Shell U.K. Limited

BRENT ALPHA JACKET DECOMMISSIONING PROGRAMME

Submitted to the UK Department for Business, Energy and Industrial Strategy

Shell Report Number BDE-A-JKT-AA-5880-00001

July 2020

Approval

Intentionally left blank

CONTENTS

Table of Contents

1 Executive Summary 9
2 Decommissioning Programme 17
2.1 Introduction 17
2.2 Overview of Installation being Decommissioned 17
2.3 Partner Letter of Support 18
2.4 Summary of Proposed Programme of Work 18
2.5 Implications for Decommissioning other Infrastructure and Materials 19
2.6 Field Location including Field Layout and Adjacent Facilities 19
2.7 Public Consultation 19
2.8 Industrial Implications 19
3 Background Information 21
3.1 The Brent Field 21
3.2 Managing Declining Production 21
3.3 Planning for Decommissioning 21
3.4 Brent Decommissioning Programmes 22
4 Description of the Brent Alpha Jacket 25
4.1 General Description 25
4.2 Present and Planned Condition 28
4.3 Seabed Drill Cuttings Pile 29
5 Decommissioning Options and the Comparative Assessment Method 31
5.1 Regulatory Framework 31
5.2 Method Used to Complete Comparative Assessments 31
5.2.1 Introduction 31
5.2.2 Comparative Assessment Criteria 31
5.2.3 Comparative Assessment Data 33
5.3 Assessing the Performance of each Option 36
5.4 Examining the Sensitivity of the CA-recommended Option 36
5.5 Identifying the Recommended Option 38
6 Feasible Decommissioning Options for Brent Alpha Jacket 39
6.1 Reuse of Brent Alpha Topside 39
6.2 Reuse of the Brent Alpha Jacket 39
6.3 Refloating the Whole Jacket in One Piece 39
6.4 Lifting the Whole Jacket in One Piece with the SLV 41
6.5 Brent Alpha Footings 41
6.6 Options for the Brent Alpha Footings 43
6.6.1 Introduction 43
6.6.2 Removing the footings using the SLV 44
6.7 Issues and Concerns Raised by Stakeholders 46
6.8 Interaction with the Seabed Cuttings Pile 46
6.9 Technical Issues for Removing the Footings 47
7 Specific Studies to Inform the CA for Brent Alpha Jacket Footings 51
7.1 Introduction 51
7.2 Assessment of Safety Risks to Other Users of the Sea 51

7.3 Degradation and Collapse of the Brent Alpha Footings 52
7.4 Degradation and Longevity of Conductors 53
7.5 Effects on Commercial Fisheries 53
7.6 Effects of the Disturbance of the Seabed Drill Cuttings Pile 55
7.7 Management of the Brent Alpha Drill Cuttings Pile 55
8 Results of Comparative Assessment of Options for the Brent Alpha Footings 57
8.1 Discussion of the Comparative Assessment 59
8.1.1 Discussion for the Footings Alone 59
8.1.2 Conclusion of Assessment for Jacket Footings Alone 60
8.1.3 Discussion for the Footings in Combination with the Drill Cuttings Pile 60
8.1.4 Conclusion of Assessment for Brent Alpha Jacket Footings in Combination with the Drill Cuttings Pile 62
8.2 Recommended Option for the Brent Alpha Jacket 63
9 Programme of Work for Decommissioning the Brent Alpha Jacket 65
9.1 Preparation 65
9.2 Securing the Conductors 65
9.3 Removal of the Upper Jacket 65
9.4 Material Retrieved and Material Left in Place 67
9.5 Onshore Dismantling and Recycling 68
9.6 Degradation and Longevity of Footings 68
10 Environmental Impact Assessment 69
10.1 Introduction 69
10.2 Environmental Sensitivities 69
10.3 Method used to Assess Environmental Impacts 72
10.3.1 Introduction 72
10.3.2 Summary of Method Used to Assess Environmental Impacts 72
10.3.3 Estimation of Energy Use and Emissions 74
10.4 Potentially Significant Impacts in the Environmental Statement 74
10.4.1 Stakeholder Environmental Concerns 74
10.4.2 Potentially Significant Impacts in the Environmental Statement 74
10.4.3 Impacts of Offshore Operations 76
10.4.4 Impacts of Onshore Operations 76
10.4.5 Legacy Impacts 77
10.4.6 Energy and Emissions 77
10.4.7 Cumulative Impacts 77
10.5 Mitigation Measures for Brent Alpha Jacket Programme of Work 78
10.5.1 Assurance 78
10.5.2 Summary of Mitigation Measures 78
11 Interested Party Consultations 81
11.1 Introduction 81
11.2 Work of the Independent Review Group 81
11.3 Summary of Comments on Practically-Available Options 81
11.4 Specific Comments and Responses on Footings Decommissioning 82
11.5 Brent Derogation Document 85

CONTENTS

12 Programme Management 87
12.1 Strategy 87
12.2 Project Management 87
12.3 Preparatory Work 87
12.4 Notifying Other Users of the Sea 87
12.5 Debris Clearance and Verification 87
12.6 Verification 88
12.7 Reporting Progress 88
12.8 Duty of Care for Waste Materials 88
12.9 Ongoing Management/Reporting 89
12.10 Schedule 89
12.11 Costs 90
12.12 Close-out Report 90
12.13 Post-decommissioning Monitoring and Evaluation 90
12.13.1 Introduction 90
12.13.2 Pre-decommissioning Environmental Surveys 90
12.13.3 Post-decommissioning Environmental Surveys 91
12.13.4 Future Environmental Monitoring 91
12.13.5 Monitoring Degradation and Collapse of Remains 91
13 Supporting Material 93
14 Partner Letter 95
15 Acronyms and Glossary 97

Tables

Table 1 Overview of Installation being Decommissioned. 12
Table 2 Installation being Decommissioned. 17
Table 3 Details of the Section 29 Notice Holders. 17
Table 4 Summary of Proposed Decommissioning Programme. 18
Table 5 History of Brent Alpha. 21
Table 6 Data on the Brent Alpha Jacket. 25
Table 7 Inventory for Brent Alpha Jacket after Removal of Topside. 27
Table 8 The BEIS 5 Main Criteria and the Selected Sub-criteria used in all Brent CAs. 32
Table 9 The Source and Type of Data used to Assess the Performance in each Sub-criterion. 35
Table 10 Global Scales for each Sub-criterion used in Brent Decommissioning CAs. 35
Table 11 'Standard Weights' for the BEIS Main Criteria and Sub-criteria. 36
Table 12 The Five Weighting Scenarios used to Assess the Sensitivity of the CA-recommended Decommissioning Option. 37
Table 13 Weighting Applied to Sub-criteria in Selected Weighting Scenarios. 37
Table 14 Inventory of Materials on Brent Alpha Footings. 42
Table 15 Summary of Options for the Brent Alpha Footings. 45
Table 16 The Technically Feasible Decommissioning Options for the Brent Alpha Footings and the Brent Alpha Cuttings Pile, which were Subjected to CA. 46
Table 17 Recommended Combination of Options for Brent Alpha Jacket Footings and Seabed Drill Cuttings Pile. 47
Table 18 PLL for Types of Fishing Gear during Different Phases of the Degradation of the Brent Alpha Jacket Footings. 52
Table 19 Transformed and Weighted Sub-criteria Scores for the Brent Alpha Footings Alone. 57
Table 20 Transformed and Weighted Sub-criteria Scores for the Brent Alpha Footings in Combination with the Drill Cuttings Pile. 58
Table 21 Estimated Amounts of Brent Alpha Jacket Material Retrieved and Left in Place following Partial Removal. 67
Table 22 Summary of the Physical, Biological and Socio-economic Environments in the Brent Field. 70
Table 23 Environmental Sensitivities in the Brent Field. 71
Table 24 Energy and Emissions Associated with Partial Removal and Onshore Dismantling of Brent Alpha Jacket. 77
Table 25 Summary of Methods for Managing Waste Streams. 89

CONTENTS

Figures

Figure 1 Location of the Brent Field 10
Figure 2 Layout of Installations in the Brent Field 10
Figure 3 Location of Adjacent Facilities 11
Figure 4 Brent Field Decommissioning Programmes and their Supporting Documentation 23
Figure 5 The Brent Alpha Installation in 2006 26
Figure 6 The Main Components of the Brent Alpha Jacket 26
Figure 7 Condition of the Brent Alpha Jacket after the Removal of the Topside 27
Figure 8 Brent Alpha Leg Pre-Cut for Topside Removal 29
Figure 9 Multi-beam Echo Sounder Image of the Brent Alpha Cuttings Pile and Outer Jacket Legs 29
Figure 10 Plan View of the Mapped Extent of Brent Alpha Drill Cuttings Pile in Relation to the Footings 30
Figure 11 Example of a Bar Chart Showing the Total Weighted Scores of Three Options 38
Figure 12 Example of a Difference Chart Showing the Difference between Two Options in each of the Sub-criteria 38
Figure 13 Possible Configuration for Refloating the Brent Alpha Jacket 40
Figure 14 Condition of the Brent Alpha Footings after Removal of the Upper Jacket 43
Figure 15 Typical Arrangement of a Pile Bore Grout Plug in the Brent Alpha Footings 43
Figure 16 Cross-section through a Typical Pit Excavated Around each Leg 48
Figure 17 Pile-Top Drill Rig for Battered Piles 49
Figure 18 The Total Weighted Scores for Combined Options for Brent Alpha Jacket Footings in Combination with the Drill Cuttings Pile, and the Contributions of the Sub-criteria 58
Figure 19 Difference Graph Comparing the Weighted Scores of each Sub-criterion in the Better 'Removal' Option for the Brent Alpha Jacket Footings Alone, with the 'Leave in Place' Option, Under the Standard Weighting 59
Figure 20 Difference Graph Comparing the Weighted Scores of each Sub-criterion in the Better Combined 'Removal' Option for the Brent Alpha Jacket Footings and Seabed Cuttings Pile, with the Combined 'Leave in Place' Option, Under the Standard Weighting 61
Figure 21 Artist's Impression of HLV Lifting Brent Alpha Upper Jacket and Conductors 66
Figure 22 State of the Brent Alpha Footings after Removal of the Upper Jacket 67
Figure 23 An Example of the Diagrams Used to Portray the Severity of an Impact 73
Figure 24 Environmental Impacts from Partial Removal and Onshore Dismantling of the Brent Alpha Jacket 75
Figure 25 Environmental Impacts from Leaving the Brent Alpha Footings in Place 75
Figure 26 Indicative Timing and Duration of the Proposed Brent Alpha installation Decommissioning Programme of Work 89
Figure 27 Relative Timescales of Impacts from Offshore Operations and Some of the Long-term Consequences of Leaving Material on the Seabed at Brent Alpha 90

Intentionally left blank

1 EXECUTIVE SUMMARY

Introduction

This document presents the Decommissioning Programme (DP) for the steel support structure (the "jacket") of the Brent Alpha installation. The owners of the installation are Shell U.K. Limited (registered number 0140141) (Shell, the operator) 50% and Esso Exploration and Production UK Limited (registered number 207426) (Esso) 50%. Shell has prepared this Programme in accordance with Section 29 of the *Petroleum Act 1998* [1], and Esso confirms that it supports the proposals described in it. A letter of support from Esso is presented at the end of this DP. Throughout this document therefore, the terms 'owners', 'we', 'us', and 'our' refer to 'Shell and Esso'.

Decommissioning in the UK sector of the North Sea takes place under a mature regulatory process that is stipulated in the UK's Petroleum Act 1998 and regulated by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), which is a department within the Department for Business, Energy and Industrial Strategy (BEIS)[1]. The *BEIS Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998* [2] [2] provide guidance and advice in the preparation of DPs.

Background

After more than 40 years of production, the Brent Field is reaching the end of its economically-viable life and the next step is to decommission the Alpha installation. Before considering decommissioning options, and as part of our Final Field Development Plan (FFPD), we examined possible re-use options for the installation, particularly for further oil and gas production offshore, and carbon capture and storage. In addition, as part of our Comparative Assessment process, we reviewed a range of possible re-use options such as wind-farms, marine research stations, energy hubs, and artificial reefs. After a thorough review, we were not able to identify any further oil and gas uses for the installation, and concluded that all the alternative non-oil and gas uses were either not feasible, or not economically viable because of the age of the infrastructure, its distance from shore, the lack of demand for reuse and the cost of converting the facilities. We have therefore concluded that the Alpha installation must be decommissioned.

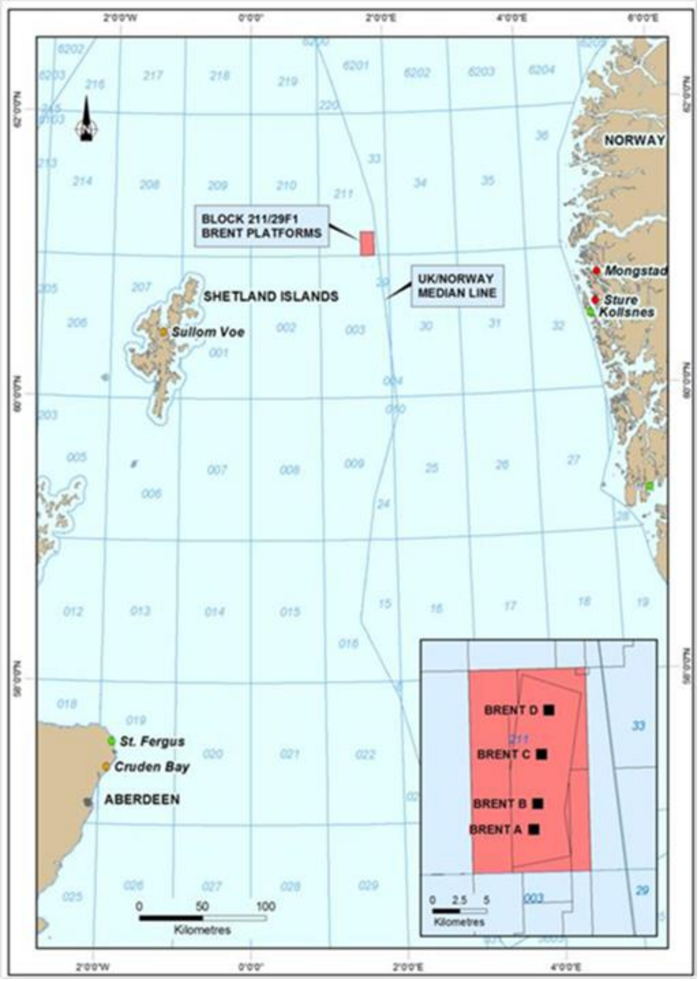
Layout and Adjacent Facilities

The Brent Field is located in the East Shetland Basin in Block 211/29 (Figure 1), midway between the Shetland Islands and Norway. Beyond the Brent Field, the oil and gas installation nearest Brent Alpha is the Statfjord B platform operated by Statoil Petroleum (about 21 km away) (Figure 3). Shipping activity is low and dominated at present by oil industry support vessels, and there are no Ministry of Defence (MOD) exercise areas near the Field. The nearest third-party, non-oil and gas submarine cable is the CANTAT 3 operated by BT located approximately 60 km away. There are no renewable energy developments or dredging or aggregate extraction operations in the area.

[1] In July 2016 the Department of Energy and Climate Change (DECC) was replaced by BEIS. At this time, a number of DECC regulatory responsibilities also transferred to the new Oil and Gas Authority (OGA). Any further references to DECC should be taken as BEIS.

[2] The Brent Decommissioning Programmes were prepared in accordance with the Guidance Notes available at the time, the *Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998*. Version V6, DECC, March 2011 [3]. The Guidance Notes have since been superseded by the BEIS Guidance Notes November 2018. This does not change any of the decommissioning outcomes, as they are in-line with the updated Guidance Notes.

Figure 1 Location of the Brent Field.



Several species of fish and shellfish are present in the area, but none is protected or of conservation importance. The Brent area is subject to commercial fishing operations, and although bottom trawling is the predominant vessel activity, the weight and value of landings from this area are dominated by mid-water (pelagic) species. Fishing intensity is low to moderate in comparison with other areas of the North Sea and is classified by Marine Scotland as being of 'low' value. The main species landed by UK vessels are mackerel, herring and haddock.

Many species of seabirds are found in the area and their abundances vary seasonally. The most frequently sighted species of marine mammal in the Field is the bottlenose dolphin. With the exception of marine mammals, there are no species or habitats in the area which have been designated for their conservation importance. The nearest Special Area of Conservation is the Braemar Pockmark, approximately 225 km from the Field.

Figure 2 Layout of Installations in the Brent Field.

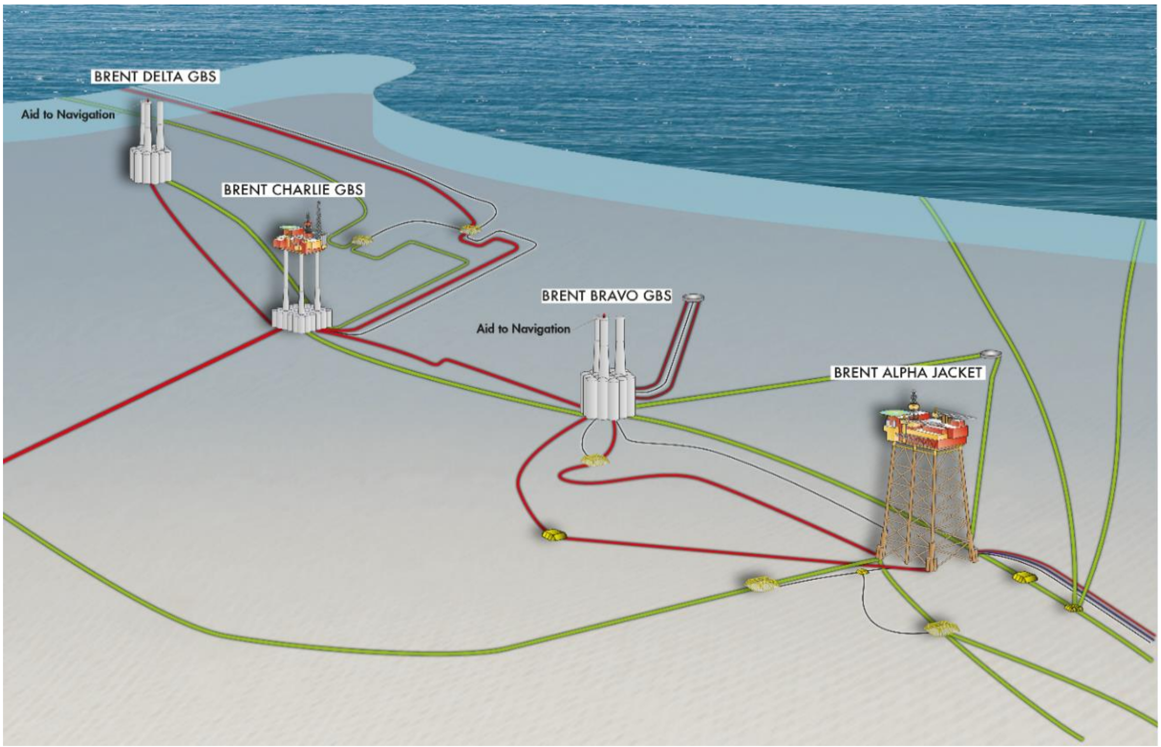
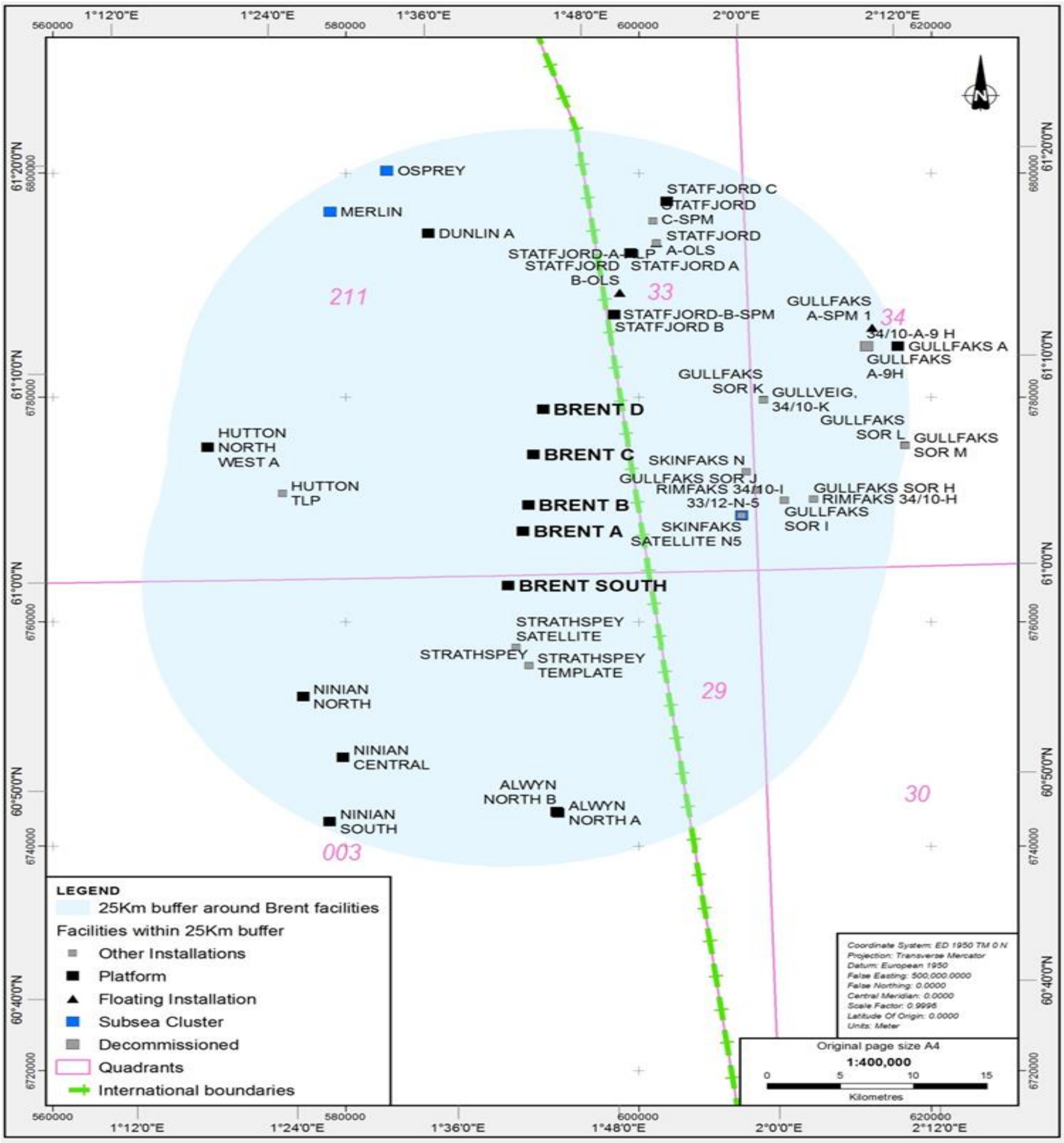


Figure 3 Location of Adjacent Facilities.



Overview of Installation being Decommissioned

Table 1 Overview of Installation being Decommissioned.

Field	BRENT	Block	211/29 UKCS	Water depth	140.2 m
Owners	Shell U.K. Limited 50%				
	Esso Exploration and Production UK Limited 50%				
Operator	Shell U.K. Limited				
Section 29 Notices issued to Owners	12 December 2014				
Distance to UK	136 km, Shetland Islands	Distance to median line	12 km, Norway		
Pre-decommissioning environmental survey	2015: Full baseline benthic survey; physical, chemical and biological data. Included sampling/coring of seabed cuttings pile.				
Previous surveys	2007: Full baseline benthic survey; physical, chemical and biological data; MBES[3]. Included sampling/coring of seabed cuttings pile.				
Cuttings pile screening	As reported in 2007, the Alpha screening results were below both of the thresholds in OSPAR Recommendation 2006/5.				
Nearest SAC	Braemar Pockmark, 225 km				
Nearest platform	Statfjord B, 20.7 km NE				
ICES rectangle	45F1	Fishing intensity	'Low'	Fishing value	'Low'
Shipping activity	'Low'	MOD activity	None	Wrecks	None
Installation	Brent Alpha				
Type	Drilling, Production				
Support structure	8 leg steel piled jacket; 28,719 tonnes[4]				
Historic drill cuttings pile	Seabed cuttings pile 6,300 m^3				
Extent of drill cuttings pile	Extends up to 25 m outside the jacket footprint				
Derogation candidate	Yes >10,000 tonnes in air				

Stakeholder Engagement

Since 2007 we have been working on the long-term planning necessary to stop production and decommission the Brent Field. This has involved in-depth work with third-party experts, academics and other interested stakeholders.

Stakeholder engagement has played a significant role in the development of the Brent Decommissioning Programmes. For more than ten years we have carried out a thorough and transparent process of stakeholder engagement with interested parties. This has involved discussing and informing stakeholders of the different risks, challenges and benefits associated with decommissioning. More than 180 organisations across Europe have been engaged including non-governmental organisations such as environmental groups, government representatives and bodies, academics and professional institutes, fisheries organisations, oil and gas industry bodies, and media and community groups. Our stakeholder engagement activities have included individual visits to stakeholders, hosting larger stakeholder events (facilitated by independent third-party facilitators The Environment Council and then latterly Resources for Change), two Public Events, publishing an online newsletter and maintaining a dedicated Brent Decommissioning website.

[3] Multi-Beam Echo Sounder

[4] Estimated total mass to 3m below the seabed, including conductors, piles and grout

Comparative Assessments

OSPAR Decision 98/3 on the Disposal of Offshore Installations [4] states that the dumping, and the leaving wholly or partly in place, of disused offshore installations is prohibited. An exemption (derogation) may be granted by the Competent Party if it is satisfied that a Comparative Evaluation shows that there are significant reasons why an alternative disposal method is preferable to re-use or recycling or final disposal on land. For steel substructures weighing more than 10,000 tonnes in air (excluding the topside) this means that the 'footings' may be left in place. The footings are that part of the jacket, and associated closely connected parts, that are below the tops of the steel piles that pin the jacket to the seabed.

The Brent Alpha substructure is a steel jacket which weighs more than 10,000 tonnes in air, being a weight of 28,719 tonnes. The point closest to the top of the piles at which it is practically feasible to cut the jacket is at a depth of 84.5 m, expressed as -84.5 m LAT (Lowest Astronomical Tide).

As such, feasible options for its decommissioning were subjected to a Comparative Assessment (CA), complying with the principles of comparative evaluation in Annex 2 of OSPAR Decision 98/3. We performed two CAs, one for the jacket on its own and one for the jacket in combination with options for the management of the historic drill cuttings pile which lies largely within the present footprint of the base of the jacket footings.

Consultation

As is to be expected when decommissioning involves large installations that are candidates for derogation, OPRED's consideration of decommissioning proposals for the Brent Field structures occurs over an extended timeframe. In these particular circumstances, OPRED recognised that the completion of topsides removals could allow decommissioning to be executed cost-effectively, and without prejudice or compromise to the feasible decommissioning options for the four substructures in the Field, including the Brent Alpha jacket.

To this end, we submitted the first DP, the *Brent Delta Topside Decommissioning Programme* [5] in February 2015, which was subject to a thirty day period of public consultation and subsequently approved in July 2015. The Brent Delta topside was successfully removed as a single lift in April 2017.

A consultation draft of the *Brent Field Decommissioning Programmes Document* [6], which described our proposals for decommissioning all the remaining facilities in the Brent Field, was submitted to OPRED in January 2017. The Programmes were subject to a sixty day period of public consultation between 8 February 2017 and 10 April 2017, and OPRED carried out a simultaneous consultation with other government departments. The consultations provided the opportunity for consultees to raise comments on our proposals, including those for the decommissioning of the Brent Alpha installation. In accordance with UK decommissioning procedures OPRED has had sight of our responses to the comments raised by consultees in relation to the Brent Alpha installation, and have informed us that they are satisfied that the comments have been addressed appropriately and that no further consideration of proposals for the installation is required.

OPRED also agreed that our proposals for decommissioning the remaining topsides in the Field could be removed from the Brent Field DP and form a separate, topsides-only, DP covering the Alpha, Bravo and Charlie topsides. Accordingly, we submitted the *Brent Field Topsides Decommissioning Programme* [7] in July 2018 and this was approved in August 2018. Subsequently, the Brent Bravo topside was successfully removed as a single lift in June 2019.

As a derogation candidate under OSPAR Decision 98/3, the Brent Alpha jacket was also included in the *Brent Decommissioning Derogation Assessment* [8], which was submitted for consultation to OSPAR in January 2019. This concluded with a Special Consultative Meeting in October 2019, and a Chairman's report issued in November 2019.

The Brent Alpha installation was demanned in October 2019, and the topside was successfully removed in June 2020. This has left the Brent Alpha jacket protruding just 6.7 m above sea level. The remaining installations in the full derogation assessment are still under consideration.

Conclusion

Detailed engineering and technical studies showed that after removal of the Brent Alpha topside:

- It is not technically feasible to lift the whole jacket in one piece by any type of heavy lift vessel (HLV), including the Single Lift Vessel (SLV) *Pioneering Spirit*, because of the weight and strength of the jacket, and the 'lifting height' required.
- It is not technically feasible to re-float the whole jacket in one piece, because re-floating would require the attachment of large external buoyancy tanks to supplement the buoyancy that could, in theory, be gained by dewatering the pontoon legs. The weakness of the relatively thin walls of the pontoon legs would make it very difficult to attach clamps to such a large, thin-walled part of the jacket.
- It is not considered feasible to strengthen the thin steel walls of the pontoon legs so that sufficiently large buoyancy tanks could be attached.
- Studies also showed that it was not practically possible to reinstate the buoyancy in the pontoon legs – because the buoyancy chambers had to be ruptured during installation of the steel piles – and that the relatively thin walls of the pontoon legs were not strong enough to withstand the high pressure of gas that would have to be injected to force out the water.

In the course of the CA process, therefore, it was concluded that for all feasible options the upper jacket and conductors would have to be removed in one or more pieces by an HLV and returned to shore for dismantling and recycling. In all cases, the upper jacket would be cut at -84.5 m LAT. This is as close as practically-possible to the top of the 'pile stick-up', which in OSPAR Decision 98/3 defines the extent of the 'footings' of steel jackets.

