MARATHON
BRAE

Brae Alpha Jacket/Sub-Structure Comparative Assessment

June 2019 I05

Marathon Oil

9020-MIP-99-PM-RT-00001-000, I05

Document Control

Approvals

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Revision Control

Revision No	Reference	Changes/Comments	Issue Date
0	Draft	Issued for internal comment	April 2016
1	Issue	Issued for use	April 2016
2	Issue	BEIS substituted for DECC	January 2017
3	DP Issue	Updated for issue with Consultation Draft Decommissioning Programmes	June 2017
4	Issue for Use	Revised in light of OPRED comments on Brae Bravo Comparative Assessment.	February 2019
5	Issue for Use	Minor revisions to align with changes to Brae Bravo CA and Brae Alpha Derogation Application	June 2019

1. Executive Summary

Marathon Oil is planning the decommissioning of the Brae Alpha platform. As part of this process Marathon Oil determined the recommended option for decommissioning the platform jacket/sub-structure.

The default option for decommissioning a platform jacket/sub-structure is complete removal in line with OSPAR Decision 93/8 [1]. However, since the Brae Alpha jacket/sub-structure was installed prior to 1999, and its weight in air is greater than 10,000 tonnes, it is a candidate for derogation from the OSPAR decision, which would allow the jacket/sub-structure footings to be left in place. The best, or recommended, decommissioning option for the jacket/sub-structure is determined by a number of different factors, ranging from technical to societal to economic aspects. To balance these factors and arrive at an optimal solution, in 2016 Marathon Oil started a comparative assessment of the complete and partial removal decommissioning options.

The comparative assessment had two objectives;

- to inform Marathon Oil's selection of the recommended decommissioning option, and, in the event that the recommended option was found to be partial removal,
- to meet OSPAR's requirement that any derogation request to leave part of an offshore installation in place is supported by a comparative assessment.

Marathon Oil's comparative assessment process followed the Department for Business, Energy and Industrial Strategy (BEIS formerly known as DECC) and Oil and Gas UK guidance [2], [11].

When Marathon Oil started the comparative assessment process in 2016, planning for decommissioning was at an early stage, and the details of the decommissioning contractors and the methods that would be used for decommissioning were undecided. Marathon Oil therefore included both complete and partial removal options in the CA process. The CA took account of safety, environmental, technical, socio economic and cost factors, and concluded that the recommended decommissioning option was partial removal.

As part of Marathon Oil's commitment to continually review the options and methods available to decommission the facilities, and following further discussions both internally and externally with contractors and others, Marathon Oil has determined that complete removal of the Brae Alpha jacket/sub-structure is not technically feasible, for the following reasons;

- It would be necessary to excavate to more than 3m below the seabed to cut the piles, as internal cutting is not feasible. The depth below the seabed and the scale and arrangement of the piles makes access to carry out the cuts extremely problematic.
- Cutting tools are not available in sizes or configurations that are able cut the Brae Alpha piles.
- The size of the jacket/sub-structure is such that it would be necessary to cut it into pieces to remove it in its entirety. There is a high likelihood that portions of the jacket/sub-structure would topple once they were cut. Recovering the toppled sections of the jacket sub-structure would involve further offshore vessel based work that would likely entail the use of divers. This would increase the risk to personnel involved in the decommissioning operations.
  Recovering the toppled sections would also involve the consumption of additional resources with the associated environmental impacts.
- There would be significant stiction and suction between the jacket/sub-structure and the seabed. These factors increase the likelihood of being unable to safely lift the jacket/sub-structure or the lower parts of it from the seabed.

The comparative assessment only considered the Brae Alpha platform jacket/sub-structure. The Brae Alpha platform topsides and associated pipelines, subsea infrastructure and stabilisation features were excluded from the scope of the comparative assessment. These aspects of the Brae Area infrastructure were subject to separate assessment.

There is a drill cuttings pile at the base of the Brae Alpha jacket/sub-structure. The presence of the cuttings pile was not included in the comparative assessment to avoid prejudice in the assessment of the jacket/sub-structure decommissioning options. The cuttings pile was the subject of a separate comparative assessment process using a Net Environmental Benefit Analysis (NEBA) methodology. This concluded that leaving the drill cuttings in place to degrade naturally was the recommended option.

In summary,

- Marathon Oil completed a comparative assessment of complete and partial removal of the Brae Alpha jacket/sub-structure. The comparative assessment concluded that the recommended decommissioning option is partial removal of the jacket/sub-structure.
- Subsequent to the comparative assessment in 2016, Marathon Oil determined that complete removal of the Brae Alpha jacket/sub-structure is not technically feasible. Therefore, partial removal of the jacket/sub-structure is the only feasible option.
- Marathon Oil proposes to remove the jacket/sub-structure to a depth of approximately 86m below sea level (lowest astronomical tide). This is approximately 26m above the seabed.

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2. Background

2.1 Regulatory Requirements

The UK's international decommissioning obligations are governed by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention [1]). In July 1998, the OSPAR Commission adopted a binding Decision (OSPAR Decision 98/3) to prohibit the disposal of offshore installations at sea. The Offshore Petroleum Regulator for the Environment and Decommissioning (OPRED) is the competent authority on decommissioning in the UK for OSPAR purposes. OPRED is part of the UK government Department for Business, Energy and Industrial Strategy (BEIS).

OSPAR Decision 98/3 recognised that there may be difficulties in removing the 'footings' of large steel jacket/sub-structures weighing more than 10,000 tonnes. Therefore, Decision 98/3 includes the possibility of derogation from the requirement to completely remove such jacket/sub-structures. Nevertheless, there is a presumption in the OSPAR Decision that installations will be removed entirely, and exceptions will only be granted if a comparative assessment including consultation with stakeholders shows that there are significant reasons why leaving footings in place is preferable to reuse, recycling, or final disposal on land.

Within the United Kingdom Continental Shelf the Petroleum Act 1988 is the principal legislation governing decommissioning of oil and gas installations. The decommissioning aspects of the Act are administered by BEIS through OPRED. If the duty holder for an installation wishes to obtain derogation from OSPAR Decision 98/3 to leave footings in place, the duty holder must first make a case to OPRED, which OPRED will then take forward to the other members of OSPAR.

The Brae Alpha jacket/sub-structure meets the OSPAR 98/3 criteria for consideration for derogation. Marathon Oil and its partners therefore wished to determine if leaving part of the Brae Alpha jacket/sub-structure in place is the recommended decommissioning option, and if it is, to make the case for derogation to OPRED and ultimately to OSPAR. Complete removal was used as the baseline, or default option, for the comparison of alternatives.

The BEIS guidance notes on decommissioning [2] identify comparative assessment criteria in five areas: safety, environment, technical, societal, and economic. Marathon Oil's aim for the comparative assessment was to ensure that the recommended decommissioning option for the Brae Alpha jacket/sub-structure represents the optimum balance of impacts against these five criteria.

