement	35 days	Jan 26 08:00	Mar 02 08:00	24 Hours	
HV Test after replacement	5 days	Mar 02 08:00	Mar 07 08:00	24 Hours	6
Jet Trenching KP 11-16	20 days	Mar 19 08:00	Apr 08 08:00	24 Hours	6
CFE Backfill Campaign	26 days	Mar 31 08:00	Apr 26 08:00	24 Hours	5FS+14 day
CFE Backfill Remedial Rock	35 days	May 17 08:00	Jun 21 08:00	24 Hours	9FS+21 day
Planned Rock Campaign	14 days	Jun 21 08:00	Jul 05 08:00	24 Hours	10