If the jacket were cut at 84.5 m below sea level as proposed, this would leave footings extending 55.7 m above the seabed. They are pinned to the seabed by 32 hollow steel piles 1.83 m in diameter, which are held in place and fixed to the jacket by grout; the piles have been filled with grout to increase the on-bottom stability of the jacket. The footings, excluding marine growth, weigh 20,207 tonnes, including the lower parts of the conductors and the steel piles and their cement grout down to a depth of 3 m below the seabed. There is a large (6,300 m^3) historic drill cuttings pile lying on the seabed below the footings, the majority of which is contained within the perimeter of the footings.

All options for the removal of the footings would require the steel piles to be cut. The footings could be released from the seabed either by cutting the piles externally, using Diamond Wire Cutting (DWC) equipment, or by cutting the piles internally after first removing the grout by drilling or water-jetting.

There are three practically-available options for the decommissioning of the Brent Alpha footings:

- Complete removal with external cutting of the piles.

  After removing all the drill cuttings pile, pits 4 m deep and about 42 m wide would be excavated around each leg. All the piles would then be cut externally 3 m below the seabed using a DWC machine. The footings would be systematically cut into large sections, which would be lifted to the surface by a semi-submersible crane vessel (SSCV) and transported to shore for dismantling and recycling.

- Complete removal with internal cutting of the piles.

  The pile-bore grout would be drilled out, and the piles cut internally 3 m below the seabed using an abrasive water jet. The footings would be systematically cut into large sections, which would be lifted to the surface by an SSCV and transported to shore for dismantling and recycling.

- Leave in place.

  The footings would be left in place in the condition attained after the removal of the upper jacket, and no further operations would take place. The footings would corrode and eventually collapse completely over a period of about 500 years. The seabed drill cuttings pile would be left in place.

Two CAs were performed for the purposes of assessing options for the footings. The first examined options for the footings alone, without consideration of the presence of the seabed drill cuttings pile, i.e. for the structure only. The second examined options for the footings in combination with the most appropriate option for the management of the drill cuttings pile.

The recommended option for the Brent Alpha Jacket Footings is 'Leave in Place'.

Through this *Brent Alpha Jacket Decommissioning Programme*, the owners seek approval to decommission the Brent Alpha jacket. If approved, the offshore programme of work is planned to take place in Q3 of 2020. The conductors have already been cut at 84.5 m below sea level, and they will be lifted away within the upper jacket by an HLV. The upper jacket and the cut sections of the conductors will be carried by the HLV to the AF Gruppen site at Vats in Norway, where it will be dismantled. All of the recovered metallic material of the upper jacket (an estimated 8,512 tonnes) will be recycled.

In the proposed option for the Alpha jacket there would be no further activities at the site after the removal of the topside and upper jacket.

The significant reasons why leaving the jacket footings in place is preferable to returning them to shore for re-use or recycling or final disposal on land are as follows:

- There are significant technical difficulties and safety risks associated with any programme of work to cut the 32 grouted steel piles using DWC equipment and remove the 20,207 tonne footings from the seabed. No operations on such a scale have ever been undertaken before. The main risks are:
    - Gaining access to the piles to cut them internally by deploying novel equipment from the surface into the piles, including the internal piles in the pontoon legs, and successfully clearing the pile bore grout by drilling or milling and then cutting the piles by abrasive water jet; or
    - Excavating very large pits in the seabed to cut the piles externally, by removing all the 6,300 m^3 drill cuttings pile and approximately 25,000 m^3 of natural seabed sediments.
    - Maintaining the stability of the footings as the piles are being cut, and as sections of the footings are being lifted away, given the fact that the footings would be prone to warping because there is only one horizontal bracing, at a height of 30 m above the seabed; and
    - Lifting the footings away from the lower parts of the conductors, given the fact that talon connections and repairs prevent the conductors from being pulled through the last conductor guide frame, or the guide frame from being pulled away from the conductors.
- The potential safety risk to project personnel from the programme of work needed to remove the footings to shore is high, with an estimated Potential Loss of Life (PLL) of approximately 30×10^{-3} (a 1 in 34 likelihood of a fatality). This is much higher than the upper limit of the UK Health and Safety Executive's (HSE) As Low As Reasonably Practicable (ALARP) 'tolerable range', which is a PLL of 1×10^{-3}, and it is not ALARP. As such it is unacceptable.

The *Brent Field Decommissioning Environmental Statement* (ES) [9], prepared on behalf of the owners by DNV GL, has assessed that there would be no significant adverse effects on the environment from the proposal to leave the footings in place. The long-term legacy effects of the presence, deterioration and eventual collapse of the footings were assessed as being 'small negative'.

The main impacts identified were;

- Impacts to the seabed and benthos in the immediate area of the footings caused by the creation of steel debris on the seafloor, and;
- The effects of falling steel debris disturbing the drill cuttings pile, which would lead to the resuspension of cuttings and the recontamination of areas of seabed that were recovering from the

effects of historic discharges. Modelling of such disturbance events suggests that any impacts will be localised and relatively short-lived.

Potential low-level safety risks to commercial fishing vessels using demersal (bottom-towed) fishing gear would be mitigated by marking the footings on FishSAFE and updating the status of the installation through 'Notices to Mariners'. The position of the Alpha footings would be clearly marked on navigational charts through the UK Hydrographic Office.

Leaving the Alpha jacket footings in place will also leave the drill cuttings pile undisturbed to degrade naturally.

In accordance with the Petroleum Act 1998, the responsibility for managing and reporting the results of the agreed post-decommissioning monitoring and evaluation, and any remedial programme, will remain with the present owners. The Alpha jacket footings which are proposed to be left in place remain the property of the Brent Field licensees.

2 DECOMMISSIONING PROGRAMME

2.1 Introduction

In accordance with the Petroleum Act 1998 [1], the BEIS Guidance Notes on Decommissioning [2], and the requirements of OSPAR Decision 98/3 [4], the owners as Section 29 Notice Holders seek approval from OPRED to decommission the Brent Alpha substructure by cutting the jacket at 84.5 m below Lowest Astronomical Tide (LAT) and removing this part (the 'upper jacket') to shore for recycling and disposal, and leaving the lower part of the jacket (the 'footings') in place.

In conjunction with public, stakeholder and regulatory consultation completed on 10 April 2017, and the OSPAR consultation completed in October 2019, this DP is submitted for approval in compliance with regulatory requirements and BEIS guidelines. It describes the options that were examined for the jacket, the Comparative Assessment (CA) process completed to assess the feasible options, the results of the CA, the removal programme that would be undertaken, and the materials that would be left in the sea. It summarises the schedule of offshore and onshore work which is expected to be completed by the end of 2021, and presents an assessment of the environmental impacts of the proposed programme.

2.2 Overview of Installation being Decommissioned

Table 2 provides an overview of the installation being decommissioned and Table 3 provides information about the Section 29 Notice Holders for the Brent Field.

Table 2 Installation being Decommissioned.

<table>
<tr><th colspan="4">Field Name</th><th colspan="2">Quad/Block</th></tr>
<tr><td colspan="4">Brent Field</td><td colspan="2">UKCS Block 211/29</td></tr>
<tr><th colspan="6">Surface Installation</th></tr>
<tr><th>Total Number</th><th colspan="2">Type</th><th colspan="2">Location</th><th>Weight</th></tr>
<tr><td>1</td><td colspan="2">Brent Alpha Jacket</td><td colspan="2">61°02.063'N 01°42.221'E</td><td>28,719 tonnes[5]</td></tr>
<tr><th colspan="2">Production Type</th><th>Water Depth (m)</th><th colspan="2">Distance from Nearest UK Coastline (km)</th><th>Distance to Median Line (if less than 5km)</th></tr>
<tr><td colspan="2">Gas and oil</td><td>140.2</td><td colspan="2">136</td><td>N/A</td></tr>
</table>

Table 3 Details of the Section 29 Notice Holders.

Section 29 Notice Holder	Registration Number	Equity Interest (%)
Shell U.K. Limited	140141	50
Esso Exploration and Production UK Limited	207426	50

[5] Estimated total mass to 3m below the seabed, including the conductors and casings, and the piles and their grout, but excluding the estimated weight of marine growth on the structure.

2.3 Partner Letter of Support

Shell has prepared this DP in accordance with Section 29 of the Petroleum Act 1998, on behalf of the owners of the installation.

By a letter dated 14th July 2020, presented at the end of this DP, Esso has confirmed that it supports the proposals described in this DP for the decommissioning of the Brent Alpha installation.

2.4 Summary of Proposed Programme of Work

Table 4 Summary of Proposed Decommissioning Programme.

Selected Option	Reason for Selection	Proposed Decommissioning Solution
1. Brent Alpha Jacket		
Complete removal of the upper jacket down to -84.5 m LAT, onshore dismantling, recycling and disposal.	Complies with requirements of OSPAR Decision 98/3.	The upper part of the Brent Alpha jacket will be removed in one piece by an HLV and transported to the AF Gruppen site at Vats in Norway, where it will be back-loaded and dismantled onshore. Some equipment may be re-used but it is estimated that about 87% by wet weight of the retrieved mass of jacket material will be recycled. The remaining 13%, which comprises mainly organic marine growth, will be disposed of to a licensed landfill site.
Leaving the footings of the jacket in place.	Assessed as the recommended option after completion of a Comparative Assessment in accordance with the requirements of OSPAR Decision 98/3.	The footings will be left in place on the seabed, and the cuttings pile will be left in place undisturbed to degrade naturally.
2. Brent Alpha Wells		
Plug and Abandon.	Meets UK Oil and Gas Authority (OGA) and UK Health and Safety Executive (HSE) regulatory requirements.	All the Brent Alpha wells have been plugged and made safe in accordance with the Oil & Gas UK *Guidelines for the Suspension and Abandonment of Wells* [10].
3. Interdependencies		
There is no alternative use for the Brent Alpha installation, including its topside, and as Cessation of Production has been agreed it can now be decommissioned. Pipelines to and from the installation have been emptied of hydrocarbons and flushed, as appropriate and feasible, before the topside and then the upper jacket are removed. The removal of the upper part of the Brent Alpha jacket and its transportation to shore will have no effects on, or implications for, any other facility either within or beyond the Brent Field.		

2.5 Implications for Decommissioning other Infrastructure and Materials

We have reviewed the removal of the upper part of the Brent Alpha jacket to determine if this would have any implications for the decommissioning of the Bravo, Charlie and Delta Gravity-Base Structures (GBS) or materials in and around these GBSs.

As a result of the detailed assessments we have completed, we consider that no technically feasible option for decommissioning or managing these installations or materials would be prejudiced or foreclosed by the removal of the Brent Alpha upper jacket.

2.6 Field Location including Field Layout and Adjacent Facilities

The Brent Field and its pipeline system are located in Block 211/29, Block 211/28, Block 211/27, Block 211/26 and Block 3/4a of the UK sector of the North Sea, approximately 136 km northeast of the Shetland Islands (Figure 1). The Field is part of the extensive oil and gas infrastructure which has been established over the last 40 years in the East Shetland Basin; there are 11 platforms, 3 floating installations, 17 templates and 4 subsea clusters within 25 km of the Alpha installation covered in this DP (Figure 3).

Figure 1 shows the location of the Brent Field, and Figure 2 shows the position of Brent Alpha in relation to the other three installations in the Field.

2.7 Public Consultation

The Brent Alpha jacket formed part of the draft Brent Field DP [6], which was submitted for an agreed sixty-day period of Public Consultation in 2017. During this period we received 38 responses from individuals and organisations, including two comments specifically concerning the decommissioning of the Brent Alpha jacket (see Section 11 'Interested Parties Consultations'). The data, narrative and recommendations in this DP have been reviewed, as appropriate, in the light of all the comments that we received, and edited or updated as necessary.

2.8 Industrial Implications

We have striven to identify safe, efficient and cost-effective methods and procedures for decommissioning the different types of structures and facilities in the Brent Field. Many contractors and consultancies have contributed to the numerous studies and assessments that have been prepared since 2006 to inform our plans and support our decision-making processes.

During the 'Concept Select' phase of our work, leading international contractors and engineering companies prepared Front End Engineering Design (FEED) studies describing how different technologies and programmes of work might be used to decommission the Brent structures.

Intentionally left blank

3 BACKGROUND INFORMATION

3.1 The Brent Field

The Brent Field is located in Block 211/29 of the UK sector of the North Sea, approximately 136 km northeast of the Shetland Islands (Figure 1). The Field is part of the extensive oil and gas infrastructure which has been established over the last 40 years in the East Shetland Basin; there are 11 platforms, 3 floating installations, 17 templates and 4 subsea clusters within 25 km of the Brent installations.

The Field is served by four installations, one of which, Brent Alpha, is a steel jacket, fixed in place by steel piles driven into the seabed. Brent Alpha was in production for 36 years (Table 5).

Table 5 History of Brent Alpha.

Event	Date
Jacket installed	1976
Production begins	1978
Cessation of Production	1st November 2014
Completion of Wells P & A	2019

3.2 Managing Declining Production

The Brent Field was discovered in 1971 and production started in 1976. Over the period 1976 to 2004, a total of 143 wells were drilled from the 154 Brent platform well slots, and three subsea wells were drilled at the now-decommissioned Brent South location.

We completed a major restructuring programme (called the Long-term Field Development project, LTFD) in 1996 and this changed the Field from producing predominantly oil to producing predominantly gas. This boosted production and extended field life by approximately 10 years.

Plateau production levels were achieved in 1985 for oil and in 2002 for gas, and since these dates production of both oil and gas have declined significantly. Despite detailed investigations since 2006, no viable or economically sustainable programmes or measures can be put in place to significantly extend production.

3.3 Planning for Decommissioning

In 2006 we initiated detailed discussions with DECC about possible dates for the Cessation of Production (CoP) from the four installations. These discussions examined the fiscal, economic, technical and safety implications both for ourselves as owners and for the UK Government. As the discussions progressed it became clear that, despite earlier hopes that it would be economically viable to continue production on some installations and thus carry out a phased cessation of production, all four installations were rapidly coming to the end of production.

Three of the four Brent installations have now ceased production and we have reached agreement with the OGA that Brent Charlie will cease production in the near future.

3.4 Brent Decommissioning Programmes

As is to be expected when decommissioning involves large steel jackets or concrete gravity base structures, OPRED's consideration of decommissioning proposals for these structures occurs over an extended timeframe. In these particular circumstances, OPRED recognised that completion of topsides removals could allow decommissioning to be executed cost-effectively, to the benefit of the taxpayer and without prejudice or compromise to the feasible decommissioning options for the four substructures in the Field, including the Brent Alpha jacket.

As such we submitted the first Decommissioning Programme in February 2015, for the Brent Delta Topside [5], which was subject to a thirty day period of public consultation and subsequently approved in July 2015. The Brent Delta topside was successfully removed as a single lift in April 2017.

A consultation draft of the Brent Field DP [6] was submitted to OPRED in January 2017. This DP described our proposals for decommissioning the facilities in the Brent Field, including proposals for decommissioning the Brent Alpha installation. The Programmes were subject to a sixty day period of public consultation between 8 February 2017 and 10 April 2017, and OPRED carried out a simultaneous consultation with other government departments.

The consultations provided the opportunity for consultees to raise comments on all our proposals, including those for the decommissioning of the Brent Alpha jacket. In accordance with UK decommissioning procedures, OPRED has had sight of our response to the comments raised by consultees in relation to the Brent Alpha jacket and have informed us that they are satisfied that they have been addressed appropriately and that no further consideration of proposals for the Brent Alpha jacket is required.

OPRED also agreed that our proposals for decommissioning the remaining topsides (Alpha, Bravo and Charlie) could be removed from the Brent Field DP, and subsequently they were presented as the Brent Field Topside DP [7], which was approved in August 2018. Subsequently, the Brent Bravo topside was successfully removed as a single lift in June 2019.

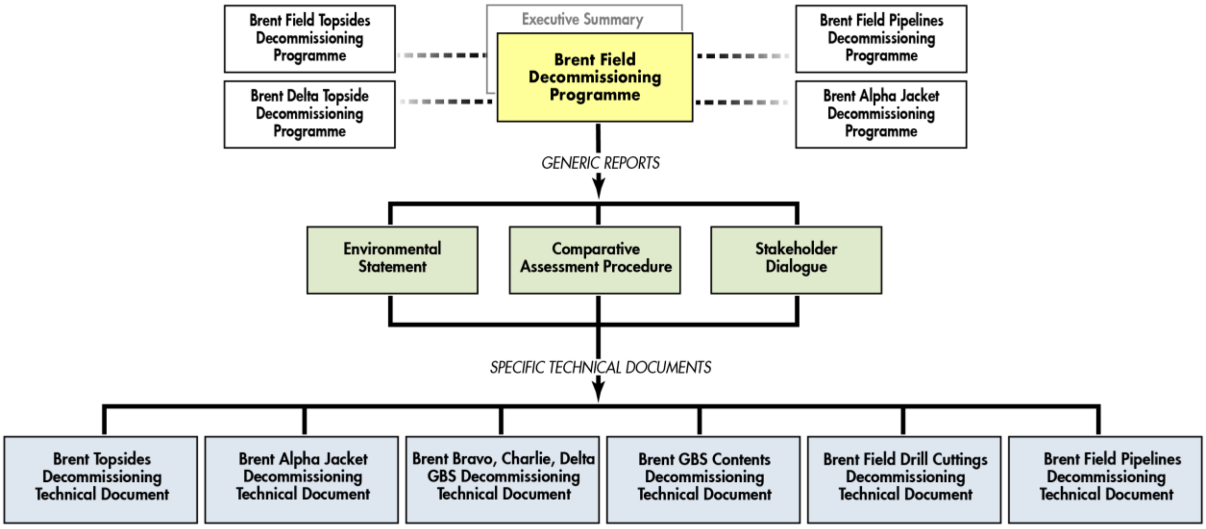
In a similar vein, OPRED also agreed that the decommissioning of the pipeline system, which is not subject to the provisions of OSPAR Decision 98/3, and which previously formed part of the Brent Field DP [6], could be presented in a separate *Brent Field Pipelines Decommissioning Programme* [11]. The Pipelines DP was approved in March 2020.

As a derogation candidate under OSPAR Decision 98/3, the Brent Alpha jacket was also included in the Brent Decommissioning Derogation Assessment [8], which was submitted for consultation to OSPAR in January 2019. That consultation, including a Special Consultative Meeting which was held in October 2019, has concluded. OPRED is now considering the views and conclusions recorded during the consultation, including the meeting.

This DP presents the recommendations for the decommissioning of the Brent Alpha jacket alone. The decommissioning of the Brent Alpha jacket has no bearing on any feasible options for the decommissioning of the other Brent platforms or the Brent pipeline system.

BACKGROUND INFORMATION

Figure 4 Brent Field Decommissioning Programmes and their Supporting Documentation.



Intentionally left blank

4 DESCRIPTION OF THE BRENT ALPHA JACKET

4.1 General Description

Brent Alpha was designed in the 1970s and is a first-generation steel platform. It is fixed to the seabed by steel piles, and originally provided all the facilities and systems needed to drill and service wells, process oil and export it to shore via Brent Charlie and Cormorant Alpha. The installation had accommodation for approximately 120 persons.

Table 6, and Figure 5 and Figure 6 show the main features of the platform, and further detailed descriptions are given in the *Brent Alpha Jacket Decommissioning Technical Document* (TD) [12].

An important feature of the jacket is the three 7.3 m wide pontoon legs on Face A (Figure 6). During emplacement, the jacket was towed into the Brent Field on a barge and then skidded off into the sea, where it floated on its pontoon legs which at that time were sealed and full of air. The legs were then flooded to rotate the jacket into a vertical orientation and lower it onto the seabed.

After removal of the topside (Figure 7), the weight in air of the jacket, complete with its conductors, and the piles and their grout to 3 m below the seabed, would be 28,719 tonnes. Table 7 summarises the jacket inventory after removal of the topside.

Table 6 Data on the Brent Alpha Jacket.

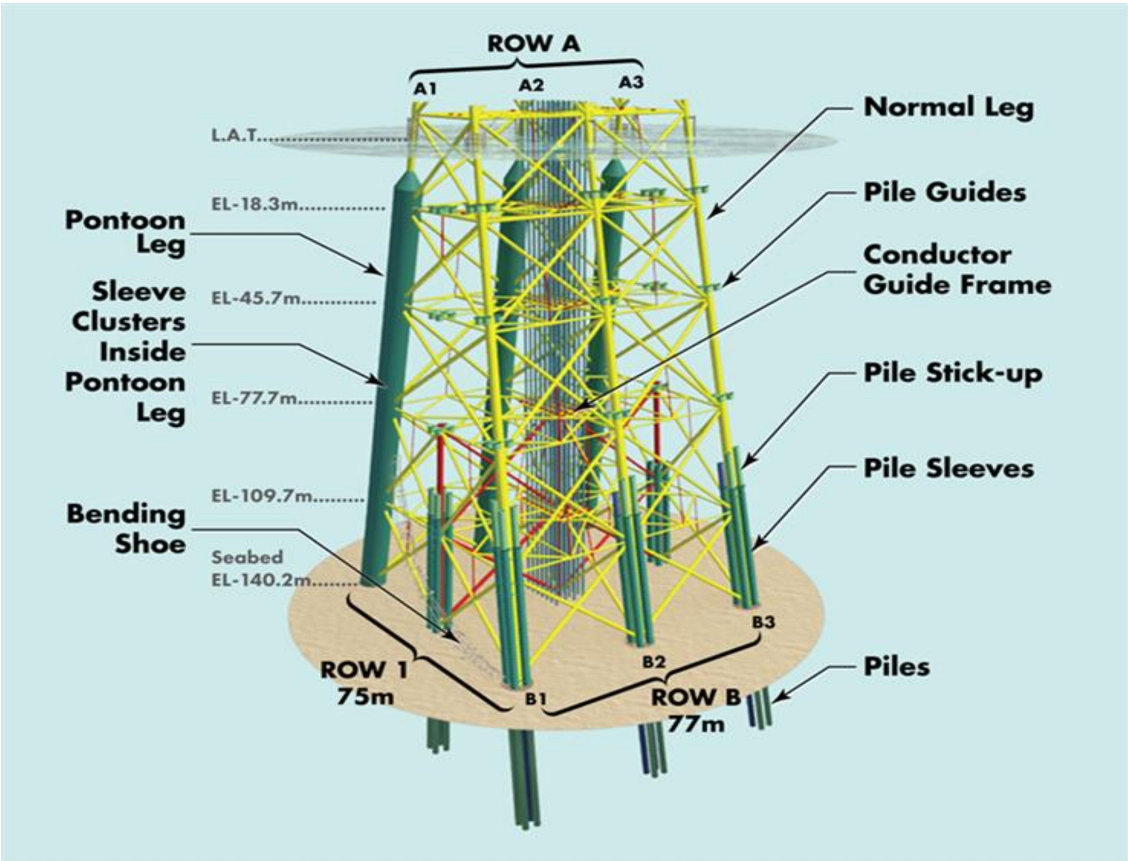
<table>
<tr><th colspan="2">Topic</th><th colspan="3">Information</th></tr>
<tr><td colspan="2">Type of facility</td><td colspan="3">Steel piled platform</td></tr>
<tr><td colspan="2">Position, decimal (WGS84)[6]</td><td colspan="3">61.034384N, 1.703685E</td></tr>
<tr><td colspan="2">Position, decimal minute (WGS84)</td><td colspan="3">61°02.063′N, 01°42.221′E</td></tr>
<tr><td colspan="2">Shortest distance to nearest coast</td><td colspan="3">136 km, Shetland Islands, UK</td></tr>
<tr><td colspan="2">Shortest distance to median line</td><td colspan="3">12 km to UK/Norway</td></tr>
<tr><td colspan="2">Jacket height from seabed to underside of Plate Girder Support Structure (PGDS)</td><td>161.9 m</td><td>Jacket height above LAT</td><td>21.7 m (to underside of PGDS)</td></tr>
<tr><td>‘Footprint’ areas</td><td>Seabed footprint</td><td>5,775 m²</td><td>Truss Deck</td><td>2,280 m²</td></tr>
<tr><td colspan="3">Total estimated weight of jacket in place, to 3 m below seabed[7]</td><td colspan="2">28,719 tonnes</td></tr>
<tr><td colspan="3">Total weight of piles, including grout (included in the total weight above)</td><td colspan="2">8,645 tonnes</td></tr>
<tr><td colspan="5">Pontoon Legs</td></tr>
<tr><td>3, full height, on Frame ‘A’</td><td>Diameter</td><td>7.32 m</td><td>Thicknesses</td><td>16-25 mm</td></tr>
<tr><td colspan="5">Other Legs</td></tr>
<tr><td>3, full height, 2 partial height</td><td>Diameters</td><td>1.83 m to 2.74 m</td><td>Thicknesses</td><td>38-48 mm</td></tr>
<tr><td colspan="5">Steel Piles</td></tr>
<tr><td>32, maximum stick-up ~10 m</td><td>Diameter</td><td>1.83 m</td><td>Thickness</td><td>48 mm</td></tr>
<tr><td colspan="5">Risers</td></tr>
<tr><td>9, full height of jacket</td><td>Diameters</td><td>0.2 m to 0.7 m</td><td>Thicknesses</td><td>10-25 mm</td></tr>
<tr><td colspan="5">Conductors</td></tr>
<tr><td>28, full height of jacket</td><td>Diameter</td><td>0.66 m to 0.76 m</td><td>Thickness</td><td>25.4 mm</td></tr>
</table>

[6] WGS84, World Geodetic System 1984

[7] Including conductors, casings, piles and grout

Figure 5 The Brent Alpha Installation in 2006.

Figure 6 The Main Components of the Brent Alpha Jacket.



DESCRIPTION OF THE BRENT ALPHA JACKET

Figure 7 Condition of the Brent Alpha Jacket after the Removal of the Topside.

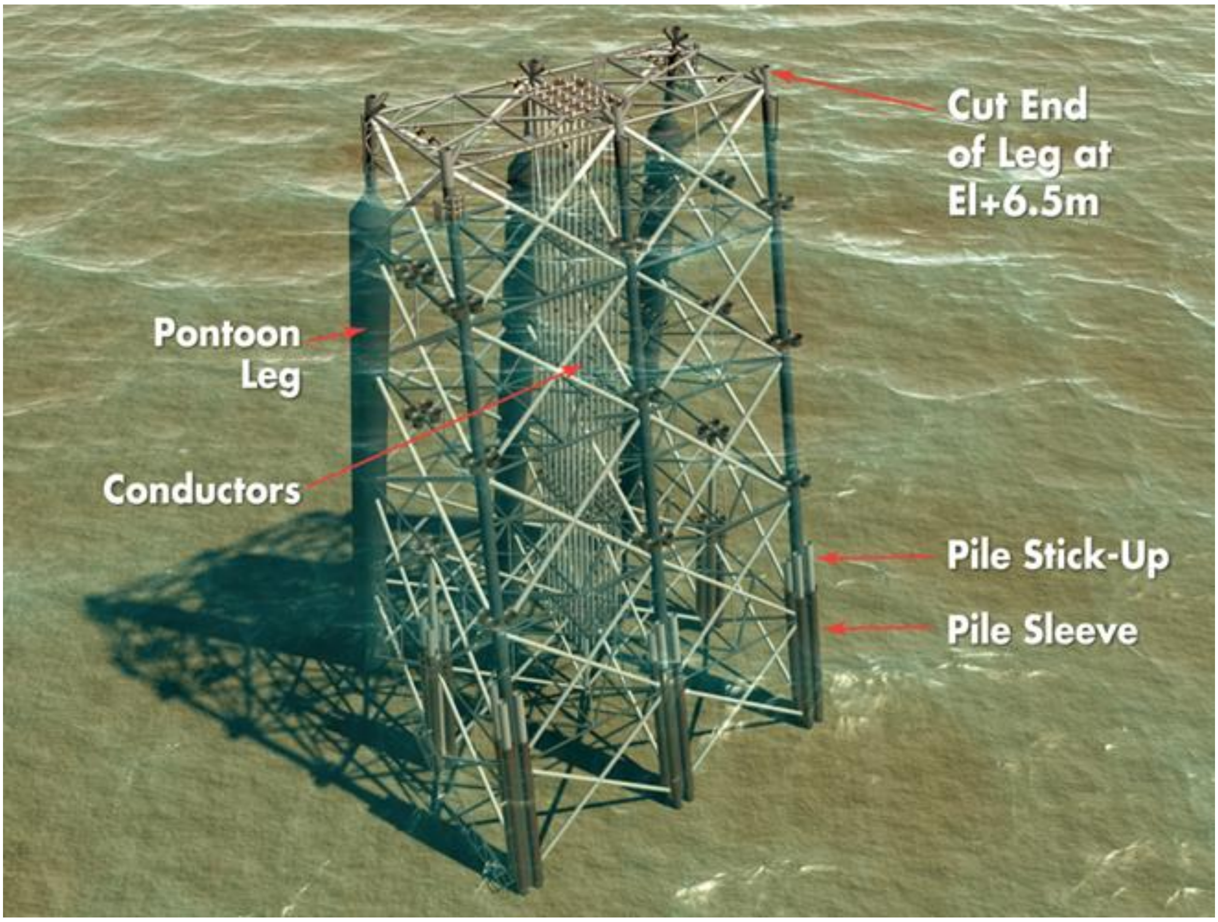


Table 7 Inventory for Brent Alpha Jacket after Removal of Topside.

Component	Material and Estimated Mass (tonnes)[8]			Totals
	Steel	Grout	Anodes	
Jacket	14,813	0	256	15,069
Conductors	2,029	720	0	2,749
Casings	2,256	0	0	2,256
Piles	4,161	4,484	0	8,645
Total	23,259	5,204	256	
Total Mass of Brent Alpha Jacket with Conductors and Piles to 3 m below seabed (tonnes)				28,719

[8] Our inventory records do not indicate that any NORM or other hazardous materials will be present on or in the Brent Alpha jacket. Once the upper jacket has been received at the onshore dismantling site, one of the pre-dismantling tasks will be a survey of the structure to check for the presence of NORM.