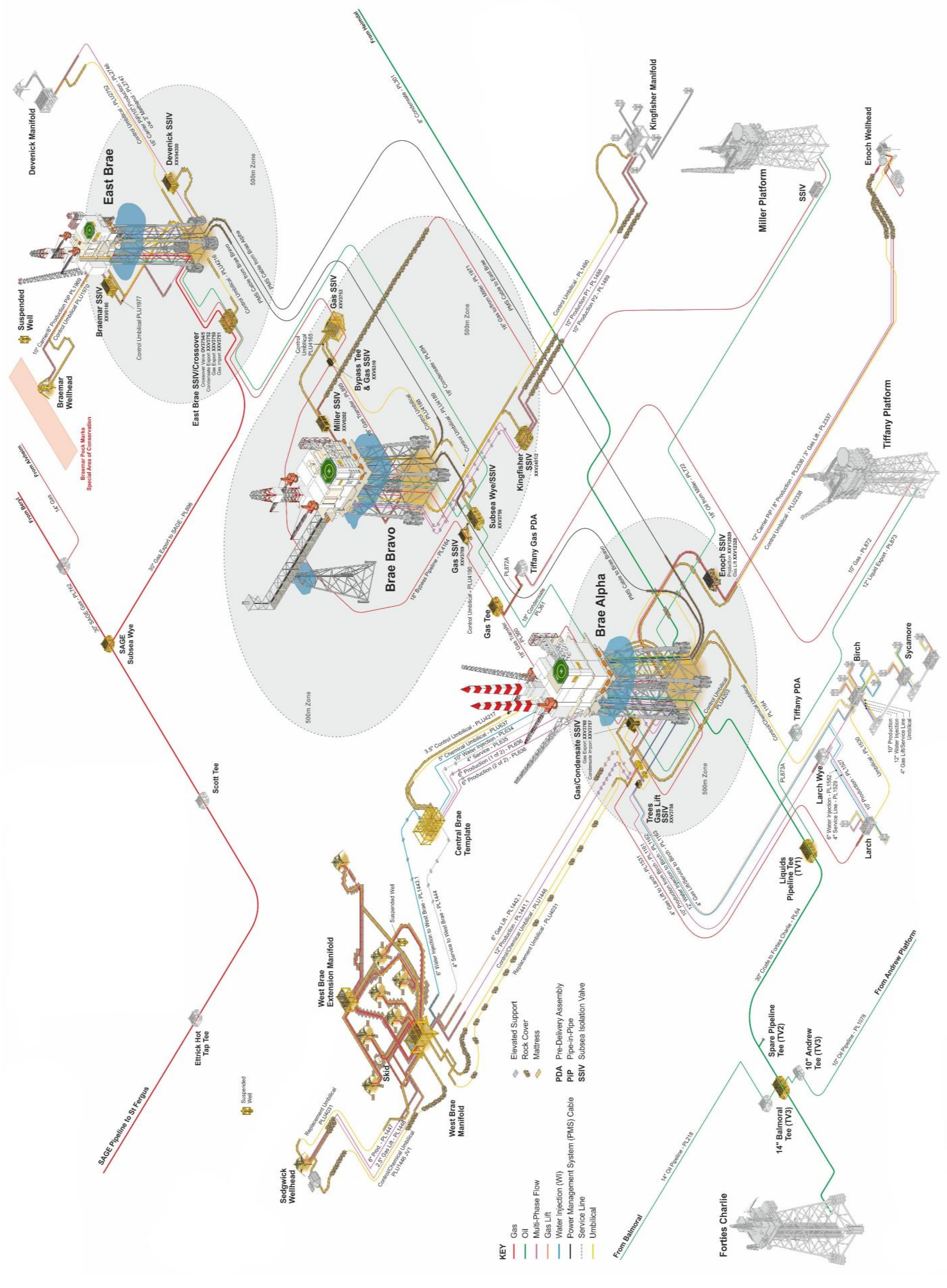
2.2 Brae Field Overview

The Brae Area lies approximately 175 miles (282 km) north-east of Aberdeen, principally within three United Kingdom Continental Shelf Blocks: 16/7a, 16/3a and 16/3b. Marathon Oil U.K. LLC is the operator of the Brae Alpha Platform. The other equity partners are TAQA Bratani Limited, TAQA Bratani LNS Limited, Spirit Energy Resources Limited, and JX Nippon Exploration and Production (U.K.) Limited. Under the Petroleum Act the partners are jointly responsible with Marathon Oil for decommissioning the Brae Alpha jacket/sub-structure.

Liquids from the Brae Alpha are exported with the rest of the fluids from the Brae Area via the Forties pipeline to Cruden Bay and on to Kinneil near Grangemouth. Gas is exported via the Scottish Area Gas Evacuation (SAGE) pipeline to the SAGE terminal at St Fergus.

The overall layout of facilities in the Brae Area is shown in Figure 2.1.

Figure 2.1: Brae Area Overview



2.3 Jacket/Sub-structure Summary

2.3.1 Jacket/Sub-structure Key Parameters

The Brae Alpha jacket/sub-structure key parameters are listed in Table2.1 and illustrated in Figure 2.2. The portion of the Brae Alpha Jacket/sub-structure that Marathon Oil proposes to leave in place is shown in Figure 2.3.

Table 2.1: Brae Alpha Jacket/Sub-structure Technical Summary	
Location	UK Block 16/7a, 161 miles (259 km) north-east of Aberdeen
Water Depth	112m (367ft)
Number of Platforms	1
Production Start Date	1983
Jacket/Sub-structure Design	8 legged steel jacket; 9 pile sleeves per corner leg; 6 horizontal bracing elevations; 46 conductor slots
Jacket/Sub-structure Steel Weight	20,364 tonnes
Height of Jacket/Sub-structure	123m (404ft)

2.3.2 Hydrocarbons and Chemicals

There are no produced hydrocarbons or chemicals associated with the Brae Alpha jacket/sub-structure itself. All of the pipeline risers and chemical and hydraulic umbilicals that form part of the jacket/sub-structure will be cleaned, and no chemicals or produced hydrocarbons will be left in place in these lines.

Diesel is stored in four tanks formed by sections of Legs A1, A2, D1, and D2. The tanks extend from the +8m level to the -39m level. The tanks will be flushed before the jacket/sub-structure is removed.

2.3.3 Schedule

Marathon Oil plans to remove the Brae Alpha jacket/sub-structure in 2030 following removal of the Brae Alpha topsides, which is scheduled in 2029. This schedule is contingent on a successful drilling programme in 2020. If the drilling programme is unsuccessful, then removal of the jacket/sub-structure and topsides may be brought forward from these dates.

Following jacket/sub-structure removal, a programme of post decommissioning monitoring will be implemented. The initial programme and any subsequent modifications to it will be discussed and agreed with OPRED.