4.2 Present and Planned Condition

All the wells on Brent Alpha were plugged and made safe by February 2019, and numerous other activities have been completed to prepare the topside for removal. The oil and gas pipelines to and from Brent Alpha have been depressurised and purged. The oil lines have been cleaned using mechanical pigging, flushed with seawater to ensure that they do not contain any bulk hydrocarbons, and then filled with inhibited seawater. The gas lines have been flushed to ensure that they do not contain any bulk hydrocarbons, and the majority have been left filled with inhibited seawater.

The Brent Bypass Project[9], designed to allow the continuing export of gas through the Western Leg Gas Pipeline (WLGP) and Far North Liquids and Associated Gas System (FLAGS) export routes without 'going over' Brent Alpha, was completed in February 2019. All connections to oil and gas pipelines have now been severed, as described in the Pipelines Decommissioning Programme [11] and presented in detail in the *Brent Field Pipelines Technical Document* [13]. In preparation for the removal of the topside, two of the six full height jacket legs were pre-cut using a flame torch. The cuts were made in a castellated fashion, as were the cuts on the remaining four legs in May 2020, to help ensure that the topside remained securely in place until lifted (Figure 8). As described in the Field Topside DP, the Brent Alpha legs have been cut at approximately +6.7 m LAT. Steel bearing blocks were welded onto the short length of leg extending from the topside Module Support Frame (MSF) to the cut line, to take the weight of the topside and secure it to the lifting yolks of the SLV.

The Brent Alpha platform was demanned on 20th October 2019. For the continued safety of other users of the sea, it was marked by an approved temporary light and its new status was reported to the UK Hydrographic Office (UKHO) and in Notices to Mariners. The 500 m radius safety zone around the platform remained in place.

The Brent Alpha topside was successfully removed in June 2020 using the SLV *Pioneering Spirit*. The UKHO has been updated regarding the status of the platform, and the jacket is presently guarded by a dedicated Field vessel to warn mariners of this hazard. Following the removal of the topside, the Brent Alpha jacket does not contain any pressurised equipment or pipework, and does not contain any hydrocarbons.

[9] The Brent Bypass Project (BBY) was undertaken to allow the continuing export of gas through the WLGP and FLAGS export routes once the Brent Alpha installation had been decommissioned, and was executed in two phases. In Phase 1, the Northern Leg Gas Pipeline (NLGP) (from the Magnus platform and WLGP (from the Ninian Central platform) were disconnected from the Brent Alpha platform. The gas from the NLGP and WLGP is now commingled at a new subsea NL-WL PLEM (Pipeline End Manifold) structure. In Phase 2, the FLAGS pipeline was disconnected from the Brent Alpha platform and existing VASP structure, with the fluids and associated gas routed to a new FLAGS PLEM before onward transmission to shore via the remaining length of the FLAGS pipeline (PL002/N0201).

Figure 8 Brent Alpha Leg Pre-Cut for Topside Removal.

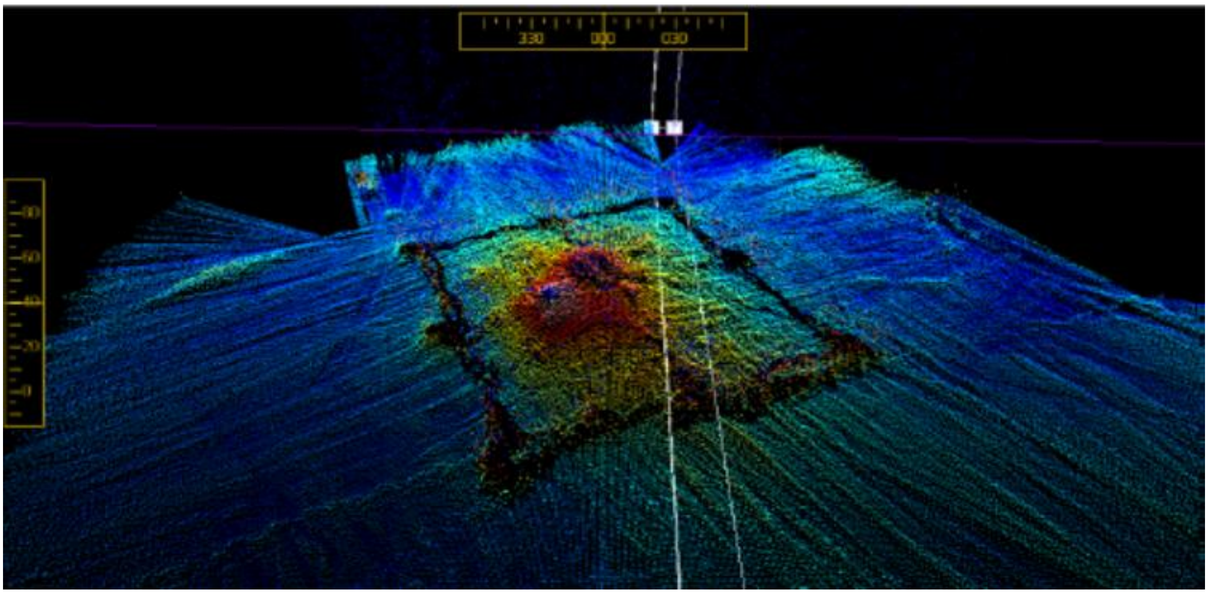
4.3 Seabed Drill Cuttings Pile

On the seabed under and around the Brent Alpha footings, there is an historic drill cuttings pile comprising approximately 6,300 m^3 of cuttings that were generated using both Water-Based Mud (WBM) and Oil-Based Mud (OBM) (Figure 9). The size, volume, composition and characteristics of the Brent Alpha drill cuttings pile are fully described in the *Brent Field Drill Cuttings Technical Document* [14].

In 2007, the physical extent and volume of the external accumulations of the Brent Field drill cuttings piles were mapped using Multi-Beam Echo-Sounder (MBES), and the results presented in the report *MBES Survey Brent Alpha* by SubSea 7 [15].

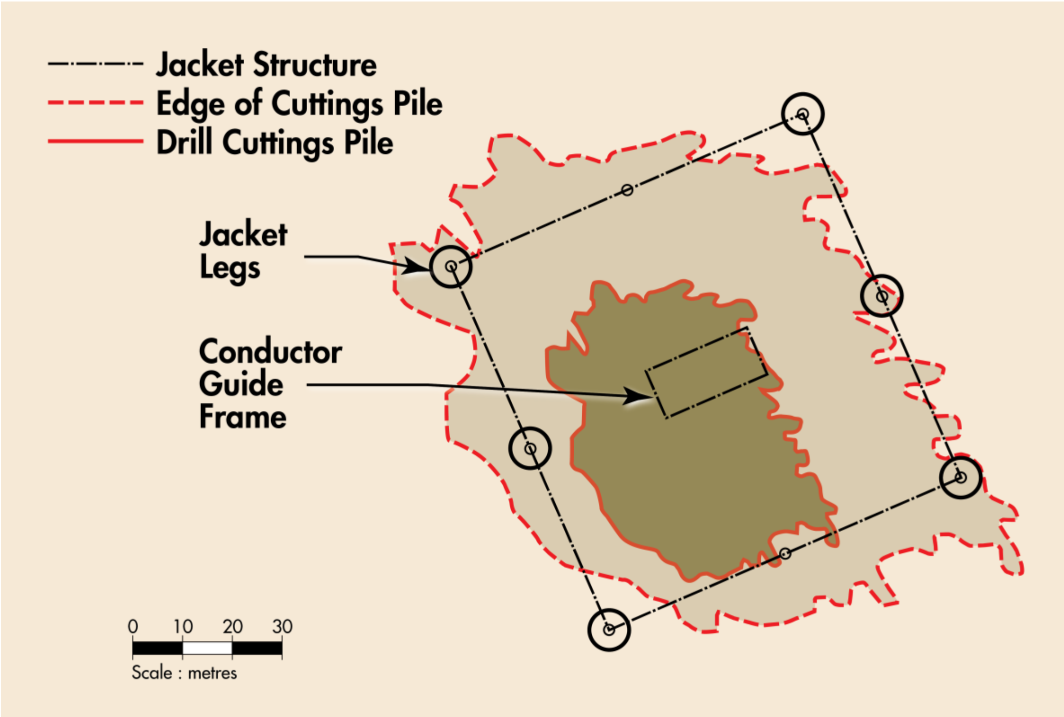
Together with the BMT study *Long Term Fate and Effects of Cuttings Piles at Brent Alpha and Brent Charlie* [16], the survey at Brent Alpha has demonstrated that this cuttings pile does not exceed the thresholds for 'rate of oil loss' and 'persistence over the area of seabed contaminated' laid down in *OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles* [17]. In line with this Recommendation, the preferred option for the management of the Brent Alpha seabed cuttings pile is therefore 'leave in place'.

Figure 9 Multi-beam Echo Sounder Image of the Brent Alpha Cuttings Pile and Outer Jacket Legs.



The 2007 survey indicated that the accumulation of drill cuttings on the seabed covered a roughly elliptical area of 8,880 m^2, its mapped volume was approximately 6,300 m^3 and its maximum height was 4 m. The Brent Alpha footings cover an area of 5,775 m^2, so approximately 3,000 m^2 of the cuttings pile (approximately 35% of the total pile area) lies outside the perimeter of the footings (Figure 10). Cross-sections through the pile show that on the longer, north-south faces of the footings (77 m long) measurable thicknesses of cuttings were found to extend approximately 10 m in both directions beyond the perimeter of the footings. On the east-west faces (75 m long), the drill cuttings were mapped along a transect that extended approximately 15 m in both directions beyond the perimeter of the footings. There has been no drilling at Brent Alpha since 2001.

Figure 10 Plan View of the Mapped Extent of Brent Alpha Drill Cuttings Pile in Relation to the Footings.



As the drill cuttings pile is largely contained within the footprint of the jacket structure (Figure 8), the decommissioning of the jacket footings will inevitably affect the drill cuttings pile. For one of the jacket decommissioning options, the seabed drill cuttings pile would have to be disturbed or displaced to gain access to the steel piles and for cutting the legs. Should both the footings and the drill cuttings pile be left in situ, then the long-term degradation of the jacket structure will impact the drill cuttings (by falling debris disturbing the drill cuttings). Accordingly, we completed separate CAs for the jacket footings and for the seabed drill cuttings pile and then a combined CA in which (i) the preferred management option for the displacement of the drill cuttings pile ('remove the whole drill cuttings pile and treat onshore') was combined with the full removal option for the footings and (ii) the long-term effects of the seabed drill cuttings pile were considered in combination with the long-term degradation of the jacket footings if they were left in place.

5 DECOMMISSIONING OPTIONS AND THE COMPARATIVE ASSESSMENT METHOD

5.1 Regulatory Framework

The decommissioning of oil and gas facilities on the UK Continental Shelf (UKCS) is regulated by the Petroleum Act 1998, as amended by the Energy Act 2008, which provides the framework for the implementation in the UK of OSPAR Decision 98/3. The BEIS Guidance Notes [2] provide guidance and advice on the preparation of DPs. Owners must prepare a programme for the decommissioning of all installations and pipelines, and submit a formal DP to OPRED in a timely manner for review and approval.

5.2 Method Used to Complete Comparative Assessments

5.2.1 Introduction

This section describes the method that we used to perform the numerical stage of CAs on the practically-available options for those facilities that were subject to CA. A description and discussion of the full procedure, with some discussion of sensitivity to changes in weightings, is presented in the Brent Decommissioning Project's (BDP) document *Brent Field Decommissioning Comparative Assessment Procedure* [18].

Throughout this description and the subsequent narratives on CA, the term 'performance' is used for simplicity to describe the ability of an option to result in desirable effects, either when expressed in terms of the raw data or weighted score for a particular *sub-criterion*, or the total weighted score of the *option*.

5.2.2 Comparative Assessment Criteria

All the CAs were performed following the BEIS Guidance Notes and the Shell BDP CA Procedure [18], with appropriate modification for the materials and the options under consideration. Technically feasible options were assessed using the five main BEIS criteria, derived from the comparative evaluation from Annex 2 of OSPAR Decision 98/3, namely:

- Safety
- Environmental
- Technical
- Societal
- Economic

We used the advice provided in the BEIS Guidance Notes which lists those matters which are to be considered during a CA of feasible management options. These include but are not restricted to:

- Technical and engineering aspects
- Timing
- Safety
- Impacts on the marine environment
- Impacts on other environmental compartments
- Consumption of natural resources and energy (and climate change)
- Other consequences to the physical environment
- Impacts on amenities and the activities of communities
- Economic aspects

In line with this guidance, therefore, we assessed each option's performance by dividing that criterion into more specific sub-criteria. For example, the main criterion 'Environmental' encompasses both the potential environmental impacts arising during the work programme (which is likely to be on a timescale of a few months) and the potential environmental impact arising from the long-term presence and degradation of jacket material left on the seabed. By evaluating these different risks as separate sub-criteria, we were able properly to record the performance of options in these two measures and examine how environmental impacts changed with different options. We decided that 'Safety' should be assessed using three sub-criteria, 'Environmental' using four sub-criteria and 'Societal' using three sub-criteria. The criteria 'Technical' and 'Economic' were each assessed by one sub-criterion (Table 8).

Table 8 The BEIS 5 Main Criteria and the Selected Sub-criteria used in all Brent CAs.

BEIS Main Criterion	Sub-criterion	Description
Safety	Safety risk to offshore project personnel	An estimate of the safety risk to offshore personnel as a result of completing the proposed offshore programme of work.
	Safety risk to other users of the sea	An estimate of the safety risk to other users of the sea from the long-term legacy of the structure after completion of the proposed programme of work.
	Safety risk to onshore project personnel	An estimate of the safety risk to onshore personnel as a result of completing the proposed onshore programme of work.
Environmental	Operational environmental impacts	An assessment of the environmental impacts that could arise as a result of the planned operations offshore and onshore.
	Legacy environmental impacts	An assessment of the environmental impacts that could arise as a result of the long-term legacy effects of the structure or facility after completion of the proposed programme of work.
	Energy use	An estimate of the total net energy use of the proposed programme of work, including an allowance for energy saved by recycling and energy used in the manufacture of new material to replace otherwise recyclable material left at sea.
	Emissions	An estimate of the total net emissions of CO_2 from the proposed programme of work, including an allowance for emissions from the manufacture of new material to replace otherwise recyclable material left at sea.
Technical	Technical feasibility	An assessment of the technical feasibility of being able to complete the proposed programme of work as planned.
Societal	Effects on commercial fisheries	An estimate of the financial gain or loss compared with the current situation that might be experienced by commercial fishermen as a result of the successful completion of the planned programme of work.
	Employment	An estimate of the man-years of employment that might be supported or created by the option.
	Impacts on communities	An assessment of the effects of the option on communities and onshore infrastructure.
Economic	Cost	An estimate of the total likely cost of the option, including an allowance for long-term monitoring.

5.2.3 Comparative Assessment Data

We elected to use a method of assessment that uses 'global scales' as a way of (i) providing a unit-less scale on which to compare different sub-criteria (e.g. safety risk to other users of the sea and environmental impact of operations) and (ii) providing a way to compare the performance of the options across all of facilities within the BDP. The procedure for generating the global scales involved the following three steps:

1. For each sub-criterion the data for each option for each facility were generated using the same method of calculation. For example, if the cost estimate for a Brent Alpha jacket option had been generated using current vessel day rate estimates and ignoring any effect of inflation that might be expected to occur between now and the execution of the work, then the cost of a GBS option was calculated using these same assumptions.
2. Considering each sub-criterion in turn, the 'best' and 'worst' data from any option and for any facility was used to fix the top and bottom of the scale for that sub-criterion. For example, the option with the highest Potential Loss of Life (PLL) is the least desirable and therefore marks the bottom of the scale and is therefore '0' on the scale. The option with the lowest PLL is the most desirable and is therefore '1' on the scale. This resulted in a 'global scale' spanning the whole data range for each sub-criterion.
3. We then arithmetically transformed the data for all other options onto these global scales. Thus, a single global scale for each sub-criterion could be used and applied consistently in all of the CAs for all of the facilities. This process of transformation converted the different sub-criteria into a common measure which then allowed us more easily and robustly to examine and compare the overall performances of the options.

For the majority of the sub-criteria listed in Table 8 we generated numerical data such as values for PLL, energy use (in gigahoules, GJ) and cost (£); the methods used to obtain these data are described in the CA Procedure [18].

The estimation of safety risk was an important aspect of this work, and the following description of the derivaion and application of PLLs is taken from our CA procedure [18]:

> 'PLL is one of the prime outputs of a quantitative risk assessment (QRA). It provides a measure of cumulative risk which is directly dependent on the number of people exposed to the risk and the duration of the activity. In this context it therefore provides a simple measure of the relative safety risk between project personnel who may be engaged in operations to complete an option, and third-parties who may be exposed to the long-term risk from the planned end-point of the option. PLLs can and are therefore used in the overall decision-making process (such as in a CA) along with considerations of the environmental impacts, costs and other criteria.
>
> There are absolute values of risk tolerability used by authorities such as the Health and Safety Executive (HSE). For example, risks between 1×10^{-1} and 1×10^{-3} are considered intolerable and risks between 1×10^{-3} and 1×10^{-6} are in the region where it has to be shown that the risks are tolerable and are As Low As Reasonable Practicable (ALARP). Within a decision-making process such as a CA, however, it should be stressed that PLL figures should not be used as an absolute measure of risk because the total PLLs here represent the cumulative predicted risk for different groups of people and activities, and there is no analysis of the options to determine the effects of any risk-reduction measures that would or could be applied. Such detailed analysis occurs once an option has been selected, and it is at this point that the specific PLLs for a given activity could be compared with the HSE thresholds above'.

The assessment of four of the sub-criteria - 'operational environmental impacts', 'legacy environmental impacts', 'technical feasibility' and 'impact on communities' - required the use of expert judgements on the performance of the options, and therefore had no fixed numerical scale against which to score the options. Following advice from the independent consultancy Catalyze, who are Multi-Criteria Decision Analysis (MCDA) experts, we established a methodology for ensuring that the scores provided by the experts could be used to create a global scale that maintained the mathematical accuracy of the performances of the options relative to each other on the global scale.

For the sub-criterion 'Technical Feasibility' (TF), the owners' technical experts attended a series of facility-based workshops to discuss and score each of the options under consideration. An aid to scoring was developed, which listed factors which would affect the likelihood of successfully executing the option and included considerations such as the novelty of the equipment required and the susceptibility of the workscope to unplanned events. This resulted in a score on a 'local scale' (which was out of 45) and an understanding of the reasons behind this score. The engineers then assessed whether the initial scores gave a realistic and justifiable measure of the relative technical feasibility of the options, and ranked the options from best to worst. The engineers then examined the differences between each of the scores to satisfy themselves that the relative position of each option was consistent and justifiable. For example, if Option A scored 30, Option B scored 15 and Option C scored 45, then the technical feasibility of Option B was half that of Option A and the difference in technical feasibility between Option B and Option C was twice that of the difference between Option A and Option B. The engineers discussed and agreed any adjustments to the scores that they deemed necessary to ensure that the scores of the options on the local scale were correct relative to each other, and the reasons for any adjustments were recorded.

A plenary TF workshop was then held at which the technical feasibilities of the options across the facilities were discussed and compared, with the objective of agreeing an assessment for each option which was relative to and consistent with all options across all facilities. This plenary workshop was facilitated by Catalyze and observed by the Independent Review Group (IRG). In summary, using the judgement of the Plenary TF Team, the best option with respect to of technical feasibility across all of the BDP facilities was defined as '1' on the global scale. Similarly, the worst option for TF across all facilities was defined as '0' on the global scale. The best and worst options for each facility were then placed on the global scale, referring to the record of the facility-based workshops as necessary. The intermediate options (those between 'best' and 'worst') were placed onto the global scale by simple arithmetic mapping from the local scale position for each facility onto the global scale, using the 'best' and 'worst' options for each facility as reference points. The resulting option placements on the global scale were then reviewed and any further changes documented.

DNV GL assessed the potential environmental impacts that could arise from each of the options under consideration in the CA as part of their work to complete the environmental impact assessment (EIA), which is reported in the *Brent Field Decommissioning Environmental Statement* [9]. We therefore asked DNV GL to provide their expert judgement for the scoring of the two environmental impact sub-criteria and the 'impact on communities' sub-criterion. As an initial step, DNV GL reviewed the type and degree of impact for each of the options under consideration. They then discounted any impact which duplicated any other sub-criterion that had been separately assessed for the purpose of the CAs; for example, the impact under the EIA category 'Fisheries' was removed because the commercial effect on fisheries was the subject of a separate sub-criterion in the CA. This resulted in a judgement of the overall impacts arising from the execution of the different options and the reasons for each judgement, similar to the process used in the facility-based workshops held by Shell to generate scores for TF. The DNV GL scores for the environmental impacts of each option were therefore informed by the EIA, but do not necessarily directly correspond to the impact assessments presented in the ES because the EIA assessments consider each facility in turn and do not assess the magnitude of impacts across the different facilities. DNV GL then attended a plenary workshop, again facilitated by the MCDA experts and observed by both the IRG and Shell representatives. The same process as described for TF was followed for operational environmental impacts, legacy environmental impacts and impacts on communities, producing scores on a global scale for each of the three sub-criteria which reflected each option's relative position.

Ultimately the work described here resulted in a suite of data appropriate for use in the BDP CA (Table 9), and a set of global scales for each sub-criterion (Table 10).

DECOMMISSIONING OPTIONS AND THE COMPARATIVE ASSESSMENT METHOD

Table 9 The Source and Type of Data used to Assess the Performance in each Sub-criterion.

Sub-criterion	Source of Information	Type of Data	Unit
Safety risk to offshore project personnel	Internal study by Shell	Numerical	PLL
Safety risk to other users of the sea	Studies by Anatec [10, 11, 12]	Numerical	PLL
Safety risk to onshore project personnel	Internal study by Shell	Numerical	PLL
Operational environmental impacts	Score provided by DNV GL	Score	
Legacy environmental impacts	Score provided by DNV GL	Score	
Energy use	Environmental Statement	Numerical	Gigajoules
Emissions	Environmental Statement	Numerical	Tonnes
Technical feasibility	Score provided by Shell	Score	
Effects on commercial fisheries	Study by McKay Consultants [13]	Numerical	GBP
Employment	Study by McKay Consultants [14]	Numerical	Man-years
Impact on communities	Score provided by DNV GL	Score	
Cost	Internal study by Shell	Numerical	GBP

Table 10 Global Scales for each Sub-criterion used in Brent Decommissioning CAs.

Sub-criterion	Units	Best Value	Worst Value
Safety risk to offshore project personnel	PLL	0.0000	0.2640
Safety risk to other users of the sea	PLL	0.0000	0.2640
Safety risk to onshore project personnel	PLL	0.0000	0.2640
Operational environmental impacts [1]	Score	1.00	0.00
Legacy environmental impacts [1]	Score	1.00	0.00
Energy use	GJ	0	1,738,959
Emissions (CO_2)	Tonnes	1	156,726
Technical feasibility [1]	Score	1.00	0.00
Effects on commercial fisheries [2]	GBP	2,318,040	0.00
Employment	Man years	2,128	0.00
Impacts on communities [1]	Score	1.00	0.00
Cost	GBP (million)	0.00	534.14

Notes: 1. The maximum possible score for these sub-criteria is 1.0.
2. Effects on commercial fisheries measured by how much the value of landings might change from the present situation. A positive value denotes an increase and a negative value a decrease from present.

[10] Anatec, 2011. *Assessment of the safety risk to fishermen from derogated footings of the Brent Alpha steel jacket* [20].

[11] Anatec, 2017. *Assessment of safety risks to mariners from Brent GBS* [21].

[12] Anatec, 2014. *Assessment of safety risk to fishermen from decommissioned pipelines in the Brent Field* [22].

[13] Mackay Consultants, 2014. *Brent Decommissioning: Assessment of socio-economic effects on commercial fisheries* [23].

[14] Mackay Consultants, 2014. *Brent Decommissioning: Likely economic and employment impacts* [24].

5.3 Assessing the Performance of each Option

To begin our assessment and comparison of options, we decided to weight each of the BEIS 5 Main Criteria equally. Where a main criterion was represented by more than one sub-criterion, we decided that these too should be weighted equally. Table 11 shows the weightings for the criteria and sub-criteria, in a weighting scenario we have called the 'standard weighting'.

Table 11 'Standard Weights' for the BEIS Main Criteria and Sub-criteria.

Selected Sub-criteria		BEIS Main Criteria	
Description	Weight	Weight	Description
Safety risk to offshore project personnel	6.7%	20%	Safety
Safety risk to other users of the sea	6.7%		
Safety risk to onshore project personnel	6.7%		
Operational environmental impacts	5.0%	20%	Environmental
Legacy environmental impacts	5.0%		
Energy use	5.0%		
Emissions (CO_2)	5.0%		
Technical feasibility	20.0%	20%	Technical
Effects on commercial fisheries	6.7%	20%	Societal
Employment	6.7%		
Impact on communities	6.7%		
Cost	20.0%	20%	Economic

The scores from the global scales for each sub-criterion were multiplied by the standard weights and then summed to derive a total weighted score for each option. The option with the highest total weighted score was identified as the 'CA-recommended option'.

5.4 Examining the Sensitivity of the CA-recommended Option

To examine the sensitivity and take account of uncertainties of the CA recommended option, we applied five 'selected weighting scenarios' to the transformed scores, to generate new total weighted scores for each option. The selected weighting scenarios were derived after a consideration of the relative values in the global scales, and reflect our view, informed by feedback from meetings and dialogue, of the importance of the various criteria and sub-criteria to all our Stakeholders.

Table 12 lists the five scenarios we used, and Table 13 lists the resultant weights for each of the sub-criteria in each of the selected weighting scenarios as well as the 'standard weights'.

We then examined the total weighted scores in each scenario, and assessed how the scores changed, and determined if the order of the options changed in some scenarios. This resulted in the identification of the option that was the 'Emerging Recommendation'. It should be noted that this option may have been so identified because, although not necessarily always the best option in every scenario, overall it performed well in a number of the scenarios.

DECOMMISSIONING OPTIONS AND THE COMPARATIVE ASSESSMENT METHOD

Table 12 The Five Weighting Scenarios used to Assess the Sensitivity of the CA-recommended Decommissioning Option.

Scenario	Description
2	Weighted to Safety: Safety criterion weighted 40%.
3	Weighted to Environment: Environmental criterion weighted 40%.
4	Weighted to Technical: Technical Feasibility criterion weighted 40%
5	Weighted to Societal: Societal criterion weighted 40%.
6	Standard weighting without Economic.

Table 13 Weighting Applied to Sub-criteria in Selected Weighting Scenarios.

Sub-criteria	Weighting Scenario					
	1	2	3	4	5	6
Safety risk to offshore project personnel	6.7%	13.3%	5.0%	5.0%	5.0%	6.7%
Safety risk to fishermen	6.7%	13.3%	5.0%	5.0%	5.0%	6.7%
Safety risk to onshore project personnel	6.7%	13.3%	5.0%	5.0%	5.0%	6.7%
Operational environmental impacts	5.0%	3.8%	10.0%	3.8%	3.8%	5.0%
Legacy environmental impacts	5.0%	3.8%	10.0%	3.8%	3.8%	5.0%
Energy use	5.0%	3.8%	10.0%	3.8%	3.8%	5.0%
Emissions (CO_2)	5.0%	3.8%	10.0%	3.8%	3.8%	5.0%
Technical feasibility	20%	15.0%	15.0%	40.0%	15.0%	20.0%
Effects on commercial fisheries	6.7%	5.0%	5.0%	5.0%	13.3%	6.7%
Employment	6.7%	5.0%	5.0%	5.0%	13.3%	6.7%
Impact on communities	6.7%	5.0%	5.0%	5.0%	13.3%	6.7%
Cost	20%	15.0%	15.0%	15.0%	15.0%	20.0%[1]

Note 1. In this weighting scenario, to preserve the spread of the weightings across the other sub-criteria, the sub-criterion 'cost' retains a weighting of 20% but all the options are accorded a cost of 'nil'; this means that cost does not contribute to the overall weighted score of an option.

Key to Weighting Scenarios

Scenario	Description
1	Standard weighting; equal weighting to the BEIS 5 Main Criteria
2	Weighted to Safety
3	Weighted to Environmental
4	Weighted to Technical
5	Weighted to Societal
6	Standard weighting without Economic

5.5 Identifying the Recommended Option

We used all the above assessments and sensitivity analyses to compare and contrast the performances of the options being assessed by means of CAs, in order to identify our 'Recommended option'. The results of our comparison and the reasons for our recommendations were then presented in a narrative and in two types of diagram. Firstly, the total weighted scores of the options are presented in coloured charts such as the example in Figure 11. These show the relative contributions of each of the sub-criteria to the overall performance of the option; the larger the coloured segment, the greater the contribution that sub-criterion has made. Secondly, to aid our examination of the important sub-criteria (the 'drivers') and enable our assessment of the trade-offs between sub-criteria, we prepared 'difference charts', as shown in Figure 12. The bars show the difference in the total weighted score between the options in each of the sub-criteria; the longer the bar, the greater the difference. In this example, green bars show where Option 2 is better than Option 1 and red bars show where Option 1 is better than Option 2. The dotted line bars show the *maximum* size of the difference that there could be between any two options in each sub-criterion.

Figure 11 Example of a Bar Chart Showing the Total Weighted Scores of Three Options.

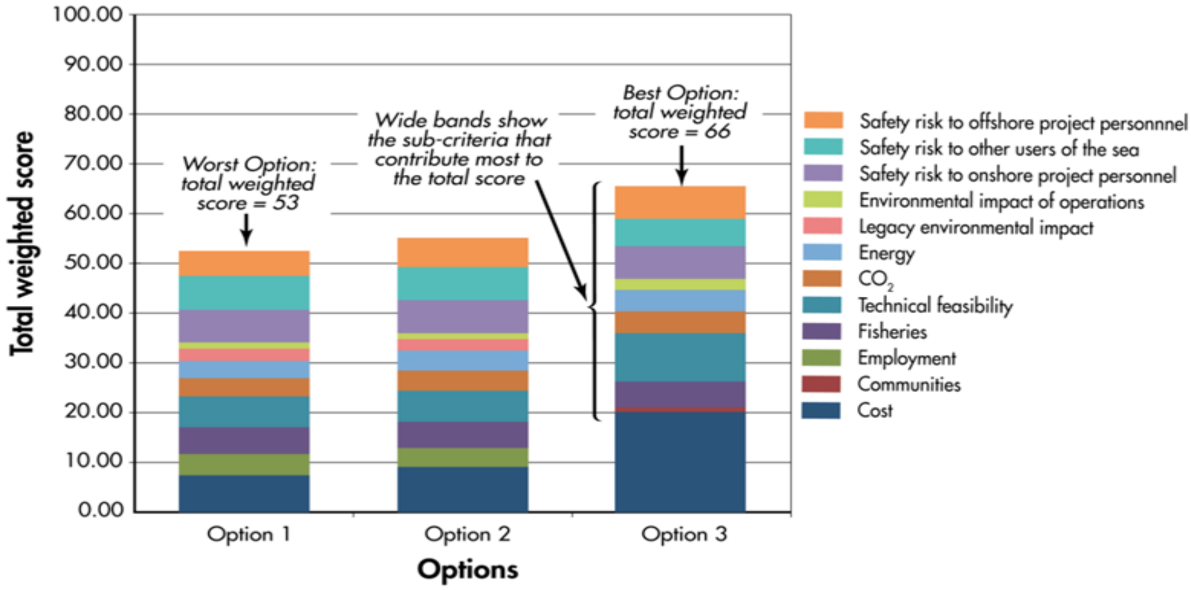
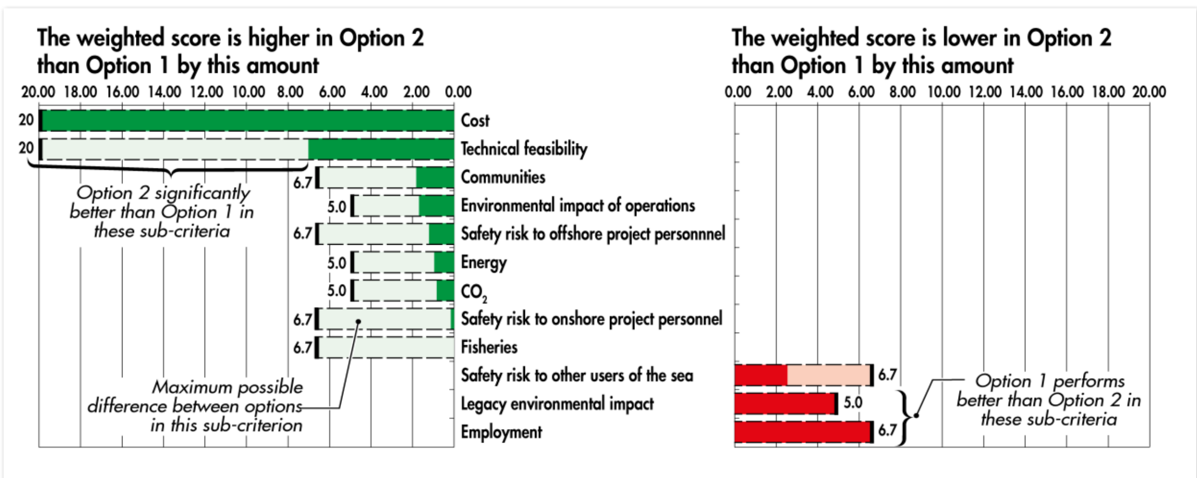


Figure 12 Example of a Difference Chart Showing the Difference between Two Options in each of the Sub-criteria.



6 FEASIBLE DECOMMISSIONING OPTIONS FOR BRENT ALPHA JACKET

6.1 Reuse of Brent Alpha Topside

We have determined that no technically feasible option for the Brent Alpha jacket would require the continuing presence of the topside. The options for the Brent Alpha jacket therefore assume that the topside has been removed, and the removal of the topside does not form any part of the programme of work for the Brent Alpha jacket.

The topsides of all four Brent platforms are not subject to any CA, and they will be removed and returned to shore for dismantling and recycling as described in the Brent Field Topsides DP [7] and the *Brent Topsides Decommissioning Technical Document* [25]. The Bravo and Delta topsides have already been removed, and the Alpha topside was removed in June 2020.

6.2 Reuse of the Brent Alpha Jacket

Opportunities for the re-use of the Brent Alpha jacket were examined during the preparation of the FFDP. The specific opportunities examined for the jacket in the FFDP and associated reviews were:

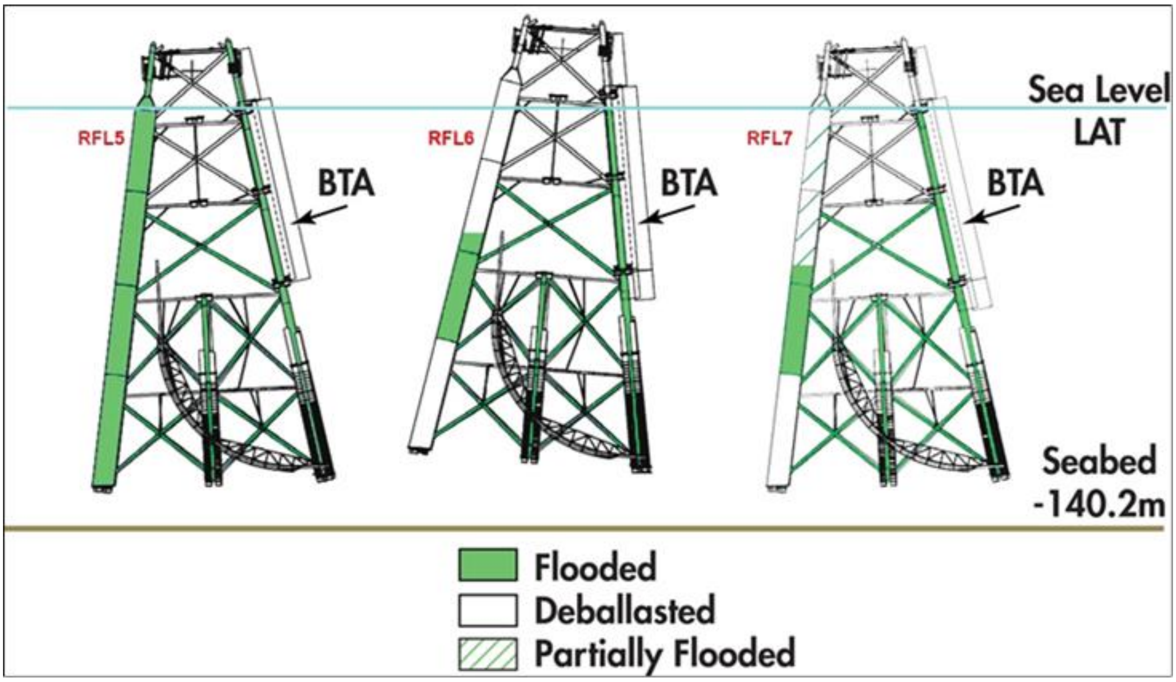
1. Use of the jacket in its current location or a new location to produce oil and gas.
2. Use of the jacket in its current location as part of a Carbon Capture and Storage (CCS) project.
3. Use of the jacket in its current location or a new location as a routing station or hub for offshore renewable energy.
4. Use of the jacket in its current location or a new location as a facility for communications
5. Use of the jacket in its current location or a new location as an offshore artificial reef.
6. Use of the jacket in its current location or a new location, as an offshore facility for marine research.
7. Use of the jacket in its current location or a new location as an alternative community.

No opportunities have been identified to use the Brent Alpha jacket anywhere for the continued production of oil and gas, and the Brent Field is unsuitable for use in a CCS project. It was also concluded that no other re-use possibilities are practically feasible and economically viable. Consequently, no re-use option for any purpose for the Brent Alpha jacket was taken forward into the numerical stage of the CA process.

6.3 Refloating the Whole Jacket in One Piece

The Brent Alpha jacket was not designed to be refloated, but because the final stage of the original installation process involved the ballasting of the pontoon legs and submergence of the floating jacket, we examined whether it might be possible to reverse this process and remove the jacket in one piece by refloating. In their report *Brent Alpha Jacket Removal Refloat Feasibility Study* [26], GL Noble Denton investigated how the jacket could be made buoyant by dewatering the original buoyancy chambers in the pontoon legs and adding additional buoyancy using Buoyancy Tank Assemblies (BTAs). Figure 13 illustrates a possible configuration for refloating the whole jacket.

Figure 13 Possible Configuration for Refloating the Brent Alpha Jacket.



In addition to the need to release the jacket from the seabed by severing the piles, described in more detail in Section 6.9, the following technical issues would have to be overcome in any option to refloat the jacket:

- Strengthening the jacket legs so that BTAs could be attached.
- Installing strong lifting points for the attachment of the BTAs.
- Re-establishing some of the water-tight compartments in the pontoon legs to give essential extra buoyancy.
- Ensuring that legs could withstand and sustain the gas pressure required to displace internal water to permit the jacket to be floated even with BTAs.
- Controlling ascent and trim with the remains of piles and their grout in place.
- Developing a safe and cost-effective way of dismantling the jacket at a deep water site nearshore.

The original buoyancy chambers in the pontoon legs were ruptured during pile-driving, and our studies have shown that it is very unlikely that they could be repaired to re-establish their integrity. However, some buoyancy would be needed in the original buoyancy chambers, even with the addition of external BTAs. Because the original buoyancy chambers cannot be re-instated, we have concluded that it is not technically feasible to refloat the whole Brent Alpha jacket.

6.4 Lifting the Whole Jacket in One Piece with the SLV

Having made the decision to remove the topside as single lifts using the SLV *Pioneering Spirit*, we examined if the whole jacket could be removed in one piece by this vessel. As described in the Brent Alpha Jacket TD [12], we concluded that because of the size and weight of the jacket with its piles, the strength and integrity of the structure, and the complexity of attaching suitably strong and secure lifting points, it was not technically feasible to remove the whole of the Brent Alpha jacket in one piece using the SLV or any other type of HLV.

There is no technically feasible method for removing the whole of the Brent Alpha jacket in one piece. All options, including the use of the SLV *Pioneering Spirit*, would require the jacket to be removed in two or more pieces, beginning with the removal of the upper jacket down to -84.5 m LAT. The recently-commissioned semi-submersible crane vessel (SSCV) *Sleipnir*, which we have contracted to lift the upper jacket, has a maximum nominal lifting capacity of 20,000 tonnes. Recent work by Heerema Marine Contractors (HMC) has confirmed that the whole jacket, from the topside cut line to the mudline, including the lengths of conductors, piles and grout, would exceed this capacity [31].

Consequently, all options for decommissioning the Brent Alpha jacket would necessarily have as their starting point the removal of the upper part of the jacket. We confirm that the upper part of the Brent Alpha jacket will be removed to shore for dismantling and recycling, and our CA considers only the technically feasible options for the decommissioning of the footings. The decommissioning options for the Brent Alpha jacket thus focus on options for decommissioning the footings; the upper jacket would be removed regardless of which option was selected for the footings, and does not form any part of the programme of work for the footings.

6.5 Brent Alpha Footings

OSPAR Decision 98/3 states that if applying for derogation for a steel jacket, only the footings may be left in place. OSPAR defines the footings as '*those parts of a steel installation which are below the highest point of the piles which connect the installation to the seabed*'.

On Brent Alpha, the external pile sleeves extend to a height of 41 m above the seabed, but some of the piles within them are not driven to their full depth and protrude up to 10 m above the sleeve. Consequently the top of the pile (the 'pile stick-up') is approximately 51 m above the seabed, which is approximately 89 m below LAT. Considering the way that the vertical and vertical-diagonal members are attached to the legs at about this depth, and the logistics of manoeuvring a DWC machine in this area, we determined that the most suitable depth for cutting the jacket as close as possible to the top of the pile stick-up was -84.5 m LAT. Table 14 summarises the masses of materials that will be in and on the footings after the removal of the upper jacket.

Table 14 Inventory of Materials on Brent Alpha Footings.

Item or Component	Material and Estimated Mass (Tonnes)			
	Steel	Grout	Marine Growth	Aluminium/Zinc
Jacket Footings	8,978	0	888 (1)	155
30 inch conductors	809 (2)	720 (3)	245	0
20 inch casing	539	0	0	0
13 3/8 inch casing	361	0	0	0
Piles	4,161 (4)	4,484 (5)	0	0
Total	14,848	5,204	1,133	155

Notes:

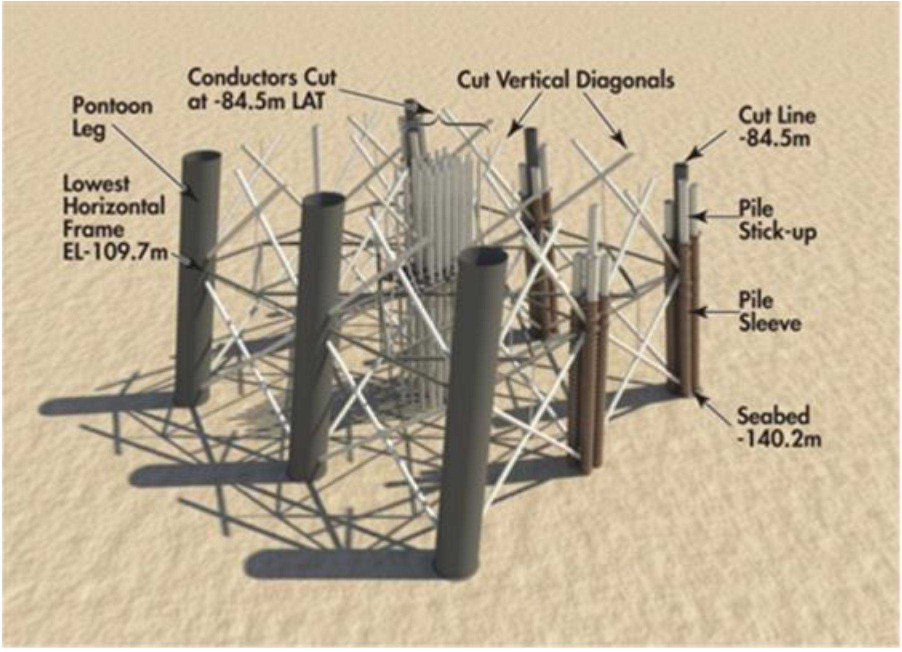
1. This is a pro rata estimate based on visual surveys not measurements, and is subject to considerable uncertainty. There is marine growth on the jacket, the anodes, the conductors and the outsides of the pile sleeves.
2. This is the estimated mass of the 30 inch conductors from the -84.5 m cut line to the presumed cut depth for footings removal of 3 m below the seabed.
3. This is the estimated total mass of grout between the 30 inch conductor and the 20 inch casing, and between the 20 inch casing and the 13 3/8 inch casing.
4. This is the estimated mass of the steel piles from the -84.5 m cut line to the presumed cut depth for footings removal of 3 m below the seabed.
5. This is the estimated total mass of grout in the pile bores and the pile sleeve annuli above the presumed cut depth for footings removal of 3 m below the seabed.

6.6 Options for the Brent Alpha Footings

6.6.1 Introduction

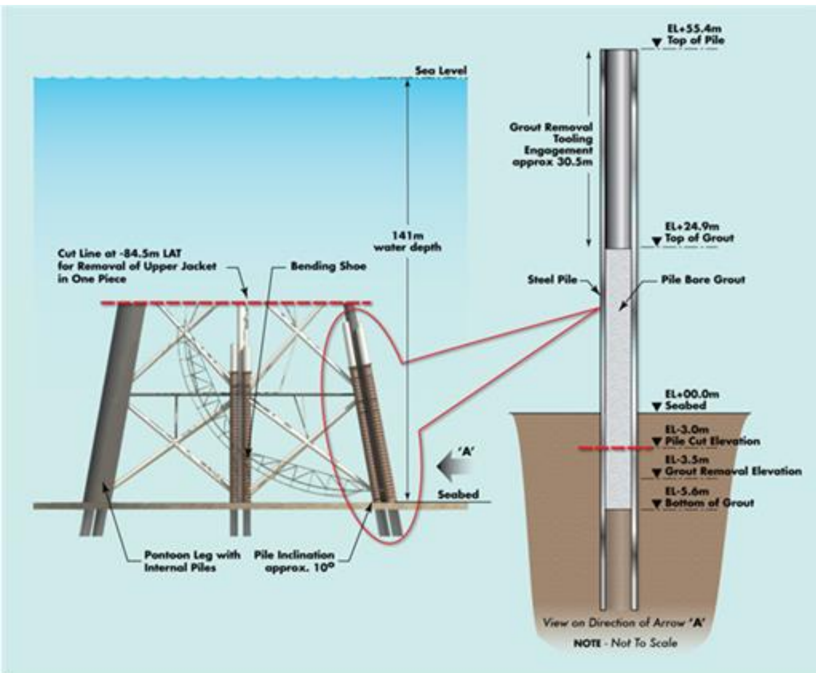
The starting point for all the options for the Brent Alpha footings would be that the upper jacket and the conductor sections have been removed down to -84.5 m LAT (Figure 14).

Figure 14 Condition of the Brent Alpha Footings after Removal of the Upper Jacket.



The footings are fixed to the seabed by 32 hollow steel piles filled with grout, and these would have to be severed at 3 m below the seabed if the footings were to be removed. The piles could be cut *externally*, after excavating a large pit around each leg, or *internally*, after drilling out the grout inside the pile (Figure 15).

Figure 15 Typical Arrangement of a Pile Bore Grout Plug in the Brent Alpha Footings.



6.6.2 Removing the footings using the SLV

In light of the fact that we have already committed to removing the topside using the SLV *Pioneering Spirit*, we examined whether this vessel or indeed any other type of HLV, could remove the footings of the Brent Alpha jacket in one piece. The technical challenges associated with such an operation are described in detail in the Brent Alpha Jacket TD [12], and summarised below.

The removal of the upper jacket would give direct access to the pile stick-ups, which would permit the deployment and attachment of subsea equipment for removing the pile bore grout (to reduce weight) and then cutting the piles internally by Abrasive Water Jetting (AWJ). A specially-constructed lifting frame would be attached to the cut ends of the legs and connected to the vessel's lifting gear. The footings would then be lifted clear of the seabed and cuttings pile, and placed on a cargo barge for transportation to shore.

The footings include a single horizontal framing that carries the conductor guide frame, through which the conductors pass; therefore, despite its mass (estimated to be 17,778 tonnes after the removal of the lower conductors and casings), the footings would be a flimsy structure, prone to warping. Because of the presence of talon connectors and repair clamps above the guide frame, the footings could not be lifted clear of the conductors without either severing them, or separating the guide frame from the footings, which would weaken the footings further.

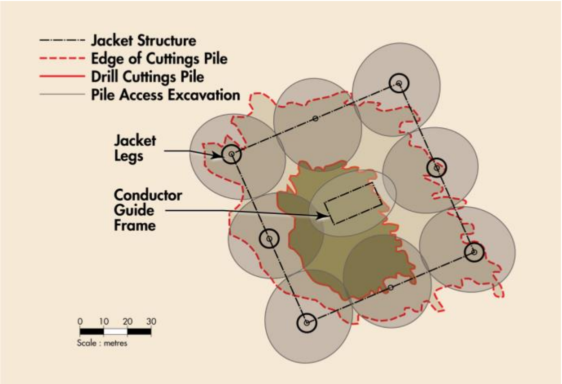
An assessment of this conceptual programme of work has shown that there are several important technical issues that would have to be resolved before this option could be considered feasible. These relate to the strength of the footings, the need to separate the footings from the lower conductors before lifting, the attachment of long lifting strops, the fixing of lifting attachments either to the top or bottom of the legs, the lifting-height capacity of the HLV, and the provision of a barge large enough to accommodate the footings.

Following this review, we have concluded that the conceptual programme of work for the removal of the footings in one piece by SLV or other HLV has too high a risk of technical failure, and consequently we have concluded that it is not a practically available option. In addition, we do not think that this option would offer any technical or commercial advantages over the more conventional approach of removing the footings in large sections using an HLV or an SSCV.

As a result of the above reviews, we have concluded that options for the removal of the footings would involve cutting the footings into sections on the seabed, and lifting the sections to the surface by an HLV, most probably an SSCV. Consequently, there are three options for the Brent Alpha jacket footings, as summarised in Table 15.

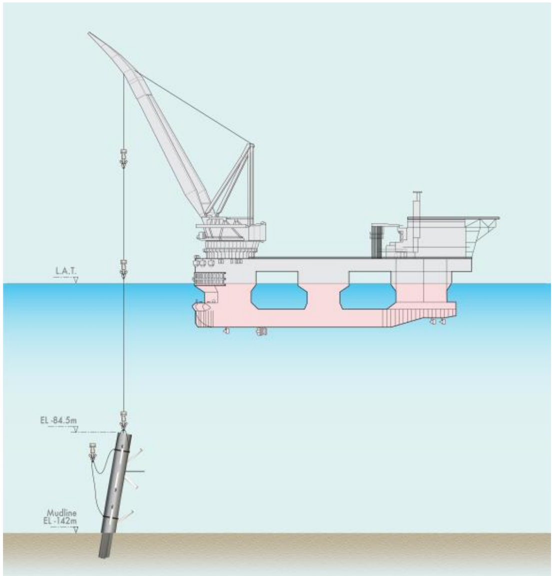
FEASIBLE DECOMMISSIONING OPTIONS FOR BRENT ALPHA JACKET

Table 15 Summary of Options for the Brent Alpha Footings.



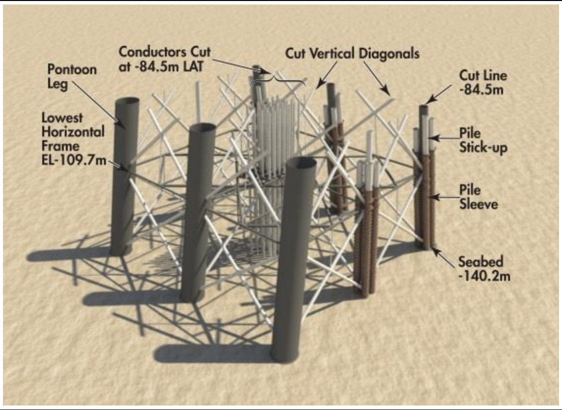
Option 1. Complete removal after external pile cutting. After removing the majority of the drill cuttings pile and excavating 4 m deep pits around each leg, all the piles would be cut externally 3 m below the seabed using a DWC machine. The footings would be systematically cut into large sections, which would be lifted to the surface by an HLV and transported to shore for further dismantling and recycling. The former site of the Brent Alpha jacket would be left clear of platform components and debris, and the drill cuttings pile would have been removed.

Locations and sizes of pits to permit external pile-cutting



Option 2. Complete removal after internal pile cutting. The pile-bore grout would be drilled out, and the piles cut internally 3 m below the seabed using an abrasive water jet. The footings would be systematically cut into large sections, which would be lifted to the surface by an HLV, and transported to shore for further dismantling and recycling. The former site of the Brent Alpha jacket would be left clear of platform components and debris, and the seabed drill cuttings pile would be left in place and largely undisturbed.

Removal of a jacket leg after cutting the piles internally



Option 3. Leave in place. The footings would be left in place in the condition attained after the removal of the upper jacket, and no further operations would take place. The footings would corrode and eventually collapse completely over a period of about 500 years. The seabed drill cuttings pile would be left in place.

Brent Alpha jacket footings after removal of upper jacket to -84.5 m LAT

6.7 Issues and Concerns Raised by Stakeholders

For the technically feasible options for the Brent Alpha footings, the main issues and concerns raised by stakeholders during the programme of stakeholder engagement were:

- The principle of leaving a clean seabed.
- Effects of underwater cutting and lifting (especially noise on marine mammals).
- Disturbance to the cuttings pile and effects on the benthos.
- Risk of dropped objects/loss of footings at sea or nearshore.
- Effects on communities of onshore dismantling and disposal.
- Benefits of recycling.
- Safety risk to fishermen from remains left offshore.
- Creation of debris from remains left offshore.
- Continued loss of access to fishing grounds from remains left offshore.

Specific stakeholder concerns about jacket decommissioning, and our responses, are presented in Section 11.4.

6.8 Interaction with the Seabed Cuttings Pile

We performed two CAs for the Brent Alpha jacket footings. The first examined options for the footings alone, without consideration of the presence of the seabed drill cuttings pile. The second examined options for the footings in combination with the most appropriate option for the management of the cuttings pile. Options for the management of the Brent Alpha cuttings pile are described and assessed in detail in the Drill Cuttings TD [14]. Table 16 lists the technically feasible options that were assessed.

Table 16 The Technically Feasible Decommissioning Options for the Brent Alpha Footings and the Brent Alpha Cuttings Pile, which were Subjected to CA.

Installation or Item	Feasible Options Identified for Comparative Assessment
Brent Alpha steel jacket footings, after removal of topside and upper jacket	1. Complete removal to shore, after excavating pits and cutting the piles externally.
	2. Complete removal to shore after drilling out the pile bore grout and cutting the piles internally.
	3. Leave in place.
Brent Alpha seabed cuttings pile	1. Remove, treat on platform, discharge treated material to sea.
	2. Remove, treat all material onshore.
	3. Remove, dewater, treat solids onshore.
	4. Remove, inject down hole at new remote well.
	5. Leave in place.

FEASIBLE DECOMMISSIONING OPTIONS FOR BRENT ALPHA JACKET

As a result of a consideration of the practically available options for the jacket footings and the seabed drill cuttings pile, we have determined that the recommended combined options would be as shown in Table 17. In summary, if the footings were to be removed by external pile-cutting, all of the drill cuttings pile would have to be displaced to allow the piles to be cut, and the recommended option for this would be 'retrieve and treat onshore', in which the cuttings would be dredged as a slurry, collected by a vessel and taken to shore, and treated and disposed of onshore. If the jacket footings were to be removed by internal pile-cutting, or if they were to be left in place, the recommended option for the cuttings pile would be 'leave in place' since this drill cuttings pile falls below both of the OSPAR thresholds.

Table 17 Recommended Combination of Options for Brent Alpha Jacket Footings and Seabed Drill Cuttings Pile.

Combined Option	Option for Footings	Option for Drill Cuttings Pile
1. Complete removal of footings after removing the cuttings pile.	Complete removal with external pile-cutting	Retrieve and treat onshore
2. Complete removal of footings leaving the cuttings pile in place.	Complete removal with internal pile-cutting	Leave in place
3. Leave footings and cuttings pile in place.	Leave in place	Leave in place

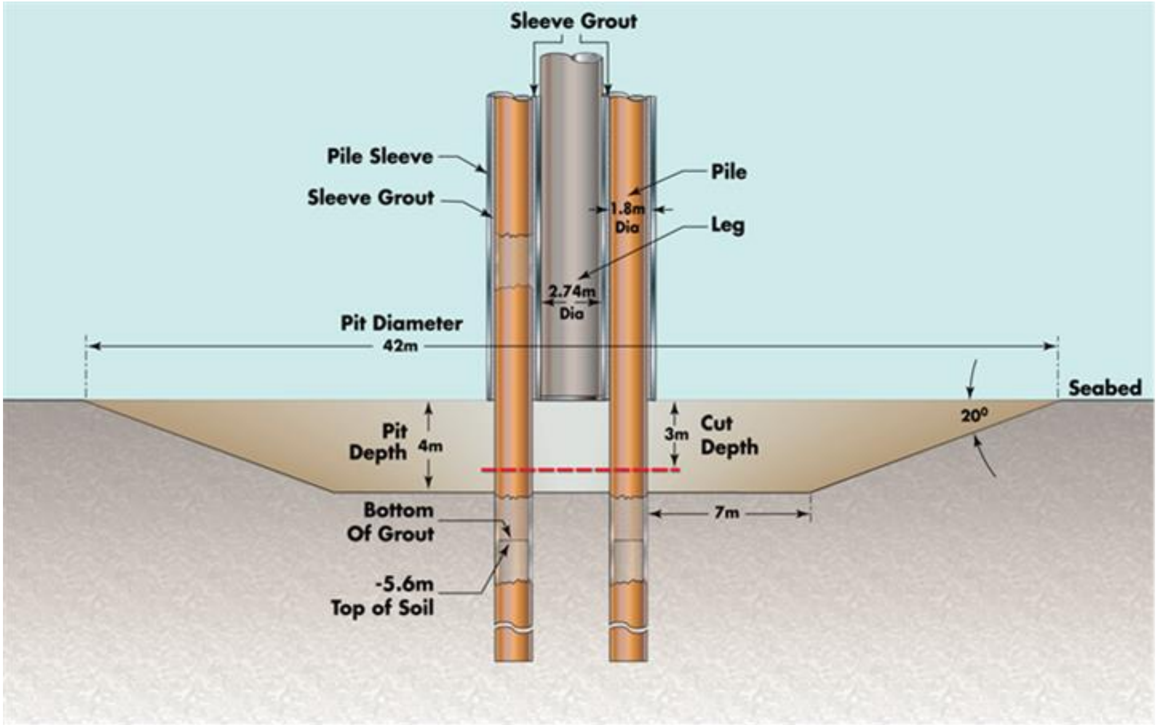
6.9 Technical Issues for Removing the Footings

The main technical issue associated with the removal of the Brent Alpha footings is the cutting of the steel piles anchoring the structure to the seabed.

In Option 1, the piles could be cut externally by DWC after excavating pits around each leg. Because of the arrangement and spacing of the external piles on the Row B and Row AB legs, and the diameter of the Row A pontoon legs, the piles would have to be cut individually in four separate deployments of the DWC around each leg. In order to achieve a cut at 3 m below the seabed, the DWC machine would have to be positioned at the bottom of a 4 m deep pit excavated around the leg; and to provide sufficient space for manoeuvring the DWC, the bottom of each pit would have to be a flat surface approximately 7 m wide from the side of the steel piles (Figure 16).

The angle of repose of the soil at Brent Alpha has conservatively been assumed to be 20°. On this assumption, and given the constraints and requirements mentioned above, we have calculated that the pits around each leg would have to be approximately 42 m in diameter (Figure 16, which shows only two of the four piles on the leg). We estimate that 2,969 m^3 of clean seabed sediment would have to be excavated around each of the eight legs, giving a total of 23,751 m^3 of clean seabed material to be excavated. This would be in addition to the 6,300 m^3 of drill cuttings, and the assumed 1,425 m^3 of contaminated seabed sediment immediately beneath the drill cuttings pile, that would also have to be removed.

Figure 16 Cross-section through a Typical Pit Excavated Around each Leg.