Figure 2.2: Complete Brae Alpha Jacket/Sub-structure

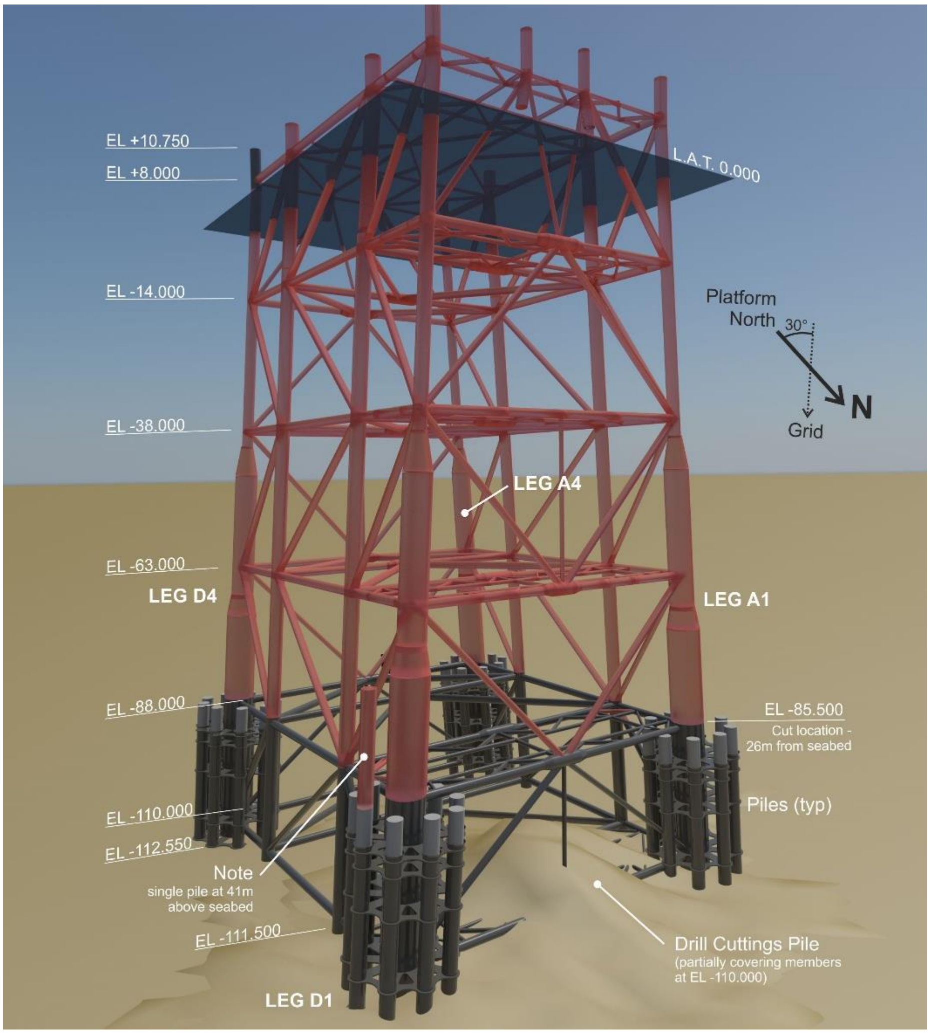
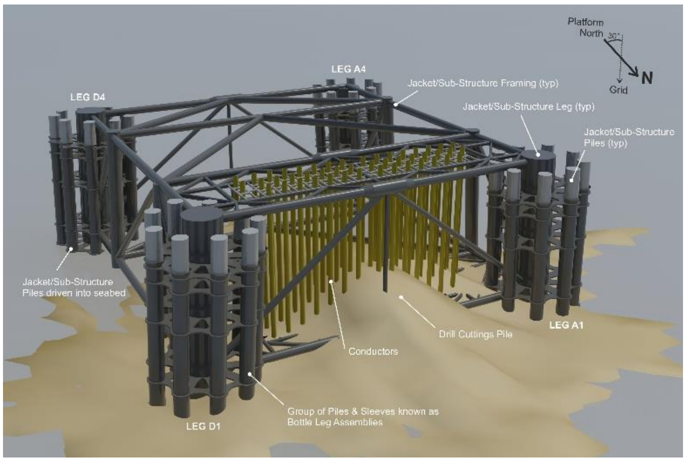


Figure 2.3: Brae Alpha Jacket/Sub-structure Footings



2.4 Comparative Assessment Methodology

OSPAR Decision 98/3 recognises that there are technical challenges associated with the removal of very large steel jacket/sub-structures. Therefore, Decision 98/3 includes the provision for an exemption, or derogation, from the requirement for complete jacket/sub-structure removal if there are significant reasons why an alternative means of disposal is preferable. To be eligible for derogation, offshore installations must meet size and type criteria set out in Decision 98/3. Potential decommissioning options for installations that are eligible for derogation must be assessed in accordance with Annex 2 to Decision 98/3 to determine the recommended alternative. This assessment is normally referred to as “Comparative Assessment” (CA). BEIS considers CA in an annex to its guidance on decommissioning offshore installations and pipelines [2], and Oil and Gas UK has published specific guidance on this topic [11].

Since conducting the CA, and as part of Marathon Oil’s commitment to continually review the options and methods available to decommission the facilities, Marathon Oil has determined that complete removal of the Brae Alpha jacket/sub-structure is not technically feasible for the following reasons;

- It would be necessary to excavate to more than 3m below the seabed to cut the piles, as internal cutting is not feasible. The depth below the seabed and the scale and arrangement of the piles makes access to carry out the cuts extremely problematic.
- Cutting tools are not available in sizes or configurations that are able cut the Brae Alpha piles.
- The size of the jacket/sub-structure is such that it would be necessary to cut it into pieces to remove it in its entirety. There is a high likelihood that portions of the jacket/sub-structure would topple once they were cut. Recovering the toppled sections of the jacket sub-structure would involve further offshore vessel based work that would likely entail the use of divers. This would increase the risk to personnel involved in the decommissioning operations.
  Recovering the toppled sections would also involve the consumption of additional resources with the associated environmental impacts.
- There would be significant stiction and suction between the jacket/sub-structure and the seabed. These factors increase the likelihood of being unable to safely lift the jacket/sub-structure or the lower parts of it from the seabed.

However, for completeness and to align with OSPAR Decision 98/3 requirements, the CA process undertaken in 2016 is detailed below.

Marathon Oil carried out the CA of the Brae Alpha jacket/sub-structure during 2016 and 2017. At that time, the decommissioning contractors and decommissioning methods that would be used at Brae Alpha were undecided. To facilitate the CA, Marathon Oil developed a conceptual complete removal methodology. This was used as one of the inputs to the CA. The complete removal methodology generally followed the partial removal methodology, but also accounted for handling more material than the partial removal option, and potential difficulties in removing the jacket/sub-structure footings.

The purpose of the Brae Alpha jacket/sub-structure comparative assessment was to provide a balanced appraisal of complete removal versus partial removal of the jacket/sub-structure. This allowed Marathon Oil to identify the recommended decommissioning option for the jacket/sub-structure. The CA was also conducted in such a way that it would support an application for derogation under Decision 98/3 if the recommended option proved to be partial removal.

Marathon Oil reviewed the BP Miller [12] and CNRI Murchison [13] installations’ decommissioning programmes to gain an understanding of the key issues to be addressed in decommissioning North Sea oil and gas platforms and jacket/sub-structures identified by others who had already gone through the process. These installations were of a similar type and scale to Brae Alpha, and therefore provide useful examples.