There are several existing tools and systems, for example the 'Scanmachine™' and the 'Scandredge™', that could be used to excavate the pits and relocate material either onto the adjacent seabed or to a surface vessel. The pits around each leg would be excavated in turn and the clean excavated soil would be used to backfill the previous pit. There would have to be a considerable period of planning and trialling before attempting to cut the large diameter piles of the Brent Alpha footings.

In Option 2 the piles would be cut internally by AWJ after drilling out the pile-bore grout. The drilling method is similar to conventional well drilling in hard clay or rock, and would be performed using a drill string consisting of drill pipe and a Bottom-hole Assembly (BHA). The BHA provides weight and stabilises the drill bit attached to the tip of the BHA. The drill bit is rotated in the conventional way and is provided with roller cutters which grind away the grout. Because the piles on Brent Alpha are inclined in line with the legs, the drill rig would have to be inclined in order to access the pile through the pile guides. Figure 17 shows such an arrangement on top of a pile above the sea. For the Brent Alpha footings, the removal of the upper jacket would facilitate access and make it easier to attach this equipment to the top of the piles.

Figure 17 Pile-Top Drill Rig for Battered Piles.

(Source Seacore)

There is a concern that drilling the grout could vibrate the pile within the sleeve, and break the grout bond between the outside of the pile and the inside of the pile sleeve. This would loosen the pile and allow it to fall onto the seabed as the section of footings was being lifted, or to jam partially out of the sleeve in such a way as to make it difficult to load the footings onto the cargo barge. Existing pinning techniques could, however, be used to secure the piles in place. Any pinning operation would have to be performed after the removal of the pile bore grout and internal cutting because the pin(s) would restrict or prevent access for this equipment.

Once the grout plug had been removed, an internal AWJ cutter could be deployed inside the pile to cut through the steel wall of the pile. Clearly, the stability of the jacket footings would have to be understood when determining the sequence of cutting the piles; the Brent Alpha jacket has minimal mud mats[15] and no horizontal bracing[16] members resting on the seabed. The removal of the upper jacket would, however, reduce the weight on the piles and the turning moment caused by wave and current action, and the on-bottom stability of the footings would thus be greater than that of the whole jacket after topside removal. If the leg sections were removed in sequence it is very likely that with careful planning the remaining footings (comprising the untouched legs, intact piles and cut bracings) would stay stable and secure on the seabed. As with Option 1, a considerable period of planning and trialling would be required before attempting this operation offshore.

There are no technical issues associated with Option 3. No further offshore operations would be performed after the removal of the upper jacket.

[15] Mud mats are horizontal steel structures fitted to the bases of legs to spread the load of a jacket onto a larger area of seabed.

[16] The bracings are the horizontal, diagonal and vertical diagonal hollow steel members linking jacket legs.

Intentionally left blank

7 SPECIFIC STUDIES TO INFORM THE CA FOR BRENT ALPHA JACKET FOOTINGS

7.1 Introduction

Several specific studies were completed to inform the CAs for the Brent Alpha jacket footings and these are summarised below. These studies were in addition to (i) the more generic studies performed for all CAs; and (ii) the technical and engineering studies already cited in the foregoing descriptions of the Brent Alpha jacket and the assessments of potential re-float and removal options.

7.2 Assessment of Safety Risks to Other Users of the Sea

If the footings were left in place they would present a long-term snagging risk for commercial fishermen working in the Brent Field. The specialist consultants Anatec completed a detailed assessment of the likelihood that fishing gear might snag on the footings or their remains, and that such snagging incidents might result in the injury or death of members of the crew. Their results are presented in the report *Assessment of safety risk to fishermen from derogated footings of the Brent Alpha steel jacket* [20]. The risk analysis used 10 years' of incident data from the Marine Accident Investigation Branch (MAIB). It also used the results of a study by the owners on the possible longevity and degradation of the footings, described in Section 7.3, to take into consideration the potential increase in risk to fishermen from partially detached members and weakened leg walls that would not be able to resist the impact of bottom-towed trawling gear.

Anatec determined that the snagging risk may arise from the interactions of different types of pelagic and demersal[17] fishing gear, and that the risks were different for different types of gear. Anatec found that safety risks changed over time as a result of changes in the height of the footings above the seabed and changes in the areal extent (footprint) of the collapsing footings on the seabed.

Table 18 shows the estimated total PLL for each phase of degradation for each type of gear, the total PLL for each phase, the average annual PLL for each phase, and the total PLL and average annual PLL for the whole period of degradation. With respect to the calculation of PLLs, and the results in Table 18, it is noted that PLLs must only be used in a comparative way to rank the relative risks of the two options for the footings.

The total estimated PLL for fishermen for the predicted 500 year lifespan of the footings is 58.8×10^{-3}, which equates to an average annual PLL from all types of fishing gear of 0.118×10^{-3}. The average annual PLLs for any type of gear in any degradation phase range from 0.145×10^{-3} (for demersal trawling in Phase 3) to 0.0000833×10^{-3} (for pelagic trawling in Phase 3). The majority of risk to fishermen (88%) is associated with demersal trawling, as a result of (i) the relatively high level of trawling activity in the area and, (ii) the increase in risk as the footings degrade and cover a slightly larger area on the local seabed. The risk for pelagic trawlers decreases over time as the footings degrade and decrease in height, and are thus increasingly less likely to snag fishing gear that is being towed in mid-water, between the surface and the seabed.

[17] In pelagic fishing the nets are deployed in the water column and in normal operation would not come into contact with the sea bed. Demersal fishing uses nets deployed on or near the seabed.

Table 18 PLL for Types of Fishing Gear during Different Phases of the Degradation of the Brent Alpha Jacket Footings.

Fishing Gear Type	Phase of Degradation and Duration (Years)				Lifetime of Footings
	Phase 1 0 to 30	Phase 2 30 to 50	Phase 3 50 to 200	Phase 4 200 to 500	
Demersal trawler	3.14×10^{-3}	2.30×10^{-3}	2.17E $\times 10^{-2}$	2.43×10^{-2}	5.18×10^{-2}
Annual average	1.05×10^{-4}	1.15×10^{-4}	1.45×10^{-4}	8.10×10^{-5}	1.04×10^{-4}
Pelagic trawler	7.81×10^{-5}	3.27×10^{-5}	1.25×10^{-5}	1.20×10^{-3}	1.32×10^{-4}
Annual average	2.60×10^{-6}	1.64×10^{-6}	8.33×10^{-8}	4.00×10^{-6}	2.64×10^{-7}
Pair trawler	3.45×10^{-4}	2.33×10^{-4}	2.20×10^{-3}	2.46×10^{-3}	5.24×10^{-3}
Annual average	1.15×10^{-5}	1.17×10^{-5}	1.47×10^{-5}	8.20×10^{-6}	1.05×10^{-5}
Purse seiner	1.42×10^{-4}	9.44×10^{-5}	7.08×10^{-4}	7.10×10^{-4}	1.65×10^{-3}
Annual average	4.73×10^{-6}	4.72×10^{-6}	4.72×10^{-6}	2.37×10^{-6}	3.30×10^{-6}
All gears	3.71×10^{-3}	2.66×10^{-3}	2.46×10^{-2}	2.87×10^{-2}	5.88×10^{-2}
Annual average	1.24×10^{-4}	1.33×10^{-4}	1.64×10^{-4}	9.57×10^{-5}	1.18×10^{-4}

7.3 Degradation and Collapse of the Brent Alpha Footings

A specific study was undertaken to estimate the longevity of any footings that might be left in place, and the results are presented in the report *Degradation and longevity study* [27]. The study identified and attempted to quantify the physical and chemical processes that would begin to degrade the footings after completion of any partial removal programme, and thus to determine how long the footings might remain in existence.

Once the remaining mass of sacrificial anodes has completely wasted, free corrosion will begin on the external faces of the legs and members. In the well-oxygenated but relatively cool waters of the Northern North Sea (NNS), a single-sided corrosion rate of between 0.1 mm and 0.3 mm per year might be experienced in the depth range 84 m to 140 m. The weight-loading and hydrodynamic stresses on the footings would be reduced after removal of the topside and upper jacket, and it is estimated that at least 50% of the wall thickness of a member would have to be corroded away before the member is likely to fail under normal metocean conditions. When the steel walls have been pierced by localised through-wall corrosion, the interior of legs and members will be increasingly exposed to oxygenated seawater, and the inside faces of these structures will also begin to corrode.

Lighter members and appurtenances may be expected to fail and begin to fall from the structure after approximately 30-40 years. The main legs, nodes and pontoon legs would last much longer, even after the loss of the structural support provided by the light members, and it is estimated that it might take up to 250 years before the main legs begin to collapse. In particular, the presence of the pile bore grout and the pile sleeve annuli grout is expected to increase the longevity of the internal piles in the pontoon legs. These internal piles may only start to corrode when the pontoon legs themselves have become extensively perforated due to corrosion and the pile sleeve annulus grout had then begun to degrade and fail significantly, such that oxygenated seawater reached the outside of the piles. Finally, after approximately 250 years, it is predicted that the only structures left standing upright on the seabed will be the hollow steel piles (wall thickness 48 mm) and the bases of the large diameter pontoon legs containing the internal piles and grout. All other material will have fallen onto the seabed and the cuttings pile, and will be present as a mass of corroded steel and broken grout. Depending on the stabilising effects of the grout, parts of the foundation piles may remain protruding from the seabed for more than 500 years.

7.4 Degradation and Longevity of Conductors

The footings include the lower parts of the conductors, which are 25.4 mm thick hollow steel tubes. After the removal of the upper jacket, the conductors in the footings will be held in place by the single horizontal framing at -107.9m LAT and the buried sections of conductor which are grouted into the seabed. In response to a specific comment during the OSPAR Consultation, we engaged the independent engineering consultancy Atkins to examine in detail how the conductors might degrade, and whether their degradation would have any effect on the overall nature or rate of the degradation of the footings, or on the risk posed by the remains of the footings to other users of the sea.

In their report *GBS and Brent Alpha Conductor Degradation Study* [28], Atkins determined that the conductors would be likely to corrode at about the same rate as other steel components in the footings of approximately the same thickness. Corrosion would initially be single-sided because of the lack of oxygenated seawater inside the conductors, but some double-sided corrosion may occur in the latter stages of degradation when the conductor walls become perforated. The vertical conductors, unsupported above the -109.7 m framing, will be exposed to additional stresses from currents and wave action, and thus are likely to fail earlier than estimates based solely on a consideration of corrosion rates. The conductors are not expected to last longer than the main components of the footings. Collapsing conductors are long enough to reach all locations within the footings, and so could impact the pile sleeves and pontoon legs.

Atkins concluded that the Brent Alpha remnant conductors are likely to accelerate the collapse of the jacket footings to some degree by imposing additional loading on it. Internal framing members in the bottom bay of the jacket will be more affected by this loading than the perimeter pontoon legs and pile clusters. This damage acceleration should be considered in combination with the likely conservatism in the original estimates of life due to greater than expected internal corrosion, but also the non-conservatism of not considering loading on the footing members themselves. Although it is possible that falling conductors could impact the corner piles and pile sleeves, it is unlikely that they will have a substantial negative effect on these structures.

7.5 Effects on Commercial Fisheries

Mackay Consultants undertook a specific study of the socio-economic effects of decommissioning the Brent Field on commercial fisheries in ICES[18] rectangle 51F1, the sea area where the Brent Field is located [23]. They examined published data on landing weights and landings values over the period 2000 to 2014, and made an assessment of the absolute value and relative importance of the Brent area in terms of demersal, pelagic and shellfish landings.

In ICES rectangle 51F1, fishing effort is dominated by bottom trawling with demersal trawls and pair trawls, and the catch is mainly haddock, cod, saithe and monkfish. Over the period 2000 to 2009, the average fishing effort was 220 days per year, which is regarded as 'moderate' in comparison to other areas of the North Sea. In terms of fisheries value, however, pelagic landings are by far the more valuable.

Historically, the value of the fishery has been dominated by the pelagic species mackerel. In the decade from 2000 to 2009, the total value of all landings from 51F1 was £67.7 million (which equates to an annual average of approximately £6.3 million), 80% of which (£54.4 million) was mackerel. The annual pelagic catch quota is usually taken over just a few weeks of effort. In the period from 2010 to 2014 the total value of all landings was £2.9 million, which equates to an annual average catch of approximately £0.6 million. This marked decrease occurred because in the period 2010 to 2013 no mackerel were caught in ICES rectangle 51F1, due, it is thought, to a northward migration of the stock.

[18] ICES, International Council for the Exploration of the Sea

Mackay Consultants acknowledged that it was not possible to forecast the long-term value or significance of the area to fisheries; the value of landings from the Brent area may change as a result of changes in several factors including the sizes and distribution of fish stocks, fishing effort, the numbers of vessels involved, technological improvements, and regulations. Nevertheless, they provided two estimates of the possible value of future landings.

In the lower estimate, they assumed that the historic level and value of the mackerel catch would be restored and that the current market value of the demersal catch would remain unchanged; this valued the total annual catch at £6,795,750. In the higher estimate, Mackay Consultants noted the 65 % increase in the Western mackerel quota and signs that the North Sea demersal stocks may be about to recover. On this basis, they estimated that the future annual mackerel catch from 51F1 could be of the order 33,816 tonnes with a value of £25,362,000. They also noted that there was reason to believe that the North Sea demersal fisheries could recover to the levels experienced in the 1970s and 1980s. They suggested that it was not unrealistic to project that the future catch of all 'other species' (which includes all the demersal species) could be five times the annual average catch observed for the period 2000 to 2013, which was 1,208 tonnes. The average annual catch of demersal species could therefore be 6,040 tonnes, with a value of £9,060,000, making an estimated total annual catch value for 51F1 of £34,422,000.

ICES rectangles are areas delineated by 1° of longitude and 0.5° of latitude, and at the latitude of the Brent Field they have an area of 3,090 km^2. Each of the four Brent installations has a safety zone of 500 m radius covering an area of 0.79 km^2 centred on the installation. In the Brent Field, therefore, approximately 3.2 km^2 of seabed is not available to fishermen, and this represents approximately 0.1% of the whole of this ICES rectangle.

With respect to the potential effects on fishing from the decommissioning of the Brent Alpha footings, we determined that none of the options would be likely to have any effects on pelagic fishing. The presence or absence of the jacket footings would only affect the size of the area of seabed available for trawling by bottom-towed fishing gear. If the Brent Alpha footings were completely removed and the 500 m radius safety zone ceased to exist, an additional area of seabed (0.025% of the ICES rectangle) would theoretically be available for demersal fishing. This additional 0.025% of seabed for fishing might result in a similar percentage increase in the value of demersal landings. If the value of demersal landings from 51F1 in the future is taken to be £9,060,000 per year (the upper future estimate provided by Mackay Consultants for the demersal fisheries), this would be equivalent to an increase of approximately £2,304 each year. Fishing effort and, ultimately, the value of landings are, however, controlled not by access to grounds but by other fisheries management measures such as Total Allowable Catch (TAC), mesh size and days at sea. In summary, the assessment by Mackay Consultants indicates that the presence or absence of the Brent installations and their safety zones would not have a significant effect on the economics of the fisheries in this area.

Although in theory the complete removal of the Brent Alpha footings might confer some very small benefit to commercial fisheries, the assessment by Mackay Consultants did not take into account the implications of the continued presence of the historic cuttings pile, which would then be fully exposed on the seabed. An exposed historic cuttings pile might be avoided by demersal trawlers, such that in effect fishermen did not gain access to any additional seabed as a result of the removal of the footings themselves.

7.6 Effects of the Disturbance of the Seabed Drill Cuttings Pile

To inform the potential environmental effects of the historic drill cuttings piles, and in addition to the Long-term Fate Modelling [16], BMT Cordah modelled the effects of over-trawling the Brent Alpha seabed drill cuttings pile. For this modelling, it was assumed that each single pass of a trawl would resuspend 10% of the pile (630 m^3) into the water column at the Brent Alpha location over a period of 45 seconds. The results of the modelling were presented in the report *Effects of Human Disturbance on the Brent Alpha and Brent Charlie Cuttings Piles* [18], which informed the EIA and hence the CA scores of the different management options for the Brent Alpha drill cuttings pile.

The results of this modelling were used to inform the assessment of potential impacts arising from the disturbance of the seabed drill cuttings pile by falling steel debris from the Alpha footings.

The studies were performed using the model PROTEUS, a particle-tracking model developed during the UKOOA[19] Drill Cuttings Initiative to model the fate and effect of historic drill cuttings piles (see *UKOOA Drill Cuttings Initiative Phase III Final Report* [29]). The model provided data on the likely spread of resuspended drill cuttings, the thickness of the newly-created layer of resettled cuttings, and the likely oil release rate and area of persistence of the new layer of cuttings with respect to the OSPAR Recommendation 2006/5 thresholds. It also provided data on the PEC:PNEC ratio for total hydrocarbon in the newly-impacted seabed sediments at different distances from the centre of the disturbed pile and within the water column. The ratio of the Predicted Environmental Concentration (*PEC*) of a contaminant and the Predicted No Effects Concentration (*PNEC*) is a measure commonly used to determine if there is likely to be an adverse effect from the contaminant on marine life. If the PEC:PNEC ratio is greater than 1 (expressed as >1), then an environmental effect may occur.

7.7 Management of the Brent Alpha Drill Cuttings Pile

Options for the footings have been undertaken without any consideration of the implications of the seabed drill cuttings pile. The options for the decommissioning of the footings do, however, have implications for the cuttings pile; if the steel piles on the footings were cut externally, all of the drill cuttings pile would have to be removed. Options for the management of the Brent Alpha seabed drill cuttings pile were subjected to an assessment using the same CA process as was applied to the jacket, because this offered a suitable and appropriate process for examining the BEP and BAT for options for the cuttings pile.

Four options were examined for the management of the Brent Alpha seabed cuttings pile if it had to be removed to allow the steel piles to be cut externally. The CA determined that in this circumstance the recommended option would be to remove the whole pile by suction dredging and transport the slurry of sea water and cuttings to shore, for treatment and disposal. If the jacket footings were to be removed by internal pile-cutting, or if they were to be left in place, the recommended option for the cuttings pile would be to leave it in place for natural degradation, since this drill cuttings pile falls below both of the thresholds in OSPAR Recommendation 2006/5 [17].

[19] UKOOA, United Kingdom Offshore Operators' Association, now Oil and Gas UK

SPECIFIC STUDIES TO INFORM THE CA FOR BRENT ALPHA JACKET FOOTINGS

Intentionally left blank

8 RESULTS OF COMPARATIVE ASSESSMENT OF OPTIONS FOR THE BRENT ALPHA FOOTINGS

The CA for the Brent Alpha jacket foo tings is presented in detail in the Brent Alpha Jacket TD [12].

Table 19 presents the weighted sub-criteria scores for each of the three options examined for the Brent Alpha footing alone. On the basis of this assessment, the 'CA-recommended option' for the Brent Alpha footings alone is Option 3 'Leave in Place'. It has a total weighted score of 81.05, in contrast to Option 1's total weighted score of 75.54 and Option 2's weighted score of 74.21.

Table 19 Transformed and Weighted Sub-criteria Scores for the Brent Alpha Footings Alone.

Sub-criterion	Option 1 Complete Removal with External Pile-cutting	Option 2 Complete Removal with Internal Pile-cutting	Option 3 Leave in Place
Safety risk offshore project personnel	6.14	6.00	6.61
Safety risk to other users of the sea	6.67	6.67	5.18
Safety risk onshore project personnel	6.61	6.61	6.67
Operational environmental impacts	3.55	4.70	5.00
Legacy environmental impacts	5.00	5.00	3.50
Energy use	3.87	3.70	3.74
Emissions	4.17	4.03	3.77
Technical feasibility	14.00	12.00	20.00
Effects on commercial fisheries	3.31	3.31	0.00
Employment	0.73	0.75	0.04
Impact on communities	3.67	3.67	6.67
Cost	17.81	17.76	19.87
Total weighted score	75.54	74.21	81.05

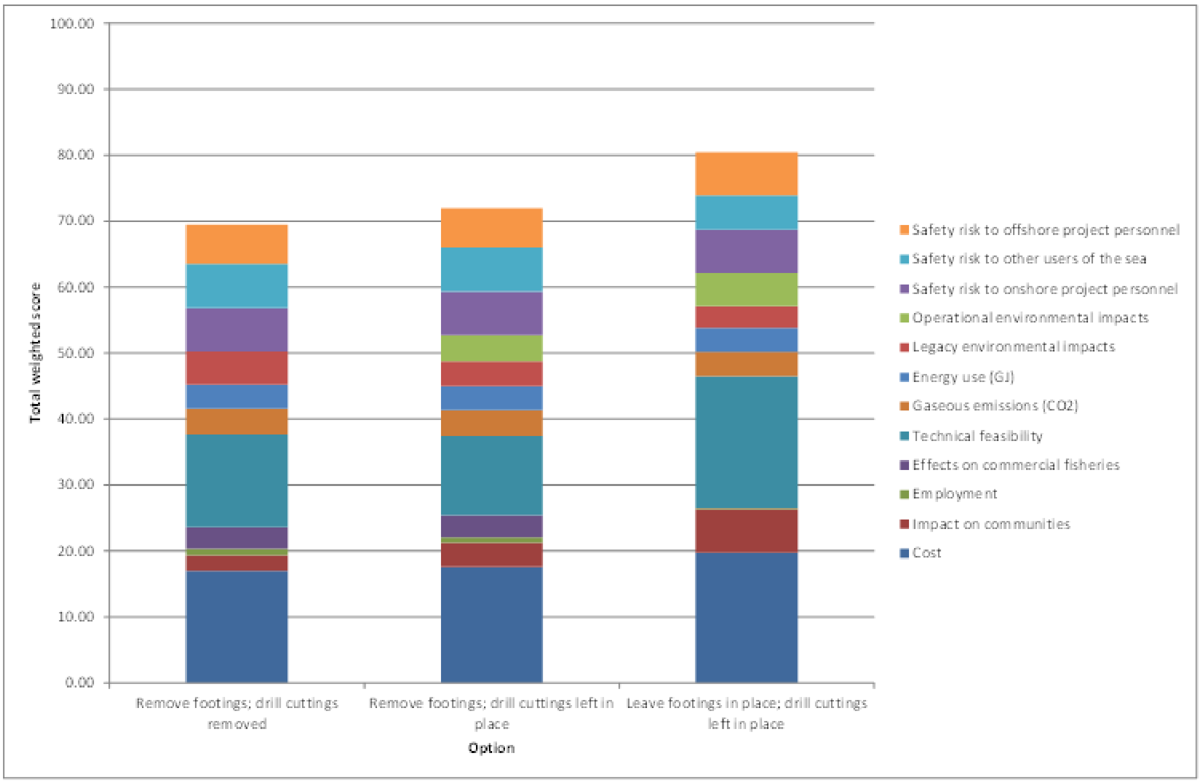
Table 20 presents the weighted sub-criteria scores for each of the three options examined for the Brent Alpha footing in combination with the appropriate options for the drill cuttings pile, and Figure 18 shows the results. The sensitivity analysis shows that Option 3 has the highest total weighted score in every scenario. On the basis of this assessment, the 'CA-recommended option' for the Brent Alpha footings in combination with the drill cuttings pile is Option 3 'Leave in place'. It has a total weighted score of 80.46, in contrast to Option 2's total weighted score of 71.91 and Option 1's weighted score of 69.48.

RESULTS OF COMPARATIVE ASSESSMENT OF OPTIONS FOR THE BRENT ALPHA FOOTINGS

Table 20 Transformed and Weighted Sub-criteria Scores for the Brent Alpha Footings in Combination with the Drill Cuttings Pile.

Sub-criterion	Combined Options for Brent Alpha footings		
	1 Remove Cuttings and Footings, with External Pile-cutting	2 Leave Cuttings, Remove Footings with Internal Pile-cutting	3 Leave Footings and Cuttings in Place
Safety risk offshore project personnel	5.99	5.91	6.52
Safety risk to other users of the sea	6.67	6.67	5.18
Safety risk onshore project personnel	6.60	6.61	6.67
Operational environmental impacts	0.00	4.00	5.00
Legacy environmental impacts	5.00	3.75	3.25
Energy use	3.62	3.62	3.65
Emissions	3.96	3.96	3.70
Technical feasibility	14.00	12.00	20.00
Effects on commercial fisheries	3.31	3.31	0.00
Employment	1.01	0.79	0.09
Impact on communities	2.33	3.67	6.67
Cost	16.98	17.62	19.73
Total weighted score	69.48	71.91	80.46

Figure 18 The Total Weighted Scores for Combined Options for Brent Alpha Jacket Footings in Combination with the Drill Cuttings Pile, and the Contributions of the Sub-criteria.

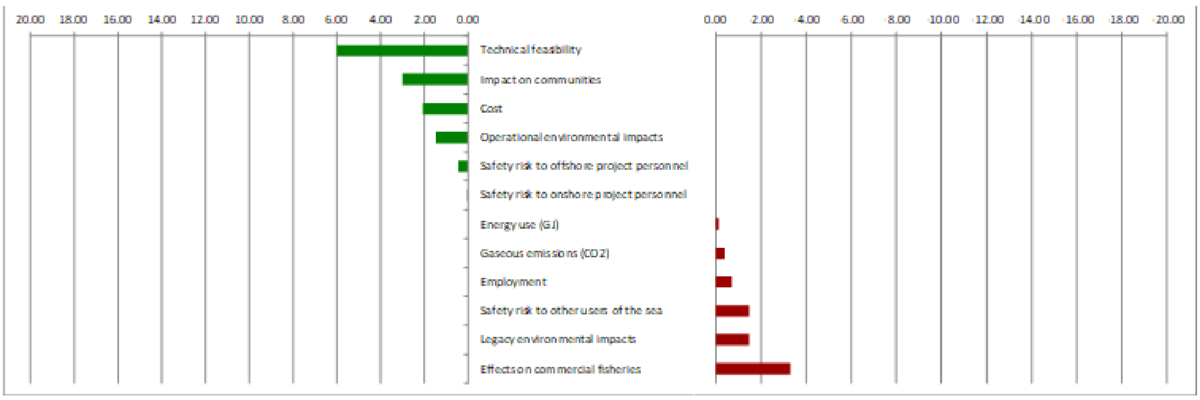


8.1 Discussion of the Comparative Assessment

8.1.1 Discussion for the Footings Alone

Examination of the weighted scores (Table 19), and the raw data for each of the sub-criteria, shows that the differences between Option 3 and the two 'removal' options are driven by the differences in performance in '**technical feasibility**', '**impact on communities**', '**cost**' and '**operational environmental impacts**' (which are better in Option 3 than in either Option 1 or Option 2), and in '**effects on commercial fisheries**', '**legacy environmental impacts'** and **'safety risk to other users of the sea**' (which are better in both of the 'removal' options). All the other sub-criteria show no or only trivial differences between the options in terms of their weighted scores. This is illustrated in Figure 19 which shows the differences (positive or negative) in the weighted scores in each sub-criterion for Option 1, 'Complete removal with external pile-cutting', which is the better of the 'removal' options, and Option 3 'Leave in place'. In Figure 19 the green bars indicate sub-criteria where Option 3 has the better performance and the red bars indicate sub-criteria where Option 1 has the better performance.

Figure 19 Difference Graph Comparing the Weighted Scores of each Sub-criterion in the Better 'Removal' Option for the Brent Alpha Jacket Footings Alone, with the 'Leave in Place' Option, Under the Standard Weighting.



Green bars: Option 3 'Leave in place' is better than Option 1 'Complete removal with external pile-cutting'

Red bars: Option 1 'Complete removal with external-pile-cutting' is better than Option 3 'Leave in place'

The removal of the Brent Alpha footings would present several technical challenges but could be achieved at a cost of about £60 million. As a result of the discussion presented in the Brent Alpha Jacket TD [12], however, we have concluded that, objectively, few environmental or societal benefits would be gained from the additional expenditure and risk that would be incurred in removing the footings. One of the tangible benefits would be the elimination of the ongoing liability that we would have if the footings were left in place. If the footings were left in place, the residual long-term safety risk to fishermen – from the footings on their own and in combination with the derogated GBS – would be very low and amenable to further reduction by means of a number of mitigation measures, discussed in Section 10.5.

RESULTS OF COMPARATIVE ASSESSMENT OF OPTIONS FOR THE BRENT ALPHA FOOTINGS

8.1.2 Conclusion of Assessment for Jacket Footings Alone

In accordance with the requirements of OSPAR 98/3, we have examined the decommissioning of the Brent Alpha jacket starting from the presumption of full removal. We have concluded that it is not tenable to consider refloating or lifting the whole jacket in one piece, so all options would start with the removal of the upper jacket to -84.5 m LAT. The CA therefore focussed on three options for the management of the remaining footings. We have considered the raw data and the scores, and assessed the performances of the options, and have concluded that there is very little to choose between the options in many of the sub-criteria. In some, the difference is very small, or, after considering the raw data, we think the sub-criterion itself is in fact not an important one for our decision-making.

We have therefore concluded that there are few real differences between the options, except safety risk to fishermen, technical feasibility, and cost.