Marathon Oil’s comparative assessment process [3] aligns with the BEIS guidance notes [2] and published guidance from Oil and Gas UK [11]. The BEIS guidance gives five criteria against which each option should be assessed:

1. Safety
2. Environmental
3. Technical
4. Socio-Economic
5. Economic

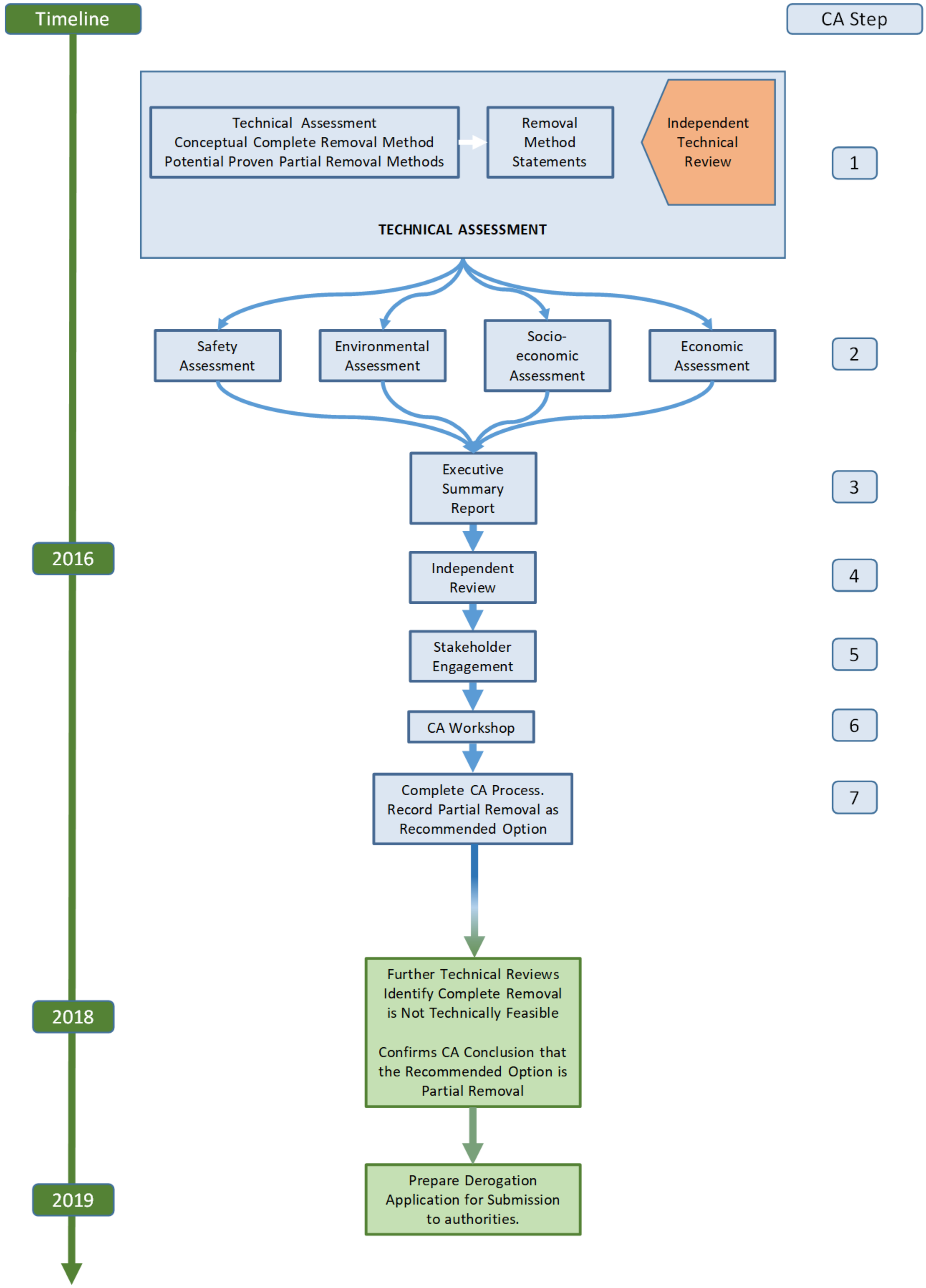
Each of these criteria is broken down into various matters to be considered, for example safety is divided into risk to decommissioning personnel, and risk to other sea users.

The overall comparative assessment methodology employed by Marathon Oil is shown in Figure 2.4. The methodology involved the following steps:

1. Identifying potential methods for complete and partial jacket/sub-structure removal. . (Although complete removal is not technically feasible, it was included in the CA for completeness).
2. Preparing a detailed estimate of the resources required to implement each of the methods using 'norms' from verified databases. Resources include but are not limited to personnel, vessels, port facilities, onshore transport, dismantling yards, and disposal sites.
3. Carrying out further studies to provide more detail to allow assessment against each of the five criteria.
4. Appointing an independent body (IRC - Independent Review Committee) to review, verify and validate the comparative assessment and provide assurance that the process was unbiased and sufficiently detailed to support decision making.
5. Consulting key stakeholders on the process to obtain their feedback.
6. Conducting a Comparative Assessment Workshop, taking inputs from all studies and feedback from stakeholders (see Section 3.1).
7. Completing the CA process. This identified that partial removal is the recommended option for the Brae Alpha jacket sub-structure.

Following the CA Marathon Oil undertook further reviews that determined that complete removal of the Brae Alpha jacket sub-structure is not technically feasible. This determination confirmed the CA conclusion that partial removal is the recommended option. Marathon Oil then prepared the Derogation Application for submission to OPRED and OSPAR. This overall process is shown in Figure 2.4.

Figure 2.4: Comparative Assessment Process



2.5 Technical Studies

Technical assessments were commissioned to identify and review the options and methods available for the partial removal and hypothetical complete removal of the Brae Area platform jacket/sub-structures. The options and methods identified for technical assessment were:

- Section Cut and Lift using an HLV (Heavy Lift Vessel). The assessment included a number of sub methods; complete removal of the jacket/sub-structure in two, three or four sections; and partial removal of the jacket/sub-structure in one or three sections.
- Buoyancy Aided Removal.
- Removal by SLV (Single Lift Vessel), for example Allseas *Pioneering Spirit*.

The 2016 CA workshop included consideration of complete removal by the above techniques. However, further consideration subsequent to the workshop concluded that complete removal is not technically feasible using any of these techniques. The reasons for this are:

- It would be necessary to excavate to more than 3m below the seabed to cut the piles as internal cutting is not feasible. The depth below the seabed and the scale and arrangement of the piles makes access to carry out the cuts extremely problematic.
- Cutting tools are not available in a size or configuration able cut the Brae Alpha piles.
- The size of the jacket/sub-structure is such that it would be necessary to cut it into pieces to remove it in its entirety. There is a high likelihood that portions of the jacket/sub-structure would topple once they were cut. Recovering the toppled sections of the jacket sub-structure would involve further offshore vessel based work that would likely entail the use of divers. This would increase the risk to personnel involved in the decommissioning operations.
  Recovering the toppled sections would also involve the consumption of additional resources with the associated environmental impacts.
- There would be significant stiction and suction between the jacket/sub-structure and the seabed. These factors increase the likelihood of being unable to safely lift the jacket/sub-structure or the lower parts of it from the seabed.

An external database [16] was used as the basis for identifying and assessing removal methods. The database holds a significant quantity of data reflecting previous Decommissioning Programmes and close out reports, and actual experience gained during decommissioning projects. This database was independently verified to ensure its suitability for the Brae Area. No complete removal of a jacket/sub-structure the size of Brae Alpha has been undertaken before. Therefore, for the purpose of the CA, data for complete removal were extrapolated from the partial removal projects.

Method statements were generated for each removal technique. The method statements identify the major activities involved and typical types of equipment required. They made no assumption as to the availability or technical applicability of such technology (for example a cutting tool of sufficient capacity to cut the piles). Marathon Oil used information from the database to develop an estimate of the resources required for each complete and partial removal method, in terms of people, equipment, vessels, HLVs, etc. The method statements and resource estimates were then used as input data for further studies in the areas of safety, environment and socio-economics.

The drill cuttings pile was not included in the assessment of the recommended decommissioning option for the Brae Alpha jacket/sub-structure. Consequently, the comparative assessment studies did not include any allowance for the removal of cuttings that would be necessary to allow full removal of the jacket/sub-structure. Including this factor in the comparative assessment would further support the partial removal option.

The technical assessments and industry experience show that partial removal by section cut and lift using an HLV is technically feasible. It is a proven method and has been used to remove similar jacket/sub-structures in the United Kingdom Continental Shelf (UKCS) and carries a relatively low element of technical risk. Although complete removal by section cut and lift was considered in the CA workshop, this technique has never been used for the removal of an entire steel jacket/sub-structure of the size of Brae Alpha. Further consideration following the CA workshop determined that complete removal using this method is not feasible. The main difficulties are cutting the foundation piles, as this involves excavating the seabed to a depth of more than 3m in and around the piles where access for work class ROVs is restricted, toppling of cut sections and breaking the suction and stiction between the jacket/sub-structure and the seabed.

Removal by HLV in a single lift was not considered possible for partial removal at the time of the CA workshop. This was because it was not considered feasible to transfer the jacket/sub-structure to a barge at sea, and, it was thought that if the jacket/sub-structure were moved inshore suspended on the HLV hook temporary footings would be required at the inshore location. It was also thought that the resources required to fabricate footings would be disproportionate to any benefit gained by adopting this approach. However, since conducting the workshop, detailed discussions with the decommissioning contractor have established that transferring the jacket/sub-structure suspended on the HLV hook is feasible, as the jacket/sub-structure can be transferred directly to the quay at the decommissioning yard, negating the requirement for new footings.

The technical studies also showed that complete removal using buoyancy tanks may be theoretically possible, assuming that the dredging, cutting and stiction issues could be overcome. However, the depth of water in the Brae Area and the height of the jacket/sub-structure would pose significant concerns if the jacket/sub-structure were floated to an inshore location for dismantling because of the risk of damaging pipelines, etc., that the structure would traverse on its way to the shore. Additionally, for both complete and partial removal, if this approach were used the jacket/sub-structure would have to be cut into sections and handled at an inshore location. This would consume a similar amount of resources to dealing with it offshore. However, the additional preparation activities at the offshore location to install the buoyancy tanks, and flotation to an inshore location, would introduce considerable additional work. This carries significant technical and safety risks around installation of the tanks, transportation of the jacket/sub-structure, and set down at an inshore location. The technical studies concluded that buoyancy aided removal is unlikely to reduce the work involved and the associated risks or offer a greater chance of success than section cut and lift at the offshore location.

The technical studies further showed that in addition to considerations around cutting the piles, and breaking the structure free of the seabed, completely removing the Brae Alpha jacket/sub-structure with an SLV is not feasible for the further reason that the jacket/sub-structure does not have sufficient strength to withstand lifting and transportation as a single lift complete with piles and grout. Partial removal by SLV may be possible, however further structural analyses are required to determine whether this is a realistic option. For the purposes of the CA workshop, removal by HLV cut and lift was considered for both the partial removal option and the complete removal option. However, further consideration following the workshop deemed the complete removal option not technically feasible.

Table 2.2 summarises the findings of the reviews of the decommissioning methods. The table also indicates technical feasibility using colour coding, where dark green shows the method proposed is known and has a track record of success; pale green indicates that the method is feasible but has associated challenges and amber signifies that there are significant issues associated with the method. Red indicates that the technique is not considered feasible.

Table 2.2: Summary of Technical Options for Jacket/Sub-structure Removal

Most Feasible				Least / Not Feasible

	Complete Removal	Partial Removal
Section, Cut and Lift	Not technically feasible due to issues and safety concerns associated with excavating seabed to cut piles, cutting piles, breaking suction and stiction between structure and seabed, and instability of pile clusters following cuts.	Technically feasible with use of proven technology. This technique has previously been used successfully in the North Sea.
Buoyancy Tank Assemblies	Not technically feasible due to issues and safety concerns associated with excavating seabed to cut piles, cutting piles and breaking suction and stiction between structure and seabed. There are also significant concerns over technical feasibility regarding tank capacity, design and installation. Transit routes over live pipelines with small clearances are also problematic. Requires complete marine lifting and transportation spread once in inshore waters to facilitate section cut and lift, and transfer to shore for final dismantling and disposal.	There are significant concerns over technical feasibility regarding tank capacity, design and installation. Transit route over live pipelines with a small clearance is also problematic. Requires complete marine lifting and transportation spread once in inshore waters to facilitate section cut and lift, and transfer to shore for final dismantling and disposal. The jacket/sub-structure will not include the footings, so set down in shallow waters an issue due to instability or additional fabrication/disposal required for temporary mud mats.
HLV Single Lift	Not technically feasible due to issues and safety concerns associated with excavating seabed to cut piles, cutting piles, breaking suction and stiction between structure and seabed, and instability of pile clusters following cuts. Jacket/Sub-structure also significantly exceeds the lift capacity of the largest HLVs.	Weight and buoyancy of jacket/sub-structure prevents rotation into horizontal at sea and therefore prevents transfer to barge at sea. Sub-structure can be transferred inshore 'on hook'.
Single Lift *E.g. Pioneering Spirit*	Not technically feasible due to issues and safety concerns associated with excavating seabed to cut piles, cutting piles, breaking suction and stiction between structure and seabed, and instability of pile clusters following cuts. There are also concerns with the jacket/sub-structure integrity during transport due to the weight of piles and grout in the pile guides.	Conceptually possible subject to detailed structural analysis and lift and tilt assessment.

2.6 Safety Studies

The safety studies involved identification of the hazards associated with decommissioning the jacket/sub-structure, and analysis of the associated risks to personnel. The method statements formed the basis of these studies. The safety studies considered partial removal by cut and lift, and complete removal by cut and lift to provide a comparison. Subsequently, further consideration determined that complete removal is not technically feasible.

Quantitative Risk Assessment (QRA) techniques were used to provide a numerical evaluation of the risks arising from the identified hazards. These values are expressed as Potential Loss of Life (PLL) [5], where PLL is the estimated statistical number of fatalities associated with a particular activity. The QRA was undertaken using established techniques to provide an estimate of removal and disposal risks and has drawn on the experience and lessons from decommissioning similar large steel jacket/sub-structures, such as the BP North West Hutton and Miller platforms, and general offshore and onshore occupational safety statistics.

2.6.1 Risk to Personnel Removing Jacket/Sub-structure

For the purpose of the comparative assessment, Marathon Oil evaluated the difference in PLL between the hypothetical complete removal option and partial removal [6]. The results are presented in Table 2.3.

Table 2.3: Comparison of PLL Between Complete and Partial Jacket/ Sub-structure Removal

Option	PLL
Complete Removal	0.32
Partial Removal	0.16
Difference	50%

2.6.2 Risk to Fishermen

In the partial removal option there is a risk to fishermen arising from vessels foundering if they snag nets on the jacket/sub-structure footings.

The predicted average increase in individual risk for UK fishermen if the Brae Alpha jacket/sub-structure footings are left in place is <0.1% [7]. With appropriate mitigations, such as inclusion of the hazard in the FishSAFE electronic hazard charting system [8], Admiralty charts and the Kingfisher notification system [9], it is considered likely that the increase in risk to fishermen would be less than this.