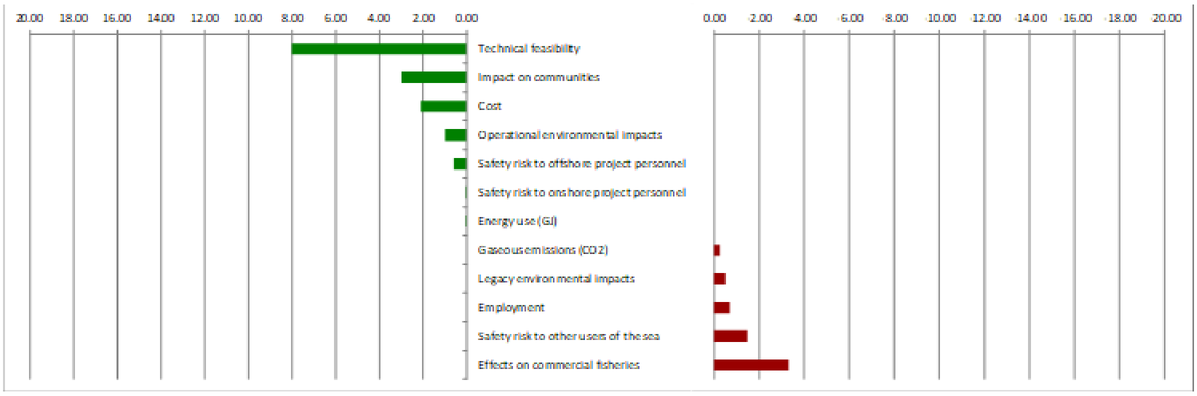
We have examined the estimated long-term safety risk to fishermen, which is necessarily a prediction based on current levels of fishing and current practices, and is intended to be a conservative or pessimistic estimate (as required by the BEIS guidelines). In their *Assessment of safety risks to fishermen* [20], Anatec presented an estimate of the long-term snagging risk to pelagic and demersal fishing operations from the presence and slow collapse of the approximately 58 m high footings left on the seabed after the removal of the upper jacket. The estimated safety risk to other users of the sea, an average annual PLL of 0.12×10^{-3}, is below the upper limit of tolerability (an annual PLL of 1×10^{-3}) and is amenable to further reduction by additional site-specific management measures. We have therefore concluded that, overall, there is little to choose between the options – their performances are broadly equal (with the exception of 'employment' which is directly correlated with 'cost') – and thus that the influences of two remaining criteria – technical feasibility and cost – are material to our decision-making. In this regard, Option 3 is clearly more assured of technical success and is an order of magnitude cheaper – it would be the condition that is achieved after the removal of the upper jacket. On balance, since Option 1 does not yield any significant benefits or improvements in the other measures, we conclude that, for the footings alone, the risks and costs of Option 1 are disproportionate to the small benefits (if any) that would be gained by full removal, and that Option 3 'Leave in place' is preferable to the 'removal' option.

8.1.3 Discussion for the Footings in Combination with the Drill Cuttings Pile

Examination of both the raw data and the weighted scores for each of the sub-criteria shows that the differences between Combined Option 3 'Leave footings and cuttings in place' and the two 'removal' options are very strongly driven by the differences in performance in '**technical feasibility**' and, to a lesser extent, '**impact on communities**', '**cost**' and '**operational environmental impacts**' (which are better in Combined Option 3 than in either Combined Option 1 or Combined Option 2), and in '**safety risks to other users of the sea**', and '**effects on commercial fisheries**' (which are better in both of the 'removal' options). All the other sub-criteria show no or only trivial differences between the options in terms of their weighted scores. This is illustrated in Figure 20, which shows the differences (positive or negative) in the weighted scores in each sub-criterion for Combined Option 2, 'Leave cuttings, remove footings with internal pile-cutting', which is the better of the 'removal' options, and Combined Option 3 'Leave footings and cuttings in place'. In Figure 20 the green bars indicate sub-criteria where Combined Option 3 has the better performance and the red bars indicate sub-criteria where Combined Option 2 has the better performance.

There are two technically feasible options for the complete removal of the Brent Alpha footings in the presence of the seabed drill cuttings pile. Either the seabed drill cuttings pile could be removed to permit pits to be dug around each leg so that the piles could be cut externally by DWC, or the pile bore grout could be removed to permit the piles to be cut internally by AWJ. Although feasible, both options have numerous uncertainties and technical issues (Section 6.9) that would have to be resolved during any detailed FEED of a possible programme of work. The CA showed that Combined Option 2 'Leave Cuttings, Remove Footings with Internal Pile-cutting' was, marginally, better than the other 'removal' option, Combined Option 1 'Remove Cuttings, Remove Footings with External Pile-cutting'.

Figure 20 Difference Graph Comparing the Weighted Scores of each Sub-criterion in the Better Combined 'Removal' Option for the Brent Alpha Jacket Footings and Seabed Cuttings Pile, with the Combined 'Leave in Place' Option, Under the Standard Weighting.



Green bars: Combined Option 3 'Leave footings and cuttings in place' is better than Combined Option 2 'Leave cuttings, remove footings with internal pile-cutting'

Red bars: Combined Option 2 'Leave cuttings, remove footings with internal pile-cutting' is better than Combined Option 3 'Leave footings and cuttings in place'

The advantages that would be realised by the complete removal of the footings would be the elimination of a long-term legacy safety risk for fishermen, the removal of a small source of seabed debris, and support for additional employment offshore and onshore. These could be realised without the need to remove and treat the whole cuttings pile, by removing the pile bore grout and cutting the piles internally, and then extracting sections of footings through the relatively thin layers of drill cuttings around the perimeter of the footings. This operation would disturb some cuttings, which would drift and settle on the adjacent seabed but would probably not increase the present extent of hydrocarbon contamination around the jacket.

Following our assessment of the real data informing those scores, we have concluded that in terms of the Brent Alpha footings in combination with the seabed drill cuttings pile, the sub-criteria serving to differentiate the options are '**technical feasibility**' and, to a lesser extent '**impact on communities**', '**cost**' and '**operational environmental impacts**' (which are better in Combined Option 3 than in Combined Option 2), and '**safety risks to other users of the sea**' and '**effects on commercial fisheries**' (which are better in Combined Option 2). The drivers and trade-offs for the decommissioning of the Brent Alpha footings in combination with the drill cuttings involve a consideration of how feasible and safe it would be to remove the footings and leave the cuttings in place, and what real reduction in safety risk to other users of the sea or benefit to commercial fisheries would thus be achieved.

As far as can be determined on the basis of a conceptual programme, the *increases* in technical difficulty, cost and safety risk for project personnel associated with the programme of work to drill out the pile bore grout, cut the piles internally and extract the footings while leaving the cuttings pile undistributed, is not balanced by any real commensurate *decrease* in safety risk to other users of the sea or legacy environmental impacts or *increase* in benefit to commercial fisheries. If the footings were to be removed, the safety risk to fishermen would be zero and the total safety risk to project personnel engaged in these operations offshore and onshore would be a PLL of 0.0323; that is, if we were to decommission the whole of the 'Brent Alpha footings and cuttings pile' in this way approximately 31 times (by drilling out the pile bore grout and cutting the piles internally then cutting and lifting the sections of footings) there is a risk that one project person might be killed. In terms of the overall BDP this value is low and transforms to a value of close to 1 on the normalised global scale of safety risk where the maximum estimated total risk of any option for any facility for any exposed group of persons is a PLL of 0.2640.

RESULTS OF COMPARATIVE ASSESSMENT OF OPTIONS FOR THE BRENT ALPHA FOOTINGS

If the footings were to be left in place they would present a potential snagging risk to fishermen. Initially this would be for both pelagic and demersal gear, but as the footings degraded and the height of the remains above the seabed decreased, the risk to pelagic gear would decrease and then disappear. The estimate of total PLL for fishermen for the whole predicted lifetime of the footings on the seabed as they degrade is intended to be conservative. It ignores the fact that fishing practices, vessels and equipment are all likely to change over time in a way that reduces safety risks for fishermen, and that fishermen themselves would take active measures to ensure that their gear did not interact with any remains on the seabed. We would work with the fishermen and the Fisheries Offshore Oil & Gas Legacy Trust Fund Limited (FLTC) to ensure that any remains were properly marked and maintained, and included in the FishSAFE system, to ensure that any risks to fisherman were minimised. We will have a long-term commitment to monitoring and management in the Brent Field and will be able to review the developing situation in conjunction with OPRED and take any necessary mitigation measures as appropriate.

The removal of the Brent Alpha footings, leaving the cuttings pile in place and largely undisturbed, would present several technical challenges but could be achieved at a cost of about £64 million. As a result of the discussion presented in this Section, however, we have concluded that, objectively, few environmental or societal benefits would be gained from the additional expenditure and risk that would be incurred in removing the footings in this way. One of the tangible benefits would be the elimination of the ongoing liability that we would have if the footings were left in place. If the footings were left in place, the residual long-term safety risk to fishermen – from the footings on their own and in combination with the derogated GBS – would be very low and amenable to further reduction by means of a number of mitigation measures.

8.1.4 Conclusion of Assessment for Brent Alpha Jacket Footings in Combination with the Drill Cuttings Pile

Although we have performed two CAs, one for the footings options on their own and one for the combined options for the jacket footings and seabed cuttings pile, it is impossible to ignore the implications of the cuttings pile when considering options for the footings. The Brent Alpha cuttings pile falls below both of the OSPAR thresholds and, as described in the Drill Cuttings TD [14], the best option for the pile would be to leave it undisturbed to degrade naturally. Considering the drill cuttings pile alone, there is little to be gained by undertaking a programme of work to remove it. The additional safety risk, environmental impacts, energy use, emissions and cost of removing the pile would therefore be incurred simply to gain access to the footings.

When the footings alone is considered, Option 3 'Leave in place' is the recommended option in all of the six sensitivity scenarios. There is therefore no indication that a programme of work to remove the cuttings pile would then yield significant, or even any, benefits through being able to remove the footings.

When the footings options are considered in combination with the appropriate best options for the cuttings pile, examination of the raw data shows that the significant criteria differentiating the Combined Options are 'Safety risk to fishermen', 'Technical Feasibility' and 'Cost'. The estimates of the long-term legacy safety risk to fishermen have already been discussed and assessed as being tolerable and amenable to additional mitigation measures. More importantly, the safety risks to fishermen are much smaller than the estimated safety risks to project personnel who might be engaged in drilling out the pile-bore grout and retrieving the sections of footings.

The technical challenges, safety risks and cost of Combined Option 2 'Leave cuttings, remove footings with internal pile-cutting' are significant and disproportionately large in relation to the very small benefits that would be gained. Consequently, this assessment reinforces the earlier conclusion (Section 8.1.2) that for the Brent Alpha jacket footings, Option 3 'Leave footings and cuttings in place' is preferable to full removal.

8.2 Recommended Option for the Brent Alpha Jacket

The detailed CA of feasible options, carried out in accordance with the requirements of OSPAR Decision 98/3, and using the selection criteria and matters to be considered set out in Annex 2 of that Decision, has indicated that the recommended option for the Brent Alpha jacket in the presence of the seabed drill cuttings pile is follows:

- Brent Alpha Jacket: 'Partial Removal to -84.5m LAT'

RESULTS OF COMPARATIVE ASSESSMENT OF OPTIONS FOR THE BRENT ALPHA FOOTINGS

Intentionally left blank

9 PROGRAMME OF WORK FOR DECOMMISSIONING THE BRENT ALPHA JACKET

9.1 Preparation

In June 2020, the topside (including the PGDS) was removed in a single lift by the SLV *Pioneering Spirit* and returned to shore for dismantling, recycling and disposal.

While preparing the topside for lifting, all the inner strings and conductors were cut at approximately +7m LAT, i.e. just above the cut line for the topside, and removed. The conductors and inner strings were then cut at -84.5m LAT, in line with the top of the footings, using external DWC deployed from a work-class remotely-operated vehicle (WROV), and the inner strings removed where possible. This will enable the middle sections of the conductors and any remaining inner strings to be removed with the upper jacket when it is lifted away.

Two temporary working platforms, each weighing approximately 63 tonnes, will be fitted to the top of the jacket by the HLV. These will provide a safe platform from which to undertake further preparatory work on the jacket, including the fitting of the lifting points, spreader bars, and conductor hanging frame. Some additional strengthening and support will have to be provided to horizontal members on the jacket at the -77 m level.

No significant environmental impacts are expected from any of these preparatory activities.

9.2 Securing the Conductors

Some of the conductors will be held in place by external grippers or by welded connections, but the majority of conductors (19 of the 28) have Talon connections and will have to be supported from the bottom. This will be achieved by deploying 'ball grabs' from small winches positioned over each conductor. A specially-designed steel conductor hanging frame will be fitted over the cut ends of the jacket legs, to support the winches of this ball grab system. From the winch, a ball-grab will be lowered on a steel wire to the bottom of the cut conductor. The ball grab will then be inflated, gripping the conductor inside and carrying the full weight of the conductor from the bottom. By this means, the middle section of the conductors will be held securely in place while the upper jacket is lifted, transported vertically, and set down onshore.

The lower sections of the conductors will be left in place with the footings.

9.3 Removal of the Upper Jacket

If approved, it is planned that the upper jacket will be removed in the summer of 2020, about one month after removing the Brent Alpha topside. During this short interval, the Brent Alpha jacket, which will protrude approximately 6.7 m above LAT, will be guarded by a dedicated Field vessel to warn mariners of this hazard. Notices to mariners will be issued and the UKHO and Maritime and Coastguard Agency (MCA) informed of the changed status of the platform. The new status of the Brent structure will be entered into the FishSAFE programme of electronic warning.

If there is a longer break in the programme of work between the removal of the topside and the removal of the upper jacket, we will install an Aid to Navigation (AtoN) by marking the structure with two cardinal buoys that will be placed between 500 m and 1,000 m East and West of the remaining structure. The buoys will be at least 3 m in diameter. They will be fitted with radar reflectors and will carry a white light of the appropriate character that is at least 3 m above sea level, giving a nominal visibility of about 5 miles.

The upper jacket will be separated from the footings by cutting it at a depth of approximately -84.5 m LAT. This will require a total of forty cuts comprising the three 7 m diameter pontoon legs in Row A, the three large legs on Row B, the two legs on Row AB and thirty-one vertical-diagonal bracings. It is estimated that if there were no complications caused by weather or equipment failure, the cutting programme will take approximately 17 days. Some carefully selected legs and braces will be left intact until just before removal, to ensure that the jacket does not move until ready for lifting off. Some of the cuts may be castellated (stepped) so that the upper jacket remains stable and secure until lifted.

All underwater cutting will be completed using a DWC system deployed by ROVs from the HLV, operating on dynamic positioning (DyP); it is not envisaged that divers will be needed. All the cuts will be well above the top of the existing seabed cuttings pile, so the drill cuttings will not be disturbed. We do not plan to use underwater explosives, but if their use were required as a contingency we would consult with OPRED on their use and follow the JNCC's[20] *Guidelines for minimizing the risk of injury to marine mammals from using explosives* [30].

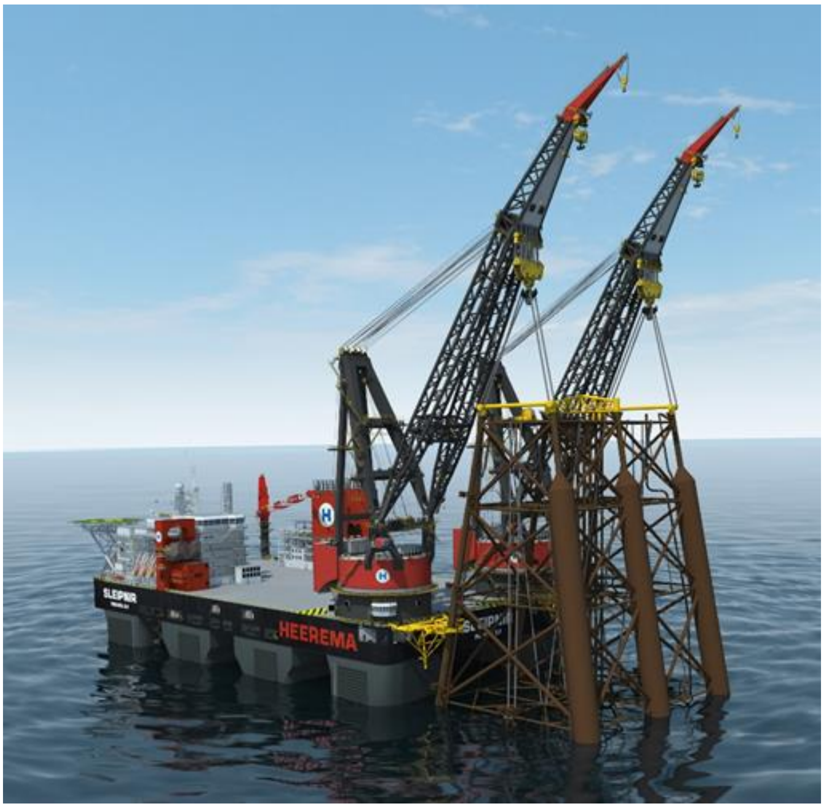
Before the final cuts are made, new specially-designed lifting trunnions will be inserted and welded inside the open tops of the four corner legs. The HLV will then move into position and take station, working on DyP. The crane lifting strops will be attached to the lifting trunnions and the slack taken up.

Once clear of the sea, the jacket will be attached to a specially-designed cradle on the stern of the HLV so that it can be transported securely in an upright orientation while still supported by the cranes (Figure 21). From beginning the final cuts to completing the sea-fastening of the jacket on the HLV, this whole process should take approximately 44 hours.

The jacket will then be transported to Vats in Norway, where it will be set down vertically on the quayside. It is estimated that this voyage will take about 30 hours.

In a later campaign, seabed debris will be removed from within the 500 m radius zone around the footings. Debris that is buried by significant volumes of drill cuttings will be cut back to the drill cuttings pile and the visible section removed.

Figure 21 Artist's Impression of HLV Lifting Brent Alpha Upper Jacket and Conductors.



[20] JNCC, Joint Nature Conservation Committee.

9.4 Material Retrieved and Material Left in Place

Figure 22 shows the state of the footings after the removal of the upper jacket, and Table 21 shows the estimated amounts of material to be removed or left in place on completion of this programme of work.

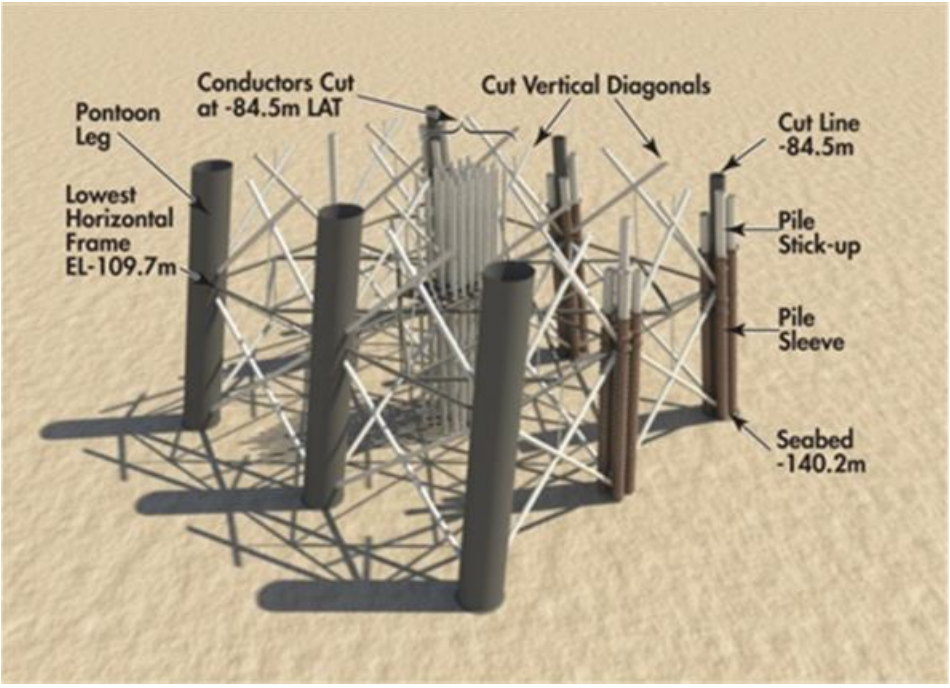
Table 21 Estimated Amounts of Brent Alpha Jacket Material Retrieved and Left in Place following Partial Removal.

Material	Removed on Upper Jacket	Recycled	Disposed of in Landfill	Left in Place
Steel	8,411	8,411	0	14,848
Aluminium/Zinc	101	101	0	155
Organic marine growth	1,601	0	1,601	1,133
Cementitious grout	0	0	0	5,204
Totals	10,113	8,512	1,601	21,340

Since the completion of the supporting studies, we have engaged HMC to remove the Alpha upper jacket. They have performed more detailed calculations on the mass of the jacket (*Brent Alpha Jacket and Conductors – Calculation – Jacket Weight Reconciliation* [31]), and estimate that during removal, the upper jacket, including conductors, spreader bars and associated additional lifting equipment, will have a mass of approximately 9,494 tonnes in air.

This will comprise 8,219 tonnes of steel and anodes and 1,275 tonnes (wet) of marine growth. This small decrease in estimated mass, of approximately 619 tonnes (about 6%) from the 10,113 tonnes shown in Table 21 above, does not make any material difference to the energy use, environmental impact, or cost of removing the upper jacket.

Figure 22 State of the Brent Alpha Footings after Removal of the Upper Jacket.



9.5 Onshore Dismantling and Recycling

On the basis of the latest calculations performed by HMC [31], we now estimate that 8,219 tonnes of steel and aluminium-zinc anodes will be returned to shore in the upper jacket and its conductors. The estimated 1,275 tonnes of marine growth on the upper jacket will be removed soon after reception, and disposed of to a landfill site.

At the AF Gruppen dismantling site at Vats, the contractor will use a variety of hot and cold cutting techniques to quickly reduce the height of the jacket and bring the whole structure down to ground level. With a much simpler construction and a more limited materials inventory than a topside, it is likely that the jacket would be dismantled to ground level within a matter of months. All material will be segregated into different waste streams for storage and, ultimately, recycling, treatment or disposal. All the anodes will be removed and recycled, and all the steel will be recycled. It is therefore planned that all of the retrieved metallic material (8,219 tonnes) will be recycled. Accordingly, at least 97% of the recovered recyclable material will be recycled.

9.6 Degradation and Longevity of Footings

The footings are still protected by sacrificial anodes which have an estimated remaining life of approximately 20 years. The steel footings will only begin to corrode freely when the bulk of the anode mass has wasted away. Lighter horizontal and vertical diagonal members would corrode and begin to fall from the footings after perhaps 30-40 years of corrosion. All four jacket faces are inclined inwards and so it is likely that these components would fall largely within the existing perimeter of the jacket footings.

Legs with external pile clusters, and the pontoon legs with internal piles and grout, will also begin to corrode freely after this time. Although the shells of the pontoon legs (16 mm to 25 mm thick) might exist for up to about 190 years, the piles are expected to degrade much more slowly because the walls of these hollow steel tubes are 48 mm thick. It is it difficult to calculate exactly how long the piles would last, but estimates show that they could remain upright for perhaps 500 years. Eventually, however, perhaps after 300-500 years, all the steel will have corroded [27]. The former site of Brent Alpha will comprise the remains of the historic cuttings pile, overlain with corrosion products from the steel jacket and pieces of concrete from the grout in the piles and pile sleeves.

Atkins [28] concluded that the lower conductors remaining in the footings would be likely to enhance the overall rate of degradation of the footings, and slightly reduce its longevity.

10 ENVIRONMENTAL IMPACT ASSESSMENT

10.1 Introduction

DNV GL prepared the *Brent Field Decommissioning Environmental Statement* [9], on behalf of and as endorsed by Shell U.K. Limited and Esso Exploration and Production UK Limited, the Brent Field owners. The ES presents the results of the EIA which was completed in accordance with the requirements of the BEIS Guidance Notes and the UK *Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) (Amendment) Regulations* [32].

This section presents:

1. Descriptions of the environmental settings in which the jacket decommissioning activities will take place.
2. A summary of the methods that were used to assess the potential impacts of the proposed programme of work.
3. A summary of the mitigation measures proposed to reduce or eliminate potential impacts.

The EIA and ES are based upon the 2007 pre-decommissioning seabed surveys by Gardline [33], [34] and [35]. During the preparation of the ES and the DP, a further pre-decommissioning survey was completed in 2015 by Fugro EMU and is presented in a series of *Pre-Decommissioning Environmental Survey Data Reports*, including one for Brent Alpha [36], and a *Brent Field Temporal Report Block 211/29* [37],which examined changes in the extent of perturbation and effects on the benthos over time across the whole Field. The 2015 survey endeavoured to re-sample all the grab sample and reference stations from the 2007 surveys although this was not always possible. The 2015 survey also sampled new areas of the seabed to fill in identified data gaps and sampled new reference stations for the Field.

The results from the 2015 seabed environmental survey were not available in time for the submission of the consultation draft DP document. However, DNV GL have reviewed the results of this survey and presented the following statement:

> *DNV-GL believe that the 2015 Brent Field survey data indicates that the Brent Field is, in general, recovering over time (which is to be expected given biodegradation processes and bioturbation). As such, DNV-GL consider that the environmental impact assessment (and thus the CA scores), which are based on the 2007 Brent Field survey data, do not require amendment or updating to reflect the 2015 Brent field survey data.*

Information on the spatial and temporal changes and trends in the physical, chemical and biological characteristics of the seabed adjacent to each of the five Brent sites is presented in more detail in the ES [9] and in the Drill Cuttings TD [14].

10.2 Environmental Sensitivities

The environmental setting of the Brent Field is summarised below in Table 22 and Table 23. A full description of the physical, biological and socio-economic environments in the Brent Field is presented in the ES [9].

The character of the benthos, and in particular the changes that have occurred as a result of the permitted discharge of cleaned oily cuttings and the recovery that has begun since those discharges ceased, are well documented by a series of seabed surveys, the most recent of which was in 2015. All the offshore activities for the decommissioning of the Brent Alpha jacket will occur within the 500 m safety zone around the installation; this area has been covered by all the benthic surveys.

Table 22 Summary of the Physical, Biological and Socio-economic Environments in the Brent Field.

Aspect	Summary Data			
Water column	Water depth	140.2 to 142.1m	Tidal range	1.83 m
100 year return wave	Amplitude	26.2 m	Period	15.5 seconds
Maximum current speeds	Surface	$0.86\ m.s^{-1}$	Seabed	$0.46\ m.s^{-1}$
Water temperature	Maximum	13°C	Minimum	6°C
Seabed sediments	Muddy sand, with holes and mounds created by burrowing fauna especially Norway lobster *Nephrops*.			
Benthos	Characterised as 'North British Coastal zone' and 'offshore Northern North Sea', dominated by polychaetes, crustaceans, bivalves and echinoderms.			
Fish	Demersal and pelagic species, predominantly cod, haddock, whiting and herring. Platform located within spawning areas for herring, whiting, lemon sole, Norway pout, sandeels, sprat and *Nephrops*.			
Shellfish	Norway lobster *Nephrops*.			
Marine mammals	Low densities of cetaceans; most commonly occurring species are harbour porpoise and white-beaked dolphin. White-sided dolphin, Risso's dolphin, bottlenose dolphin, fin whale and minke whale have also been recorded.			
Seabirds	Important area for seabirds, particularly in summer, especially guillemot, fulmar, kittiwake and razorbill. Other species include puffin, herring gull, little auk, arctic tern, gannet, great skua, arctic skua, sooty shearwater, cormorant and common tern.			
Conservation interests	Marine mammals are designated species. There are numerous colonies of coral *Lophelia pertusa* on all four installations. The nearest offshore SAC[21] is Braemar Pockmark, 225 km away.			
Commercial fishing	The relative value of commercial fisheries in ICES rectangle 51F1, in the Brent Field area, is 'Moderate' to 'Low'. Fishing effort in 51F1 is 'Low' and dominated by demersal gear types.			
Shipping	Within 50 km there are 14 recognised shipping lanes, used by 8,430 vessels each year. Shipping density in the Brent Field ranges from 'low' to 'very low'.			
Nearest oil and gas activities	Statfjord Field, 9.6 km to the northeast.			
Commercial activity	With the exception of oil and gas activity, and commercial fishing, there is no other commercial activity at the site.			
MOD activity	None.			
Wrecks	Nearest marked wrecks are 9 km away from Brent Alpha.			

[21] SAC, Special Area of Conservation.

Table 23 Environmental Sensitivities in the Brent Field.

Environmental Receptor	Main Features
Conservation Interests	There are no known Annex I habitats in the Brent Field area. Of the four Annex II species only the harbour porpoise has been sighted in the Brent Field area, with low abundance in February, from April to September and in December.
Seabed	The only significant seabed features are the Brent platforms, associated pipelines and drill cuttings piles. Surveys at Brent Alpha indicate elevated concentrations of total hydrocarbons and of heavy metals in the seabed sediments. At distances of >500m from the installation, the concentrations of hydrocarbons had fallen to <50mg/kg, and the concentrations of heavy metals had fallen to concentrations similar to those at the (distant) reference stations. Benthic communities in the Brent Field area are similar to those found throughout a large surrounding area of the northern North Sea.
Fish	The Brent Field is located in spawning grounds for cod (January to April), haddock (February to May), Norway pout (January to April), saithe (January to April), sandeel (November to February) and whiting (February to June), and within nursery grounds for anglerfish, blue whiting, European hake, haddock, herring, ling, mackerel, Norway pout, sandeel, spurdog and whiting (throughout the year).
Fisheries	The relative value of commercial fisheries in ICES rectangle 51F1, in the Brent Field area, is 'Moderate' to 'Low'. Fishing effort in 51F1 is 'Low' and dominated by demersal gear types.
Marine Mammals	Marine mammal species occurring in the Brent Field area are harbour porpoise, killer whale, minke whale, sperm whale, white-beaked dolphin and white-sided dolphin. The majority of sightings have occurred during spring and summer.
Birds	Seabird vulnerability to oil pollution in the Brent Field area (Block 211/29 and adjacent blocks) is 'High' in January, March and July, and between September and November. The overall vulnerability in the area is 'Low'.
Other Users of the Sea	Shipping density in the Brent Field ranges from low to very low.
Atmosphere	Local atmospheric conditions are influenced by the day-to-day operations of the nearby Charlie platform and associated vessels.

10.3 Method used to Assess Environmental Impacts

10.3.1 Introduction

This section presents a summary of the methods that were used to assess and compare the potential impacts of short-listed options, and the way they presented their results. The method is fully described in the ES [9].

10.3.2 Summary of Method Used to Assess Environmental Impacts

To complete the EIA and prepare the ES, DNV-GL:

1. Described the possible programmes of work that would be undertaken to complete each of the short-listed options. This was done with reference to reports, studies and data supplied by the BDP and through numerous interviews and meetings with each of the lead engineers on the BDP.
2. Described the 'environmental settings', all the locations and sites offshore, nearshore and onshore, where project-related activities or operations may be carried out. This was done with reference to site-specific offshore data gathered by the BDP, project-specific baseline descriptions provided in other studies, and published data.
3. Identified the types, number and possible severity of all potential impacts from the BDP in these settings. This was done by means of a scoping report that was undertaken following the international guidance given in the EU document *'European Commission (EC) Guidance in EIA Scoping'* [38] and the EU *'Guidance Checklist of Criteria for Evaluating the Significance of Environmental Effects'* [39]. The *'Brent Decommissioning Environmental Assessment Scoping Report'* prepared by DNV [40] was published in June 2011, and stakeholders were invited to comment on its findings.
4. Calculated the total energy use and the total gaseous emissions of the proposed programmes of work. To prepare these estimates DNV GL used the widely-accepted method, reference data and factors in the Institute of Petroleum's (IoP) '*Guidelines for the calculation of estimates of energy use and gaseous emissions in the removal and disposal of offshore structures'* [41].
5. Identified those potential impacts that were considered significant, and assessed their effects in greater detail. This was achieved by scrutinising the results of the scoping report, and the comments and concerns expressed by stakeholders either in our programme of stakeholder engagement or as a result of the scoping report. Particularly significant or important issues were examined in greater depth, often by means of specialist independent studies, reports or modelling.
6. Assessed the potential cumulative effects of the both proposed Brent Decommissioning Programmes. This was done by examining the phasing of the offshore and onshore work, the numbers and magnitudes of impacts, and the ways in which these impacts might overlap or interact spatially and temporally. Specialist studies and modelling by independent experts were again used as necessary.

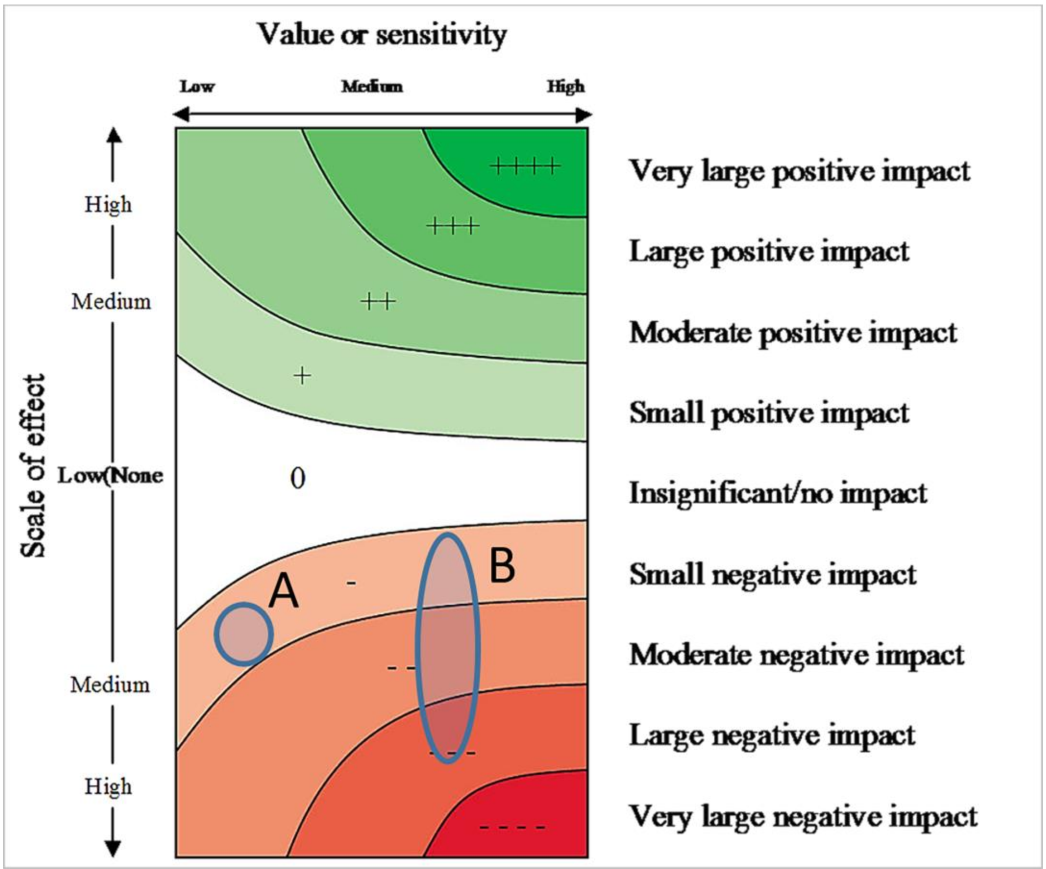
For each potential impact, DNV GL assessed the likely scale of effect, taking into consideration standard mitigation measures commonly applied by the offshore industry and the project- and site-specific mitigation measures that are identified in the ES.

The likely overall **severity** of the effect was determined by considering the **sensitivity** of the receptor or the environment and the **scale or magnitude** of the potential impact. For every facility, the severity of the overall effect of the option on each receptor is shown on a single diagram, as shown in Figure 23.

In these diagrams, the four curved bands shaded green indicate positive impacts of increasing (positive) effect, and the four curved bands shaded red indicate negative impacts of increasing effect. The white zone indicates where the combination of sensitivity and severity would result in no impact or an insignificant impact. The labels on the right of the diagram indicate the severities of each band. The position of the circular or elliptical area within a band or straddling a band indicates the degree of certainty or uncertainty in the assessment. For example, Point A has a small negative impact and a relatively small degree of uncertainty, as indicated by the small circle. The value or sensitivity (horizontal axis) is well defined, and the assessment of effect (vertical axis) has been determined with confidence. By contrast, Point B represents a relatively larger degree of uncertainty, because although the value or sensitivity is well defined, there is a high uncertainty about the scale of effect, and this translates into an impact ranging from 'small negative' to 'large negative'. DNV-GL noted that detailed planning of activities, substantial knowledge, and robust methodologies and procedures can contribute to a reduction in the uncertainty of the assessment.

As a result of applying this methodology, the same scale of effect may give a different impact depending on the value or sensitivity of the receptor or environment. DNV-GL consider this a sound basis for assessing and presenting environmental impacts. They noted that a 'moderate negative' or 'large negative' impact does not necessarily mean that the impact is unacceptable, but that further consideration should be given to it.

Figure 23 An Example of the Diagrams Used to Portray the Severity of an Impact.



10.3.3 Estimation of Energy Use and Emissions

Decommissioning options will use energy and emit gases as a result of several different types of activity, including the use of vessels offshore, the transportation of material at sea and on land, and the dismantling, treatment, recycling or disposal of material onshore.

All these activities are 'direct' sources of energy use. To properly account for any energy 'savings' that may be made when material is removed and taken to shore for recycling, options in which no such removal is undertaken must be 'debited' with the energy and emissions that would be associated with the new manufacture of replacement materials [41].

The total net energy use and the total masses of gaseous emissions for all short-listed options were estimated by following the IoP guidelines [41]. DNV-GL took the IoP factors for the amounts of energy used and gases emitted during the combustion of different fuels and during the recycling or new manufacture of different types of materials, and applied these to our estimates of the durations of operations, the sizes of the vessel spreads for each option, and inventories of the masses of materials in structures and of the material that would be removed or left in the sea under different options.

10.4 Potentially Significant Impacts in the Environmental Statement

10.4.1 Stakeholder Environmental Concerns

For the recommended option for the Brent Alpha jacket, the specific environmental concerns or issues raised by our stakeholders were:

- Accidental loss of large components to sea.
- Impacts to local communities at onshore dismantling and recycling sites caused by noise, dust and odour.
- Recycling and disposal of recovered materials.
- Impacts to commercial fisheries from remains left at sea.
- Effects of collapsing footings on seabed cuttings pile.
- Creation of debris from remains left at sea.

10.4.2 Potentially Significant Impacts in the Environmental Statement

Figure 24 presents DNV GL's summary of the results of the environmental impact assessment of the programme of work that would be carried out to partially remove the Brent Alpha jacket to -84.5 m by an HLV. Figure 25 presents their summary of the results of the environmental impact assessment of leaving the footings in place on the seabed.

The most significant impacts from the proposed decommissioning programme for the Brent Alpha jacket were the treatment and recycling of recovered steel in the upper jacket, which was assessed as 'small-moderate positive', and the long-term presence of the footings on the seabed, which was assessed as 'small negative'.

Figure 24 Environmental Impacts from Partial Removal and Onshore Dismantling of the Brent Alpha Jacket.

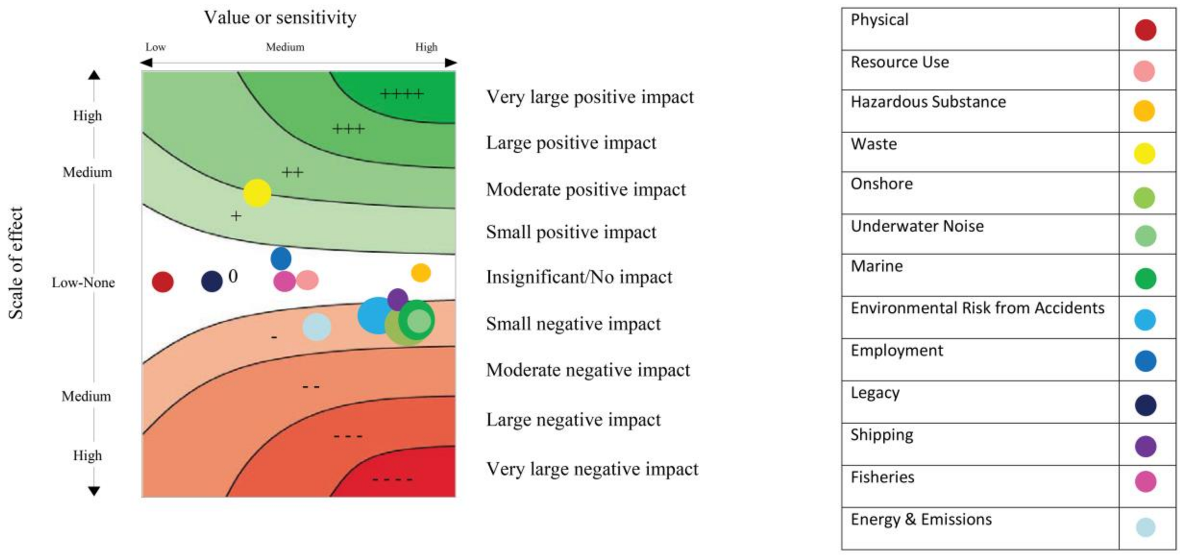
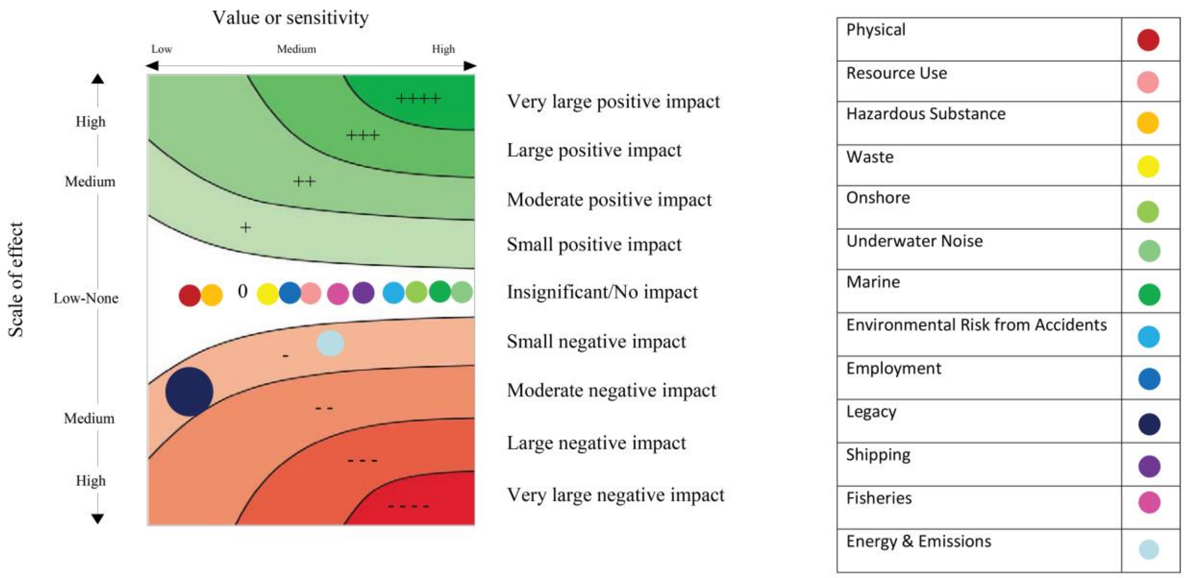


Figure 25 Environmental Impacts from Leaving the Brent Alpha Footings in Place.



10.4.3 Impacts of Offshore Operations

There are no significant negative impacts from the offshore operations to remove the upper jacket. All identified impacts were either insignificant or small (Figure 24). The footings left in place have no operational environmental impacts.

All the proposed offshore operations on the Brent Alpha substructure would occur within the 500 m safety zone around the installation and consequently will not result in any impacts to fishermen or other users of the sea.

The transportation of the upper jacket on an HLV will be a normal marine operation that will not impact other users of the sea. Transportation to Norway is planned to take about 30 hours, and will be suitably notified to mariners and fishermen and is not expected to have any effect on other users of the sea.

Barring a major and very unlikely accident during lifting or transportation, the main potential impact offshore would be the underwater noise from the HLV. The presence of the HLV will increase the level of underwater noise in the area of the installation. Modelling showed that this would be localised and transient, and unlikely to reach a level that would cause more than short-term disturbance to a few individual marine mammals. This noise will be very similar to that already experienced at the site, and is likely to vary depending on the levels of activity. Noises will not begin suddenly, but are likely to increase steadily as vessels enter the 500 m safety zone. Modelling has shown that although the noise frequency from the vessel spread will be within the hearing range of several species of marine mammals, the received noise levels at distances of more than about 900 m are not likely to be high enough to cause 'disturbance behaviour' in marine mammals, and certainly not high enough to cause a temporary threshold shift in their hearing ability. The noise will not cause any harm to fish or other marine species.

10.4.4 Impacts of Onshore Operations

The upper jacket will be received, dismantled, treated and disposed of through the AF Gruppen dismantling facility at Vats in Norway. There are not likely to be any significant impacts to the environment or to communities from these activities at this existing, active, licensed site. However, before the upper jacket is received at the site, we will undertake appropriate assurance assessments for the planned programme of work there, to satisfy our own internal performance requirements.

Pending the completion of our assurance activities for Vats, the DNV-GL assessment of the potential impacts of the dismantling of the upper jacket in the Able Seaton Port facility in Teesside, where the topsides are currently being dismantled, gives a good indication of the likely effects of onshore dismantling. For the Teesside facility, the ES [9] showed that there would be no significant impacts to the communities close to the site during the dismantling of the upper jacket. All the sources of impact were identified and understood and there were, or could be, specific measures in place to minimise or eliminate each type of potential impact. The ES identified no onshore impacts that were worse than 'small negative'. In addition, the removal of the upper jacket was estimated to have a 'small-moderate positive' effect with regards to waste, primarily because of the quantity of steel that would be recycled. Since Vats too is an existing, licensed onshore dismantling site with a record of successful dismantling, it is likely that the impacts of dismantling the upper jacket there will be no worse than those identified for the Able site.

In previous dismantling operations at Vats, for example, various restrictions have been imposed at the site to reduce noise levels and control odour from marine growth.

10.4.5 Legacy Impacts

All the legacy impacts of decommissioning the jacket are associated with the long-term presence of the footings at the Brent Alpha site, and its interaction with the seabed drill cuttings pile. We estimate that about 87% of the total wet mass of material returned to shore will be recycled and consequently it is likely that only a relatively small amount of non-recyclable material, predominantly organic marine growth, will have to be disposed of to landfill. It is not expected that this will have any impact on landfill sites.

As shown in Figure 25, the legacy impact of the footings left in place is estimated to be 'small negative'. This includes the impacts to the marine environment as a result of the degradation and collapse of the footings, and on commercial fisheries as a result of the long-term presence of the footings.

As parts of the footings degrade they will collapse onto the cuttings pile, and so from time to time over a period of perhaps up to 500 years, some small amounts of cuttings may be re-suspended into the water column, and drift and then settle on the adjacent seabed. Modelling of such disturbance events suggests that any impacts will be localised and relatively short-lived, and would be most likely to affect areas of seabed that were previously impacted by the discharge and presence of OBM drill cuttings, or are in the process of recovering from such impacts.

10.4.6 Energy and Emissions

DNV-GL estimate that the planned programme of work for the removal, dismantling and recycling of the upper part of the Brent Alpha jacket will directly use about 240,000 GJ of energy and result in the direct emission of about 16,000 tonnes of CO_2 (Table 24).

Table 24 Energy and Emissions Associated with Partial Removal and Onshore Dismantling of Brent Alpha Jacket.

Operations	Energy (GJ)	Emissions to Atmosphere (tonnes)		
		CO_2	NO_X	SO_2
Marine operations	148,600	11,200	290	110
Onshore dismantling	5,100	400	8	0.3
Onshore transport	2,400	200	4	0.2
Sum	*156,100*	*11,800*	*303*	*110*
Recycling				
Material recycling	82,800	3,800	10	30
Total Direct Usage	238,900	15,600	313	140
Materials not recycled	412,900	36,600	40	30
Total Direct plus Indirect	651,800	52,200	353	170

10.4.7 Cumulative Impacts

There will be no cumulative impacts offshore from the proposed programme of work to remove the upper jacket. The Delta and Bravo topsides have already been removed in previous years, and the 2-3 day operation to remove the Brent Alpha topside was completed in June 2020, approximately one month before the planned upper jacket lift. It is estimated that the Charlie topside will be removed in 2021/22. Consequently, any local and transient effects from underwater noise or gaseous emissions associated with any of these individual operations will not overlap.

There will be no significant cumulative impacts at the onshore dismantling site. The AF Gruppen site at Vats is a large existing facility capable of handling several dismantling programmes simultaneously, and all the operations will be conducted within the terms of its existing licence(s) and conditions as regulated by, for example, the Norwegian Environment Agency and the Norwegian Radiation Protection Authority.

10.5 Mitigation Measures for Brent Alpha Jacket Programme of Work

10.5.1 Assurance

The potential environmental impacts of the programme of work to remove and dispose of the Brent Alpha upper jacket – including offshore cutting, lifting, transportation, onshore dismantling and disposal – have been identified and assessed in the ES [9].

If all or part of the upper jacket were lost to sea, there is a procedure that must be followed for dropped objects associated with oil and gas infrastructure. OPRED must always be notified by a PON2 notification, through which other agencies are also notified. Depending on the location of the dropped object, other statutory notifications and/or procedures will apply to ensure compliance with other legislation e.g. a Marine Licence under the Marine and Coastal Access Act 2009.

10.5.2 Summary of Mitigation Measures

- The programme of work to remove and dismantle the Brent Alpha upper jacket will be conducted under all necessary UK and Norwegian permits, including permits for the transfrontier shipment of waste.
- Appropriate Notices to Mariners will be issued to alert other users of the sea to the proposed operations in the Brent Field, along the tow route to Norway and the back-loading to the Vats dismantling site.
- Explosives will not be used to remove the upper jacket.
- Vessels will be well maintained, to reduce the effects of underwater noise, and use low sulphur fuel, to reduce the effects of gaseous emissions.
- A HAZID was carried out covering the removal of the Brent Alpha upper jacket and its transportation to Vats. The objective of the HAZID was to assess high level controls and interface issues. An activity-specific guideword process was used to help review these issues. The lift contractor HMC will perform detailed risk assessments of the procedures to be used.
- Several actions were generated from the HAZID but the overall conclusion was that suitable arrangements are being put in place to provide a safe lifting and transportation process, although work is still ongoing to define the details of procedures and to provide independent assurance of the safety of the procedures and adequacy of the engineering controls to be applied. A 'small negative' impact from accidental events was determined due to a combination of (i) the risk of dropped objects, (ii) the risk of the jacket being lost, and (iii) the risk of a spillage of heavy fuel oil (HFO) to sea.

  The *Brent Field System and Associated Pipelines Offshore Oil Pollution Emergency Plan (OPEP)* [42] will be in place during lifting operations and Shell have a contract for specialist response services through OSRL should a spill occur. Once the jacket is secured to the HLV any spill of hydrocarbons will be managed through the vessel's SOPEP. Shell will have a bridging document in place with HMC to confirm all responsibilities and response arrangements. It is noted that there is no oil on or in the jacket itself, only the HLV and any attendant vessels.

  Shell and HMC will ensure that all safety testing is completed and warranties are in place before the jacket lift and transportation begins.

ENVIRONMENTAL IMPACT ASSESSMENT

- On completion of offshore operations to remove the upper jacket, other users of the sea will be advised, through the UKHO and Notices to Mariners, of the changed status and condition of the jacket and footings.
- The location and status of the Brent Alpha footings will be entered onto the FishSAFE system to alert fishermen when approaching the structure.
- After the upper jacket has been removed, an as-left structural survey will be performed to accurately determine the condition of the remaining footings and provide a baseline against which to monitor its future condition. This will be completed as part of the Brent Field post-decommissioning surveys. After the upper jacket has been removed, debris in a 500 m radius area around the footings will be removed and the area surveyed to verify that it is free of obstructions to bottom-towed fishing gear. The nature of this survey will be determined by OPRED and may consist of non-contact methods (e.g. side scan survey) or an over-trawl of the area. This may be conducted as part of the wider debris removal programme and over-trawling surveys that will be conducted after all offshore decommissioning work in the Brent Field has been completed.
- The dismantling of the upper jacket, and the treatment and disposal of all resultant waste streams, will take place at the AF Gruppen dismantling site at Vats in Norway, which is fully licensed for the dismantling of offshore structures and the management of these wastes.
- A range of mitigation measures will be applied to minimise the potential impacts of onshore dismantling. These are likely to include carefully planned work practices and programmes, limits to working at night, dust-control measures, and measures to plan and monitor additional road traffic and the movement of large loads.
- A risk-based environmental and structural monitoring programme, to track the long-term degradation and fate of the Brent Alpha footings, will be discussed and agreed with OPRED.

Intentionally left blank

11 INTERESTED PARTY CONSULTATIONS

11.1 Introduction

Throughout the development of the Brent Decommissioning Programmes we have carried out a programme of engagement with both formal and informal consultees and stakeholders. The aims of this programme were to:

- Provide all interested parties with news and information about the BDP, the issues that we were addressing and the information that we were obtaining.
- Create a means by which stakeholders could tell us of their concerns and views on any aspect of the BDP.
- Provide mechanisms for stakeholders to learn about, and discuss, the views and concerns of other stakeholders.
- Allow us to appreciate and understand our stakeholders' concerns, and take these into account when assessing the advantages and disadvantages of different options, and identifying recommended options.

A full description of our stakeholder engagement programme, our stakeholders, and the concerns and issues they raised is given in our *Brent Decommissioning Stakeholder Engagement Report* [43].

In accordance with the BEIS Guidance Notes, we undertook a programme of formal statutory consultation on the Consultation Draft DP Document and its supporting documentation from February 2017 to April 2017.

11.2 Work of the Independent Review Group

In view of the breadth and complexity of our CAs and of the technical engineering and environmental studies performed to support them, we established an IRG to review and report on the completeness, objectivity and rigour of the supporting studies, and the methods used to assess and compare options. The IRG, which comprised technical, engineering and environmental experts, did not comment or express any view on our final recommendations, confining its comments solely to whether our conclusions were supported by the evidence we presented. It should be noted that its remit did not cover the wells P&A programme or the decommissioning of the topsides.

The IRG met on twenty-three occasions from January 2007 to September 2016. Details of the IRG and its terms of reference can be found at http://www.shell.co.uk/sustainability/decommissioning/brent-field-decommissioning/brent-field-stakeholder-engagement/irg.html.

In February 2017, the IRG published a final report on its assessments and reviews of our important supporting engineering studies, the six TDs, the DNV GL EIA, our CA procedure and the consultation draft DP. The full report may be found at the Brent Decommissioning website. The IRG had complete editorial control over its report and findings.

11.3 Summary of Comments on Practically-Available Options

For the practically-available options for the Brent Alpha footings, the main issues and concerns raised by stakeholders during the programme of stakeholder engagement were:

Impacts during execution associated with underwater cutting (effects of noise on marine mammals); dropped objects at sea or nearshore; effects on communities of onshore dismantling; and benefits of recycling.

Legacy impacts associated with snagging risks from degrading footings; creation of debris from remains left on the seabed; effect of collapsing footings on seabed cuttings pile and the benthos; and the continued loss of access to fishing grounds from remains left offshore.

11.4 Specific Comments and Responses on Footings Decommissioning

The questions and issues from stakeholders specifically on the decommissioning of the Brent Alpha jacket during the period of Public Consultation were:

- For Brent Alpha your proposal is to leave the footings in situ. However you are also proposing to leave the well conductors partially in place - despite the fact that earlier in the document you claim the wells will be P & A'd in compliance with guidelines that usually include for conductor removal to a level below the seabed. There is clearly a contradiction here.

  Please also note that the conductors are not classified as part of the footings - so please explain what the justification is for leaving them in situ - it is not clear, but I am sure there is one.

  Our response to this question:

  "There are several reasons for seeking to leave the lower parts of the conductors in place with the Brent Alpha footings. After the removal of the upper part of the jacket and the sections of conductor therein, by cutting at approximately -84.5m LAT, the conductors would be held in place by the last conductor guide frame at approximately 109.7m LAT. Because of the presence of Talon connections and other modifications, not all of the conductors could be pulled through this frame. The parts of the conductors above the guide frame would have to be cut and removed, and then guide frame itself would have to be removed, and then the remaining parts of the conductors cut and removed. All of this is feasible, but would add to the complexity, risk and cost, for very little benefit in terms of safety risk to other users of the sea or environmental impact. We recommend that the lower parts of the conductors should be left in place, within the guide frame. The continued presence of the guide frame will add strength to the footings, and leaving the lower parts of the conductors (below the guide frame) in place will avoid physically disturbing the seabed drill cuttings pile which lies within the footprint of the Brent Alpha footings."

- There is no technical reason it [the Brent Alpha jacket] cannot be fully removed. The proposal leaves 55.7 metres protruding from the seabed and as there cannot be navigation lights this will remain a hazard for fishing in perpetuity. Derogation is sought as the jacket weighs over 10,000 tonnes (OSPAR 98/3). Under OSPAR 98/3 there is a general prohibition on the dumping and leaving wholly or partly in place of offshore installations. There is a presumption that the footings will be removed entirely and exceptions will only be granted if it can be demonstrated that there are significant reasons why an alternative disposal option is preferable to reuse, recycling or final disposal on land. OSPAR 98/3 is enshrined in EU law and as the UK will not be in the EU much longer, derogations sought under it will be out of date. It is stated on page 27 of the Brent Field Decommissioning Programme consultation document. "The potential risk of snagging on submerged leg stubs is recognised by fishermen, who prefer the legs to be left upright where they can be seen". If this is the case then the jacket should be left in place with navigation lights. The best solution is to leave the seabed as you found it and the worst solution is to remove part of it leaving behind a snagging hazard in perpetuity, which is what you propose.

  Our response to this question:

  "We have examined a range of technically feasible options for the management of the BA jacket and whilst our studies show that the whole jacket cannot be removed in one piece, it is technically feasible to remove the whole jacket in several pieces. The studies also show that a sensible place to cut the jacket into sections would be at the top of the "footings", some 84m below sea level. Therefore, our Comparative Assessment (CA) includes options for removing the footings, i.e. the complete removal of the whole jacket, as well as leaving the footings in place.

Our CA for the jacket footings shows that while feasible, the technical challenges, safety risks and cost of removing the Brent Alpha jacket footings (while leaving the drill cuttings pile undisturbed on the seabed) are significant, and disproportionately large in relation to the relatively small benefits that would gained in terms of the long- term safety risks to other users of the sea and the environmental impact of removing the footings to shore.

The fishermen have expressed a pragmatic view about leaving footings at this depth. The concern that you refer to is associated with the Gravity Base Structure (GBS) legs, where the fishermen have indeed stated a preference for the legs to be left upright, projecting above the water, where they can be seen."

The following questions and issues were raised specifically on the decommissioning of the Brent Alpha jacket as part of the letter received from the World Wildlife Fund UK (WWF UK) on behalf of WWF UK, Greenpeace UK, Whale and Dolphin Conservation, the Marine Conservation Society, Friends of the Earth Scotland, the Scottish Wildlife Trust, KIMO and RSPB Scotland:

- The CA report states that leaving the Alpha steel footings in place is the best option for safety, technical and cost reasons. Selection of option based on these three criteria only is not compliant with 98/3 – which requires the full list of criteria in Annex 2 of 98/3 to be applied in the CA, including but not limited to environmental impacts and impacts on other users and uses of the area. (e.g. fisheries).

  Our response to this question:

  "As described in the various TDs and summarised in the Brent DPs, the recommendations for each of the facilities subject to CA either under OSPAR Decision 98/3, the DECC Guidance Notes, or OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles are based on a full assessment of all of the sub-criteria that we identified and defined (from the "matters to be considered") as being requisite and complete for the CA procedure.

  For the CAs of the cell contents, drilling leg contents, minicell annulus contents, and drill cuttings piles, either one or both of the sub-criteria "safety risk to other users of the sea" and "impacts on commercial fisheries" were considered not be applicable. In such cases, the description of these particular CAs makes it clear which sub-criterion is not applicable, and why it is considered not applicable.

  Apart from the exceptions explained above, we used all 12 sub-criteria in all the CAs. The narrative sections ("Identification and Discussion of the Recommended Option") of each of the CAs, presented in full in the relevant TDs, describe the performance of each option in each sub-criterion, and the "difference charts" help to identify those sub-criteria that show greatest differences between options.

  After reviewing the performances of the options in all the sub-criteria, and in line with OSPAR Decision 98/3 and the DECC Guidance Notes, we then examined in more detail the performances of options in those sub-criteria that showed greatest differences between the options, having acknowledged and described all the other sub-criteria where there are no, or only very small, differences between the options.

  We believe this overall approach is in line with the DECC Guidance Notes which state (Annex A, page 60):

  > "*If the comparative assessment of the options identifies two or three matters that show a significant difference, judgement will need to be exercised as to which should be given the greatest consideration*"."

- It should be noted that decommissioning of the Ekofisk platforms in Norwegian waters in 2008-2014 included the successful removal and recycling onshore of the complete steel jackets from no less than nine (9) offshore platforms."

  Our response to this question:

  "Whilst preparing our decommissioning plans, and examining potential options and engineering solutions, we have kept abreast of current engineering and technical developments in decommissioning, and with the experience and lessons learned from past and current decommissioning programmes by other operators.