2.7 Environmental Studies

The environmental studies reviewed the impacts of the jacket/sub-structure removal offshore and at onshore dismantling and disposal site(s). A generic assessment was conducted for a typical disposal site as the actual site had not been selected at the time of the CA.

Studies were conducted as Brae Area wide assessments where practical and appropriate. Close alignment between the environmental studies and those required as part of the EIA (Environmental Impact Assessment) and ES (Environmental Statement) for the decommissioning programme as a whole has been maintained to ensure consistency of approach and to eliminate duplicate or otherwise unnecessary study work.

The environmental studies considered partial removal by cut and lift, and complete removal by cut and lift to provide a comparison. Subsequently, further consideration identified that complete removal is not technically feasible because of difficulties associated with excavating and cutting the piles, and breaking suction and stiction between the seabed and the jacket/sub-structure.

2.7.1 Energy and Emissions

The Institute of Petroleum has published guidance [14] for assessing energy and emissions associated with decommissioning. Marathon Oil used this guidance to calculate the energy use and gaseous emissions associated with decommissioning the Brae Alpha jacket/sub-structure.

Complete and partial removal of the jacket/sub-structure by section cut and lift using a HLV were studied to estimate the energy consumption and emissions generated during the removal operations. The study took into consideration the types of vessels required during preparation and removal of the jacket/sub-structure and the subsequent treatment of the jacket/sub-structure materials through dismantling, reuse, recycling or replacement.

The assessment took account of the energy that would be required to manufacture new steel to replace any steel left in place on the seabed in the partial removal option. This is greater than the energy that would be required to recycle an equivalent amount of steel in the complete removal option.

The types of vessels and equipment used for complete and partial removal are broadly the same. Complete removal requires more effort than partial removal, and therefore higher energy usage and atmospheric emissions are associated with complete removal. The total energy consumption of each option and the expected emissions to the atmosphere from the consumption of the fuel to generate that energy were calculated. A comparison of the energy requirements and the CO_2 emissions is presented in Table 2.4.

Overall, considering both the operation of decommissioning vessels and materials processing, partial removal of the Brae Alpha jacket/sub-structure uses less energy and creates fewer emissions than complete removal.

Table 2.4: Comparison of Energy Consumption and CO2 Emissions

	Option	
Parameter	**Complete Removal**	**Partial Removal**
Materials Processing Energy Used (GJ)	225,500	437,500
Vessels Energy Used (GJ)	995,000	458,000
Total Energy Used (GJ)	1,180,500	895,500
CO2 Emissions (tonnes)	92,000	64,000

The tabulated figures are for complete and partial removal by HLV cut and lift. There is a possibility of achieving partial removal using an SLV. The use of an SLV would potentially use less fuel and generate fewer emissions than an HLV. However, partial removal by HLV has been considered as the worst case, as this tends to skew the analysis in favour of complete removal. Notwithstanding, the partial removal option uses less energy and emits less CO_2 than the complete removal option.

Sulphur oxides (SO_x) and Nitrogen oxides (NO_x) were assessed in the supporting studies. SO_x and NO_x emissions are greater in the complete removal option than in the partial removal option [17].

2.7.2 Underwater Noise

Underwater noise can be harmful to marine wildlife, specifically marine mammals. The noise sources associated with the complete and partial jacket/sub-structure removal options are expected to be the same, as both methods would use similar types of vessels, and similar cutting methods Therefore, it is the number of noise generating operations and their duration that determine the environmental impact of the complete and partial removal options.

Due to the longer duration and additional activities associated with complete removal there is expected to be more noise emitted into the marine environment in this option than in the partial removal option. Complete removal would have an increased potential to impact marine mammal populations compared to partial removal. However, it is likely that mitigation measures could be deployed for both removal options that would reduce the likelihood of harm to marine mammals.

The estimated numbers of “vessel days” for the complete and partial removal options are shown in Table 2.5. This is the total number of days for which vessels of all types will be required for the removal operations, and this metric is used as an indicator of the amount of underwater noise and disturbance associated with each option.

Table 2.5: Removal Options Durations (Total Vessel Days)	
Option	**Vessel Days**
Complete Removal	1533
Partial Removal	777
Difference	49%

The tabulated figures are for complete and partial removal by cut and lift using an HLV. Partial removal is considered the recommended option against this criterion.

2.7.3 Inshore Environmental Impacts

The complete removal option includes operations that could result in increased interaction with sites of conservation importance. The scale of this interaction will depend on the inshore locations selected for either option. With appropriate management procedures in place the magnitude of the impacts of both complete and partial removal are likely to be similar.

2.7.4 Onshore Environmental Impacts

There are potential impacts associated with bringing quantities of marine growth onshore and for there being discharges connected with dismantling and treating the jacket/sub-structure. Although the extent of these impacts is undefined, the quantity of material is greater in the complete removal option. Therefore, the complete removal option is likely to have more impact than the partial removal option. However, site environmental management systems and local environmental regulatory controls will ensure that the environmental impact of both complete and partial decommissioning options is appropriately managed.

2.7.5 Waste

Overall, the amount of waste sent to landfill from the jacket/sub-structure decommissioning options will be relatively small, but this will depend on a number of factors including the nature and condition of the recovered materials and the availability of reuse or recycle opportunities. The bulk of the material in the jacket/sub-structure is steel, which is eminently recyclable. In the complete removal option grout would also be returned onshore.

The key variable is the quantity of materials removed. The complete removal option will result in a greater total quantity of materials returned to shore. The complete removal option would also result in grout being returned to shore, which would not be the case in the partial removal option. Therefore, in the complete removal option it is likely that a greater quantity of waste would go to landfill. However, site management systems and local environmental regulatory controls should ensure that the waste arising from both complete and partial removal options is dealt with appropriately.

2.7.6 Socio-Economic

The review of the impact on society of all jacket/sub-structure decommissioning activities and potential removal options took cognisance of:

- Impacts on other sea users, primarily the commercial fishing industry.
- Impacts on onshore dismantling and disposal sites' neighbours.
- Opportunities for employment and regional development.

2.7.6.1 Offshore Societal Impacts

The impacts from complete or partial jacket/sub-structure removal may be so small as to render the difference effectively irrelevant in overall societal terms. However, partial removal will result in part of the jacket/sub-structure remaining on the seabed, therefore restricting access for fishing in the immediate area. The impact on fishermen of leaving part of the jacket/sub-structure in place is a differentiator between decommissioning options.

In terms of interactions with other sea users during the execution of the decommissioning project, the complete removal option would require more vessel days than the partial removal option, presenting an increased potential for vessel collision, obstruction of usual access, etc. However, with deployment of appropriate mitigation measures, the difference in vessel days between decommissioning options may result in no real difference in the magnitude of the impacts.

2.7.6.2 Onshore Societal Impacts

Decommissioning the Brae Alpha jacket/sub-structure may cause disturbance to onshore communities that are close to decommissioning yards and waste treatment facilities. As much of the detail around the disposal of the jacket/sub-structure is unknown, the number of trips and quantity of material to be disposed of has been used as a proxy for comparison. However, any resulting issues should largely be mitigated and managed within existing site environmental management plans and permits.

There are likely to be benefits to local communities associated with decommissioning. These include employment and other direct or indirect economic effects. The duration and volume of work associated with complete removal is likely to be greater than that associated with partial removal and to have a correspondingly larger positive benefit to communities.

On balance, given that both the benefits and disadvantages to communities are in proportion to the amount of material brought ashore for treatment, onshore societal impacts were not considered a differentiator in the comparative assessment.

2.8 Economics

The economics associated with decommissioning the jacket/sub-structure are expressed as costs in money of the day. From a project perspective, it is important to develop representative cost estimates based on current industry experience.

For the purpose of estimating, the costs associated with the removal of the jacket/sub-structure have been assumed to be directly proportional to the weight of steel to be removed. This approach is in line with industry practice. However, it under-predicts the costs associated with complete removal, as the estimate does not include the expenses associated with sea-bed preparatory works and cutting piles. However, for comparative assessment purposes this is an appropriate indicative approximation. The cost comparison is presented in Table 2.6.

Table 2.6: Comparison of Costs for Complete and Partial Jacket/Sub-structure Removal

Option	Cost
Complete Removal	100%
Partial Removal	56%

(Based on Industry Norms per Tonne of Steel)

The tabulated figures are based on the HLV cut and lift method for both complete and partial removal. The economic studies considered partial removal by cut and lift, and complete removal by cut and lift to provide a comparison. Subsequently further consideration identified that complete removal is not technically feasible.

2.9 Hazard Assessment Verification Review

Following completion of the jacket/sub-structure decommissioning supporting studies, Marathon Oil performed a Hazard Assessment Verification Review (HAVR) to confirm that all the significant hazards had been identified. The HAVR was conducted as a structured workshop to draw out ideas.

The HAVR was primarily concerned with major hazards. However, other issues identified by the HAVR that may require management once detailed engineering and decommissioning plans have been developed were recorded and added to a global risk register to ensure they are addressed as decommissioning planning and implementation progresses.

The study assessed hazards and issues to a level that would facilitate comparative assessment between removal options and that would allow verification that the hazard had been accounted for in one of the supporting studies. Where a gap was identified, an action was taken and appropriate assessments completed out-with the workshop to address the gap.

The team that took part in the workshop included the following competencies;

- Management
- Compliance
- Technical Safety
- Occupational Health and Safety
- Subsea
- Environment
- Structural
- Decommissioning

Twenty recommendations arose from the HAVR workshop. The most critical actions were those pertaining to understanding the scope of diving activities required for jacket/sub-structure removal.

The HAVR considered both partial removal and complete removal, as at the time of the workshop both of these options were considered conceptually feasible. Subsequently further consideration identified that complete removal is not technically feasible.

It was concluded that should complete jacket/sub-structure removal be required, there was a possibility that divers would be required to support excavating and cutting the foundation piles as the configuration and complexity of the jacket/sub-structure may prevent access by a suitable work class ROV. This and the other findings from the HAVR were fed into the studies that support the CA.

2.10 Independent Review Committee

As part of the Decommissioning Programme and the Derogation Application process, Marathon Oil subjected the studies and the assessments that support the chosen decommissioning option to independent expert verification. The purpose of this verification is to confirm that the assessments are reliable and the evaluation of the options is transparent.

Marathon Oil engaged a group of independent consultants to form an Independent Review Committee (IRC) to deliver assurance and verification of the Brae Alpha Comparative Assessment process. Marathon Oil has addressed the key findings from the IRC review [4]. The IRC certificate is included in Appendix 1. The findings did not materially impact the validity or appropriateness of the CA methodology, supporting studies or conclusions.

3. Comparative Assessment Workshop and Decision

3.1 Workshop

Marathon Oil conducted a Comparative Assessment Workshop on 10th March 2016 involving the statutory consultees and other stakeholders in the Brae Alpha jacket/sub-structure decommissioning process.

The purpose of the workshop was to:

- Ensure that the attendees were fully informed of the studies that support the comparative assessment. To this end a document summarising the results of the supporting studies was circulated to stakeholders prior to the workshop [18].
- Give the stakeholders an opportunity to ask questions regarding the supporting studies, or any other aspects of jacket/sub-structure decommissioning.
- Populate the comparative assessment worksheets to:
    - Provide a record of the impact of the options against the various comparative assessment criteria
    - Highlight any remaining questions from stakeholders regarding the comparative assessment supporting studies and the impacts of decommissioning the jacket/sub-structures.

The minutes from the workshop are reported in the Brae Area Sub-structures Decommissioning Comparative Assessment Workshop Meeting Minutes [15]. The significant points raised by the stakeholders at the workshop were:

- *Why should the fishing industry accept an increase in risk and the reduction in the area potentially available for fishing as a result of parts of the Brae Area jacket/sub-structures being left in place?* (**SFF**)
    - Response: The comparative assessment seeks to identify the option that represents the best balance of impacts against the evaluation criteria, and recognises the negative impacts that leaving parts of the jacket/sub-structure in place may have on commercial fishing.
- *The comparative assessment should consider the cumulative effects of all operators leaving jacket/sub-structures or snagging hazards in place.* (**SFF**)
    - Response: Marathon Oil recognises that this is an issue for the industry as a whole. Although it is considered outside the scope of the Brae Area comparative assessment, Marathon Oil is actively engaging with the industry and stakeholders on this issue.
- *Is it possible to manipulate a jacket/sub-structure before lifting it with the SLV such that the jacket/sub-structure would not require additional support to withstand transportation loads?* (**BEIS EMT**)
    - Response: this is not possible because of the configuration of the lifting arms on the SLV.
- *Have SO_x and NO_x emissions been considered in the CA?* (**SEPA**)
    - Response: It is considered that SO_x and NO_x emissions will be proportionate to energy usage and CO_2 emissions, therefore SO_x and NO_x are not considered separately in the comparative assessment.
- *Complete removal is preferred from a nature conservation point of view – previously the area has been a soft sediment environment. JNCC's preference is to remove the jacket/sub-structures, as they are a hard substrate, and leave the environment as it was before the Brae Area was developed. However, this comment was specific to the wording of the 'Environmental Impacts of Option' criteria; overall JNCC feels that partial removal is preferable to complete removal as there are fewer disturbances to the environment in the partial removal option.* (**JNCC**).
- *There is a requirement to consider foreign fishing vessel crews who are not familiar with regulations relating to trawling over sub-sea structures. Any mitigation measure must take account of foreign vessels.* (**SFF**)
    - Response: In the event that the jacket/sub-structures are left in place, Marathon will seek to ensure that mitigation measures address the issue of foreign flagged vessels.
- *Why does partial removal result in less noise?* (**JNCC**)

- Response: The partial removal option potentially involves fewer cuts, 12 cuts, or fewer, through structural members, than complete removal which requires 32 foundation piles to be cut in addition to a number of cuts through structural members.

- *Narrative should consider temporal and spatial extent of environmental impacts.* (**JNCC**)
    - Response: These aspects will be considered in the Environmental Impact Assessment and Environmental Statement.
- *If the same method is considered for both complete and partial removal, partial removal will always use fewer resources and emit less CO_2 than complete removal as less work is involved in the former.* (**OGA**)

The evaluation system used to populate the comparative assessment worksheets is set out in the terms of reference for the workshop [10]. Under this process a score of 1 represents the most preferred option against a particular criterion, and a score of 0 represents the least preferred option against that criterion. Scores between these extreme values indicate a relative degree of preference.