  In our view, the nine Ekofisk platforms decommissioned between 2008 and 2014 are not comparable to the Brent Alpha steel jacket (which in air has an estimated weight of approximately 31,000 tonnes and stands in water 140m deep). The Ekofisk platforms (Ekop, Ekor, Alba, Albf, Edda, Cod, Ekod, Ekow and Ekqq) were located in water depths ranging between 70m to 90m, and were of a simpler design and construction than the Brent Alpha jacket, and only weighed from 3,000 tonnes to 9,000 tonnes. Accordingly, none of these platforms came within the scope of a derogation category for the purposes of Annex 1 of OSPAR Decision 98/3."

- It is recommended that an independent re-evaluation of options for the Alpha steel jacket be undertaken including applying all 98/3 criteria to all options in a more complete CA.

  Our response to this question:

  "As part of our Comparative Assessment process we examined a wide range of alternative, re-use, recycling and disposal options for these facilities, as per the requirements of OSPAR Decision 98/3. As a result, we identified practically-available options, and carried these forward to the later numerical stages of our CA process. The reasons why some options were not taken forward were explained in the DP. As mentioned earlier, we will update the narrative within the DP and TDs to make this clearer.

  In accordance with the OSPAR Framework for Assessment and the DECC Guidance Notes, we identified and defined 12 sub-criteria which could be applied to all facilities and options, to assess performance.

  For the BA jacket, we subjected the technically feasible options to a CA that followed the requirements of the Framework laid down in Annex 2 of OSPAR 98/3 as supported, and as clarified, by the guidance in the DECC Guidance Notes. All 12 of our CA sub-criteria were applied in the CA for the Brent Alpha steel jacket.

  We note the following comments extracted from the IRG's Final Report:

  > "*The IRG commends the thorough and extensive efforts made by Shell to acquire, make available and document the information needed in support of the programme, to use the best available methodologies, and the cooperative and constructive response of Shell staff to IRG queries and requests for more information, including in several cases the commissioning of new or expanded studies as a result of suggestions made by the IRG*".
  >
  > *"The IRG has reviewed and commented on reports by Shell and its contractors on all relevant aspects of the DP, and is satisfied that a sufficiently wide range of options have been examined. The IRG has also assessed the rationale leading to the decisions by Shell and confirms so far as it can judge, the scientific, engineering and other evidence used, and rationale developed, appear to be adequate to enable the decisions to be made. In particular, the IRG accepts the evidence that supports the conclusions that the complete removal of the Brent Alpha jacket is technically feasible, but may well not be preferred option, because of the trade-off between low technical feasibility and high cost, versus small benefits to fishermen and a limited reduction of the small residual environmental impact expected"."*

11.5 Brent Derogation Document

Consultation on the Derogation Assessment [8] prompted comments from OSPAR signatories, including Germany and the Netherlands. Several were of a generic nature concerning, for example, the way in which the CAs had been performed, the availability of information and reports, and the way in which uncertainty had been dealt with in the assessments. Shell and OPRED have responded to all these concerns, and a summary of the concerns and responses will be presented in the post-consultation Field DP, and so is not presented here.

With regards to the proposed decommissioning programme for the Alpha jacket, the following concerns and responses were expressed:

1. Derogation has become the default position for jacket footings:

In both the Jacket DP and the Derogation Assessment document, the site- and installation-specific CA was performed for the Alpha jacket in accordance with the requirements of OSPAR Decision 98/3. The CA showed that the recommended option for the jacket, both with and without any consideration of the presence of the historical seabed drill cuttings pile, was to remove the upper jacket and return it to shore for dismantling and recycling, and leave the footings in place on the seabed.

2. The conductors are not part of the footings, and it is possible to remove them:

The lower parts of the conductors, within the depth range of the footings, are considered to be an integral part of the footings and as such could be left in place.

3. The degradation and collapse of the conductors was not taken into account when assessing the impacts of leaving the footings on the seabed:

Shell contracted the independent engineering consultants Atkins to undertake an assessment of the degradation and longevity of the conductors, and the effects of their collapse on the overall degradation and longevity of the footings [28]. The study also confirmed that the conductors are likely to corrode at about the same rate as steel components of the same thickness on the footings. The tall slender vertical conductors, supported only by a single horizontal framing about halfway along their length, will not remain upright longer than the associated footings, and therefore the degrading conductors will not present an additional snagging hazard to bottom-towed fishing gear once the footings have collapsed.

4. The effects of collapsing conductors disturbing the seabed drill cuttings pile were not properly taken into account:

Reference should be made to the separate study performed by independent consultants BMT on the effects of human disturbance and over-trawling of cuttings piles in the Field [18]. While not specifically assessing the effects of falling debris on the pile at Alpha (because of the wide range of possible impact scenarios) this study nonetheless gives a quantitative assessment of the likely extent and duration of environmental impacts when certain volumes of drill cuttings are resuspended into the water column. This study in turn helped to inform the assessment of impacts from these sources by DNV GL as reported in the ES [9].

The OSPAR consultation culminated in a Special Consultative Meeting (SCM) in October 2019. The Chairman's Report on the SCM did not contain any specific mention of the decommissioning of the Alpha jacket and it was not discussed during the additional bilateral discussions with the German and Netherlands representatives in Q1 2020.

Intentionally left blank

12 PROGRAMME MANAGEMENT

12.1 Strategy

The strategy for this project is to maximise the use of our in-house resources and existing contracts for the preparatory work, and to award lump sum contracts to pre-qualified prime contractors for the main decommissioning activities such as the removal and disposal of the upper jacket.

12.2 Project Management

The project will be managed in accordance with applicable regulatory requirements and to Shell's Global Project Management standards. The project will be led by a Shell Project Director with sub-project managers, project engineers and support functions including, but not limited, to Health, Safety and Environment, Quality, and Project Services. The project will be divided into a series of sub-projects and tendered to the open market as appropriate. Synergies will be sought with other Shell project activities (and in principle other decommissioning activities) where they make economic and business sense.

If approved, the DP will be subject to strict change management, with any significant change to scope being agreed with OPRED prior to implementation.

12.3 Preparatory Work

We will work closely with our contracting partners to prepare the upper jacket for decommissioning. This work will include topside and pipeline flushing, removal of the topside, and the design, fitting and testing of jacket lifting points and a steel frame to support the section of conductors to be removed.

12.4 Notifying Other Users of the Sea

At least six weeks before jacket lifting operations begin, we will notify the UK Hydrographic Office so that appropriate Notices to Mariners can be distributed. At the same time an advisory notice about the planned programme of work will be placed on the Sea Fish Industry Authority's Kingfisher Bulletin.

12.5 Debris Clearance and Verification

The planned programme to remove the upper jacket by HLV will not result in the deposition of any debris on the seabed at the Brent Alpha site. If an unforeseen incident results in the deposition of any item on the seabed this will be reported to OPRED and we will consult with OPRED about an appropriate course of action to ensure that it does not give rise to any safety risk, commercial impact to other users of the sea or environmental impact. The existing debris on the seabed within a 500 m radius of the Brent Alpha jacket will be removed in one or more 'campaigns' which will be performed across the whole Brent Field once all the platforms and pipelines have been decommissioned.

After removal of the upper jacket, the new status of the footings will be entered into the FishSAFE programme of electronic warning, the UKHO and MCA will be notified, and a Notice to Mariners will be issued so that other users of the sea can amend their charts.

For the decommissioning of the upper jacket, verification activities will concentrate on the management of onshore work and the disposal of waste streams through the AF Gruppen dismantling site at Vats. This will fulfil our duty of care with respect to the waste streams arising from the upper jacket, and provide confirmation of the final location or fate of all material returned to shore.

Although our dismantling and disposal contract is with AF Gruppen, we will have a continuing involvement with the planning, management and execution of the dismantling programme. After completion of the load-in at the Vats site, ownership of the upper jacket will transfer to AF Gruppen but we will continue to monitor their activities against the requirements of the dismantling contract to ensure successful completion of the dismantling and disposal phase of the work. This will include reviewing and approving necessary documents, monitoring execution activities and participating in significant joint meetings.

12.6 Verification

At significant milestones in the planning and execution of the project, work will be subject to internal peer reviews by Shell and by Esso. Major technical decisions will also be subject to approval from Shell's internal 'technical authorities'.

12.7 Reporting Progress

An interim Brent Alpha progress report will be submitted to OPRED after the upper jacket has been off-loaded at Vats. Given the relatively uncomplicated and short programme of work to dismantle and dispose of the steel jacket, it is proposed that a single final close-out report will be issued at the end of the period of dismantling. This will present details of the masses of material received and the amounts re-used, recycled or disposed of to landfill.

12.8 Duty of Care for Waste Materials

In planning and managing the responsible disposal of our materials we will follow the 'waste hierarchy', which states that re-use is preferred to recycling, and recycling is preferred to disposal to landfill. In order of decreasing preference, the hierarchy of how material from the Brent Alpha upper jacket will be disposed of is therefore as follows:

- Removal of equipment for re-use
- Segregation of pipes for re-use (recovered end sections)
- Segregation of steelwork and other materials for re-use
- Segregation of materials for recycling
- Segregation of materials (including hazardous materials) for disposal

Table 25 presents a summary of how the main waste streams will be dealt with. All hazardous materials will be appropriately handled and disposed of in accordance with the relevant legislation. We expect that the bulk of the recovered jacket material will be recycled but the organic material recovered in the marine growth adhering to the jacket and conductors will have to be disposed of to a licensed landfill site.

Any equipment and/or materials suitable for re-use will be stored and preserved in suitable warehouses or designated storage areas. Other materials will be collected by type and stored in separate areas for shipment to smelters or other recycling facilities.

Materials not suitable for any of the above treatments (including hazardous materials such as asbestos, Low Specific Activity (LSA) contaminated materials, and heavy metals) will be collected and then removed for disposal in landfill and/or other approved disposal facilities. All wastes will be dealt with in accordance with the appropriate legislation, including if applicable, the Transfrontier Shipment of Waste Regulations.

The project has set a target to recycle and re-use at least 97% by weight of the equipment and recyclable materials retrieved. Given the mass of organic material in the marine growth on the upper jacket, however, it is expected that about 87% of the total recovered wet mass of the jacket will be recycled. We will comply with our legal duties with respect to the management, treatment and disposal of all waste equipment and materials retrieved during the decommissioning programmes.

Table 25 Summary of Methods for Managing Waste Streams.

Waste Stream	Removal and Disposal Method
Steel	Steel will be removed by dismantling or by hot or cold cutting. Scrap metals will be transported by road, rail or sea to suitably-licensed facilities for processing.
Hydrocarbons	It is not expected that any hydrocarbons will be present in the upper jacket. The casings in the conductors will have been flushed and drained before removal, and the upper jacket never contained any petroleum hydrocarbons. If any residual amounts of hydrocarbon are found, they will be drained into suitable receptacles and sent to a licensed facility for recycling or disposal.
NORM/LSA Scale	It is not expected that the upper jacket will contain any Naturally-Occurring Radioactive Material (NORM) or LSA scale. During the dismantling operations, radiation monitoring will be undertaken on any part of the structure that is suspected to contain NORM. If monitoring reveals the presence of LSA scale a detailed method statement for the removal of the component will be prepared. All NORM will be handled, stored and treated in accordance with the applicable Norwegian legislation as regulated by the Norwegian Radiation Protection Authority.
Asbestos	A small amount of asbestos is present in the felt coating on one of the risers. At the onshore dismantling site, this coating will be removed by personnel wearing suitable and appropriate protective clothing and respiratory equipment, and disposed of to a licensed landfill site.
Other Hazardous Wastes	Any other hazardous wastes that are found on or in the upper jacket will be disposed of under appropriate permit(s).

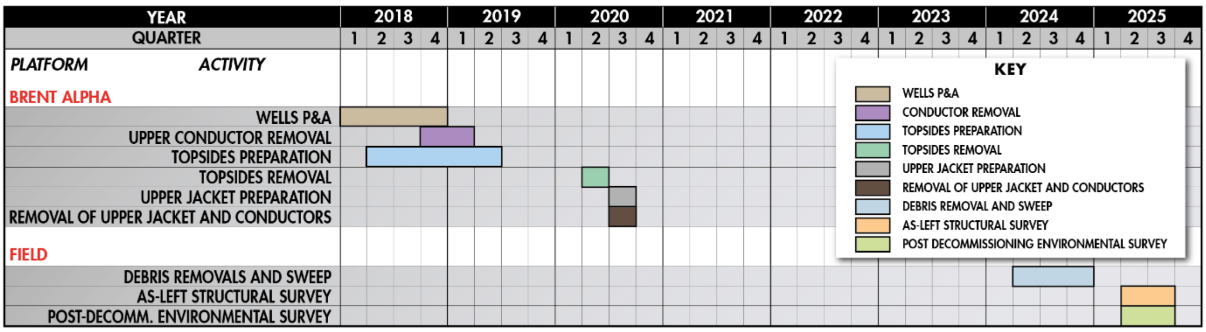
12.9 Ongoing Management/Reporting

The responsibility for the subsequent management of on-going residual liabilities of the Brent Alpha footings, including managing and reporting the results of the agreed post-decommissioning monitoring, evaluation and any remedial programme, will remain with the owners. The owners will also be the contact point for any third party claims arising from damage caused by the remaining infrastructure or materials left in place under the approved Brent Alpha Jacket Decommissioning Programme. All the parts of the Brent Alpha footings which are proposed to be left in place remain the property and responsibility of the owners, even if they were to exit the UKCS.

12.10Schedule

Figure 26 outlines the main phases of work in the decommissioning programme for the Brent Alpha installation.

Figure 26 Indicative Timing and Duration of the Proposed Brent Alpha installation Decommissioning Programme of Work.



12.11 Costs

An estimate of the overall cost of the proposed programme of work to decommission the Brent Alpha upper jacket has been provided separately to OPRED.

12.12 Close-out Report

The proposed programme of work to remove and dismantle the Brent Alpha upper jacket will take less than one year to complete (Figure 26). We therefore propose to issue an interim progress report once the upper jacket has been offloaded at Vats, and this will also include a description of the "as-left" condition of the footings. A final close-out report will be issued once the jacket has been dismantled and all the material segregated and despatched for re-use, recycling or disposal.

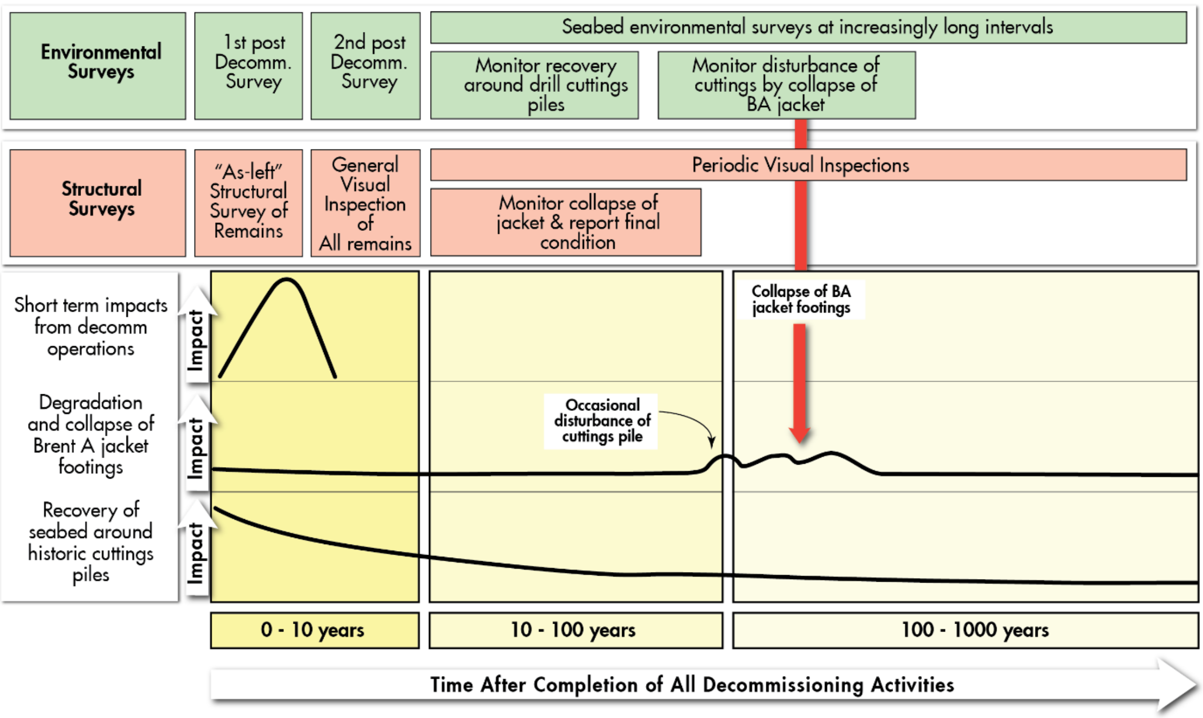
12.13 Post-decommissioning Monitoring and Evaluation

12.13.1 Introduction

Our proposed environmental and structural monitoring programmes have been designed to monitor two types of event (i) environmental effects and, (ii) the physical degradation and collapse of remains. Figure 27 presents a visualisation of the possible timing of potential effects arising from the operations and legacy of the proposed programme of work for the Brent Alpha jacket. After the local disturbance that may be caused by the offshore decommissioning operations in 2020 there are not likely to be any potential impacts to monitor for perhaps 100-200 years.

After removal of the upper jacket, we will discuss and agree with OPRED a programme of monitoring for the footings.

Figure 27 Relative Timescales of Impacts from Offshore Operations and Some of the Long-term Consequences of Leaving Material on the Seabed at Brent Alpha.



12.13.2 Pre-decommissioning Environmental Surveys

We completed a pre-decommissioning baseline environmental survey in 2007 to provide essential information for the EIA and our CAs, and repeated this survey in 2015. Together, these surveys provide a detailed assessment of the status of the seabed around the Brent Alpha jacket before offshore operations begin. They add to our time-series of data showing how the character of the benthic community and the concentrations of oil and other contaminants in the seabed immediately adjacent to the historic seabed drill cuttings pile have changed over time, especially since the discharge of oil-based drill cuttings ceased.

12.13.3 Post-decommissioning Environmental Surveys

A post-decommissioning environmental survey will be conducted when all offshore work has been completed. The survey will re-visit all the stations sampled in the two pre-decommissioning baseline surveys, to obtain a directly comparable set of data which would allow us to determine with a high degree of certainty if the offshore operations have had any impacts on the local environment.

12.13.4 Future Environmental Monitoring

We propose to carry out a second post-decommissioning environmental survey about 5 years after the first one, again re-visiting the previous sampling stations. This would be the fourth in a time series of comprehensive and comparable surveys and should provide a good assessment of the extent of any perturbation caused by the offshore operations, and more data on the general character and state of the seabed in the Field.

If the post-decommissioning surveys show that there have been impacts from our operations we will continue the environmental surveys at about 5-year intervals until such time as there is a clear trend showing that recovery is taking place and will occur within a reasonable time-scale.

Thereafter, we will discuss the need for further environmental surveys with OPRED. Once the seabed has recovered from any operational impacts it is, for many years, unlikely to experience any further perturbation, which could arise from either the physical presence of degraded remains or from disturbance to the historic seabed drill cuttings pile from falling steel debris from the footings. Future environmental surveys therefore have to be targeted to anticipated events or milestones in the slow degradation of remains when there will be a heightened risk that falling debris may resuspend drill cuttings. There are no contaminants inside the legs or members of the steel footings; the footings never contained hydrocarbons.

12.13.5 Monitoring Degradation and Collapse of Remains

Once we have performed the proposed detailed 'as-left' structural surveys after completion of the proposed Decommissioning Programme, it is unlikely that any noticeable structural degradation would occur for 30-40 years. Our programme of post-decommissioning structural monitoring therefore needs to be targeted and 'risk-based' since routine annual surveys will be very wasteful.

The post-decommissioning as-left structural survey will provide detailed information on the Brent Alpha footings. Informed by this survey, we will enter into discussions with OPRED to plan and agree the content and frequency of a risk-based long-term structural monitoring programme.

Intentionally left blank

13 SUPPORTING MATERIAL

[1] Petroleum Act, 1998.

[2] BEIS, 2018. Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines, November 2018.

[3] DECC, 2011. Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998. Version V6, Department of Energy and Climate Change, March 2011.

[4] OSPAR, 1998. Decision 98/3 on the Disposal of Disused Offshore Installations. Ministerial meeting of the OSPAR commission – SINTRA: 22 – 23 July 1998.

[5] Shell, 2015. Brent Delta Topside Decommissioning Programme, BDE-D-TOP-AA-5880-00001.

[6] Shell, 2017. Brent Field Decommissioning Programmes, BDE-F-GEN-AA-5880-00015.

[7] Shell, 2018. Brent Field Topsides Decommissioning Programme, BDE-F-TOP-AA-5880-00001.

[8] Shell, 2018. Brent Decommissioning Derogation Assessment, BDE-F-GEN-HX-7180-00001.

[9] DNV GL, 2017. Brent Field Decommissioning Environmental Statement, published by Det Norske Veritas, BDE-F-GEN-HE-0702-00006.

[10] Oil and Gas UK Limited, 2012. Guidelines for Suspension and Abandonment of Wells.

[11] Shell, 2019. Brent Field Pipelines Decommissioning Programme, BDE-F-PIP-AA-5880-00002.

[12] Shell, 2017. Brent Alpha Jacket Decommissioning Technical Document BDE-A-JKT-BA-5801-00001.

[13] Shell, 2017. Brent Field Pipelines Decommissioning Technical Document, BDE-F-PIP-BA-5801-00001.

[14] Shell, 2017. Brent Field Drill Cuttings Decommissioning Technical Document, BDE-F-SUB-BA-5801-00001.

[15] Subsea7, 2007. Shell Brent Decommissioning Project, MBES Survey Brent Alpha, BDE-A-SUB-CG-8417-00001.

[16] BMT Cordah, 2016. Long Term Fate and Effects of Cuttings Piles at Brent Alpha and Brent Charlie, BDE-F-GEN-HE-0702-00009.

[17] OSPAR, 2006. Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles.

[18] Shell, 2017. Brent Field Decommissioning Comparative Assessment Procedure, BDE-F-GEN-QA-6003-00007.

[19] BMT Cordah, 2016. Effects of Human Disturbance on the Brent Alpha and Brent Charlie Cuttings Piles with Additional Modelling, BDE-C-SUB-HE-0702-00004.

[20] Anatec Limited, 2011. Assessment of the safety risk to fishermen from derogated footings of the Brent Alpha steel jacket, BDE-A-JKT-HX-0709-00003.

[21] Anatec Limited, 2017. Assessment of Safety Risk to mariners from Derogated GBSs in the Brent Field, BDE-F-GBS-HX-0709-00003.

[22] Anatec Limited, 2014. Assessment of safety risk to fishermen from decommissioned pipelines in the Brent Field, BDE-F-PIP-HX-0709-00002.

[23] MacKay Consultants, 2014. Brent Decommissioning: Assessment of socio-economic effects on commercial fisheries, BDE-F-GEN-HE-0702-00003.

[24] MacKay Consultants, 2014. Brent Decommissioning: Likely economic and employment impacts, BDE-F-GEN-AA-6844-00001.

[25] Shell, 2017. Brent Topsides Decommissioning Technical Document; BDE-F-TOP-HE-0709-00001.

[26] GL Noble Denton, 2010. Brent Alpha jacket removal re-float feasibility study, BDE-A-JKT-CS-8225-00007.

[27] Shell, 2012. Degradation and longevity study, BDE-A-JKT-CS-8225-00006.

[28] Atkins, 2019. Shell Brent Decommissioning Study: GBS and BA Conductor Degradation Study, BDE-F-GEN-CX-8380-00001.

[29] UKOOA, 2005. UKOOA Drill Cuttings Initiative Phase III Final Report.

[30] .JNCC, 2010. JNCC guidelines for minimizing the risk of injury to marine mammals from using explosives. Joint Nature Conservation Committee, 10pp.

[31] Heerema, 2018. Brent Alpha Jacket and Conductors – Calculation – Jacket Weight Reconciliation, BDERSC-A-JKT-CS-8180-00001.

[32] Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) (Amendment) Regulations 2007.

[33] Gardline Environmental Surveys Limited, 2011. Brent A, Brent B, Brent C and Brent South pre-decommissioning environmental survey report, BDE-F-GEN-HX-7880-00001.

[34] Gardline Environmental Surveys Limited, 2011. Brent Delta pre-decommissioning environmental survey report, BDE-D-GEN-HX-0780-00001.

[35] Gardline Environmental Limited, 2012. Brent Charlie cell-top drill cuttings environmental survey report, BDE-C-SUB-HE-0702-00003.

[36] Fugro EMU 2017. Brent Alpha Pre-Decommissioning Environmental Survey Data Report, BDE-A-GEN-HX-7880-00001.

[37] Fugro EMU 2017. Brent Field Temporal Report Block 211/29, BDE-F-GEN-HX-7180-00006.

[38] European Commission, 2001. European Commission (EC) Guidance in EIA Scoping, June 2001.

[39] European Commission Guidance Checklist of Criteria for Evaluating the Significance of Environmental Effects, presented in EC 2001, above.

[40] DNV, 2011. Environmental Scoping Report for the Brent Field EIA, BDE-F-GEN-HE-0702-00004.

[41] Institute of Petroleum (IoP), 2000. Guidelines for the calculation of estimates of energy use and gaseous emissions in the removal and disposal of offshore structures. ISBN 0 85293 255 3.

[42] Shell, 2011. Brent Field System and Associated Pipelines Offshore Oil Pollution Emergency Plan (OPEP), Document Number 3149-010.

[43] Shell, 2017. Brent Decommissioning Stakeholder Engagement Report, BDE-F-GEN-HX-5480-00001.

14 PARTNER LETTER

Esso Exploration and Production UK Limited
Correspondence:
Union Plaza
1 Union Wynd
Aberdeen AB10 1SL
john.gillies@exxonmobil.com

ExxonMobil

Department for Business, Energy and Industrial Strategy
Offshore Decommissioning Unit
AB1 Building, 3rd Floor
Crimon Place
Aberdeen
AB10 1BJ

14th July 2020

Dear Sir or Madam,

Petroleum Act 1998

BRENT ALPHA JACKET DECOMMISSIONING PROGRAMME

We acknowledge receipt of your letter dated 12th December 2014 regarding the abandonment programme for the Brent installations.

We, Esso Exploration and Production U.K. Limited, confirm that Shell U.K. Limited is authorised on our behalf to submit an abandonment programme relating to the Brent Alpha Jacket, as directed by the Secretary of State on the above date.

We confirm that we support the proposed details in the Brent Alpha Jacket Decommissioning Programme which as been submitted for approval in 2020 by Shell U.K. Limited.

Yours faithfully

John Gillies
Projects and Technical Manager

For and on behalf of Esso Exploration and Production U.K. Limited

Page 1 of 1

Registered Office

ExxonMobil International Limited.

Registered Office: Ermyn House, Ermyn Way,
Leatherhead, Surrey KT22 8UX

An ExxonMobil Subsidiary

Intentionally left blank

15 ACRONYMS AND GLOSSARY

ALARP	As Low As Reasonably Practicable
AtoN	Aid To Navigation
AWJ	Abrasive Water Jetting
BAT	Best Available Technology
BDP	Brent Decommissioning Project
BEIS	Department for Business, Energy and Industrial Strategy
BEP	Best Environmental Practice
BHA	Bottom Hole Assembly
BTA	Buoyancy Tank Assemblies
CA	Comparative Assessment
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
CoP	Cessation of Production
DECC	Department of Energy and Climate Change
DP	Decommissioning Programme
DWC	Diamond Wire Cutting
DyP	Dynamic Positioning
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEED	Front End Engineering and Development
FFDP	Final Field Development Plan
FLTC	Fisheries Offshore Oil & Gas Legacy Trust Fund Limited
FishSAFE	An electronic means of alerting vessels to the proximity of a structure in the sea. (www.fishsafe.eu)
FLAGS	Far North Liquids and Associated Gas System
GBS	Gravity Base Structure
GJ	Gigajoule (10^9 joules)
HAZID	Hazard Identification
HFO	Heavy Fuel Oil
HLV	Heavy Lift Vessel
HMC	Heerema Marine Contractors
HSE	Health and Safety Executive
ICES	International Council for the Exploration of the Sea
IoP	Institute of Petroleum
IRG	Independent Review Group
JNCC	Joint Nature Conservation Committee
kg	kilogramme
KIMO	Kommunenes Internasionale Miljøorganisasjon (KIMO) UK Network
km	kilometre
LAT	Lowest Astronomical Tide
LSA	Low Specific Activity (scale)
LTFD	Long-term Field Development
m	metre
MAIB	Marine Accident Investigation Branch
MBES	Multi-Beam Echo Sounder
MCA	Maritime and Coastguard Agency
MCDA	Multi-Criteria Decision Analysis
MOD	Ministry of Defence
MSF	Module Support Frame
NLGP	Northern Leg Gas Pipeline
Nm	Nautical mile
NNS	Northern North Sea
NORM	Naturally Occurring Radioactive Material
OBM	Oil-based Mud
OGA	Oil and Gas Authority
OPEP	Oil Pollution Emergency Plan
OSPAR	Oslo Paris Commission
P&A	Plug and Abandon
PEC	Predicted Environmental Concentration
PGDS	Plate Girder Deck Support
PLL	Potential Loss of Life
PLEM	PipeLine End Manifold

PNEC	Predicted No-Effects Concentration
PON	Petroleum Operations Notice
QRA	Quantitative Risk Assessment
RSPB	Royal Society for the Protection of Birds
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SLV	Single Lift Vessel
SOPEP	Shipboard Oil Pollution Emergency Plan
SSCV	Semi-Submersible Crane Vessel
TAC	Total Allowable Catch
TD	Technical Document
te	metric tonne (1,000kg)
TF	Technical Feasibility
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
UKOOA	United Kingdom Offshore Operators' Association (now Oil and Gas UK)
VASP	Valve Assembly Spoolpiece
WBM	Water-Based Mud
WLGP	Western Leg Gas Pipeline
WWF UK	World Wildlife Fund UK
WROV	Work-class Remotely Operated Vehicle