The comparative assessment worksheets are reproduced in Table 3.1 below. Following the workshop, Marathon Oil further assessed the complete removal option, and determined that it is not technically feasible. The "Technical" row in Table 3.1 was revised to reflect this change.

Table 3.1: Comparative Assessment Matrix

Key: Most Preferred Option (dark blue) | Least Preferred Option (light blue) | No Preference (grey)

Criteria	Sub Criteria	Description	Removal Option: Complete	Removal Option: Partial	Supporting Information	Notes
Safety	Risk to personnel	Safety risk to project personnel on and offshore during the implementation of the Option	0	1	**Complete Removal** PLL = 0.32. **Partial Removal** PLL = 0.16. (Both figures are for cut and lift by HLV).	The PLL values are from the QRA base case analysis; that is without sensitivities. Complete removal would incur a larger PLL than partial removal as it would involve a greater number of more onerous cuts in harder to access locations than partial removal. Complete removal would also require excavation to approximately 3.5m below seabed to enable piles to be cut. The complete removal case would also be more likely to require the use of divers than the partial removal case.
Safety	Risk to other users	Safety risk to other users of the sea such as fishing and other commercial vessels during or as a result of the Option	1	0	**Complete Removal** Would leave no residual risk to fishermen. **Partial Removal** Results in a small increase in fishermen's risk.	Leaving part of the Brae Alpha jacket/sub-structure in place increases annual Individual risk to fishermen. The increased risk may be mitigated by charts and FishSAFE.

Table 3.1: Comparative Assessment Matrix

Key	Most Preferred Option		Least Preferred Option		No Preference	
		(dark blue)		(light blue)		(grey)

Criteria	Sub Criteria	Description	Removal Option: Complete	Removal Option: Partial	Supporting Information	Notes
Environmental	Energy Consumption/ Emissions	Total energy used and emissions arising from each Option (includes implementation and embodied energy in materials)	0	1	**Complete Removal** Would use 1,180,000 GJ of energy **Partial Removal** Energy usage 895,000GJ **Complete Removal** Would produce 91,500 tonnes of CO_2 Emissions **Partial Removal** CO_2 Emissions 64,000 tonnes (All figures are for cut and lift using HLV)	Energy use and CO_2 emissions for Partial Removal take account of energy consumption and CO_2 emissions associated with steel manufactured to replace any material that is left in place.
Environmental	Impacts of Option	Impacts to the environment during or as a result of the Option	0	1	**Complete Removal** Would result in noise and other disturbance, and disruption of the seabed, and the cuttings pile. (1533 Vessel Days) **Partial Removal** Results in less noise and disturbance and less disruption to the seabed. However, it removes less foreign habitat from the environment than complete removal. (777 vessel days) (All figures are for cut and lift using HLV).	At the jacket/sub-structure decommissioning CA workshop on 10 March 2016 It was stated that from the perspective of the marine environment complete removal would be preferable, as it would remove the steel making up the sub-structure from the environment. It was also stated that on balance taking the disturbance to the environment and associated animal species within it into account, partial removal is preferable overall.

Table 3.1: Comparative Assessment Matrix					
Key	Most Preferred Option		Least Preferred Option		No Preference

Criteria	Sub Criteria	Description	Removal Option: Complete	Removal Option: Partial	Supporting Information	Notes
Technical	Technical Feasibility / Challenge	Is the Option technically feasible, to what extent does the Option make use of proven technology is it likely to fail?	0[1]	1	**Complete Removal** Has not been carried out on a jacket/sub-structure of this size and complexity, and is considered not technically feasible. There are no emerging technologies that would facilitate complete removal of a jacket/sub-structure of this size. **Partial Removal** Technically feasible using cut and lift and conceptually feasible using SLV. SLV solution is subject to assessment of the tilt and lift phases of the operation.	Partial removal of large jacket/sub-structures by HLV cut and lift has been carried out successfully a number of times in the UKCS
Socio-Economic	Commercial Impact on Fisheries	Impacts both during the implementation and as a result of the Option on commercial fisheries	1	0	**Complete Removal** Would result in $0.79km^2$ of additional seabed becoming available for fishing. **Partial Removal** Potentially results in between $0.77km^2$ and $0.78km^2$ of additional seabed becoming available for fishing.	The partial removal option results in less disturbance to the marine environment than complete removal, in terms of vessel movement, noise, and disturbance of the seabed. In the partial removal option, the jacket/sub-structure footings may also provide a refuge for fish.

[1] The CA workshop marked the technical criterion 0.25:0.75. It has subsequently been identified that complete removal is not feasible. This score now reflects this.

Table 3.1: Comparative Assessment Matrix

Key	Most Preferred Option	Least Preferred Option	No Preference

Criteria	Sub Criteria	Description	Removal Option: Complete	Removal Option: Partial	Supporting Information	Notes
Socio-Economic	Wider Community Impact	Impacts on the health, well-being, standard of living, structure or coherence of communities both during the implementation and as a result of the Option	**0.5**	**0.5**	**Complete Removal** Involves various interactions onshore, for example transport of materials, recycling, waste disposal, etc. These activities will generate employment, but may also disturb, or be a nuisance to, the wider community. **Partial Removal** Will result in fewer disturbances to the wider community, but fewer employment opportunities.	In both options the scale of benefits and detriments are likely to be proportionate to the amount of material removed and brought onshore. Therefore, this criterion is not a differentiator between options.
Economic	Total Removal Cost	Total costs incurred during the implementation and as a result of the Option	**0**	**1**	**Complete Removal** Cost = 100% **Partial Removal** Cost = 56%	Costs are based on Oil and Gas UK norms and tonnage of steel removed.

3.2 Decision

The final decision on the recommended option was taken by Marathon Oil in March 2016 taking cognisance of the stakeholder workshop and the conclusions of the supporting studies.

The comparative assessment process concluded that the recommended decommissioning option for the Brae Alpha jacket/sub-structure is partial removal.

The main reasons for this decision are:

- Complete removal is not technically feasible because of the significant technical challenges and constraints associated with cutting the piles 3m below the seabed and breaking seabed suction and stiction, and additionally cutting sections of the bottle leg assemblies and stabilising them during dismantling in the case of complete removal by cut and lift. These challenges are exacerbated by the diameter of the piles and the overall size of the bottle assemblies and the difficulties in deploying any technology to cut them and the potential instability of the bottle assemblies during cutting.
- Notwithstanding the technical unfeasibility of complete removal, partial removal is the safer option. This is because the partial removal option results in a lower potential loss of life for the personnel carrying out the work than the complete removal option. This outweighs the increase in risk to fishermen arising from leaving the footings in place. The main reason for the higher risk to decommissioning personnel in the complete removal option is the greater amount of work that is required. The additional work includes clearing mud and debris from within the piles to allow cutting, excavating around the piles to facilitate cutting and to break the connection between the piles and the sub-soil, and to break the suction between the mud mats and the seabed. The

complete removal option is also more likely to necessitate the use of divers which further increases the overall risk to decommissioning personnel.

- The partial removal option results in lower energy use and emissions than the hypothetical complete removal option. The energy use and emissions figures take account of the energy that will be required and the emissions that will be generated to replace the steel left in place in the partial removal option. The assessment considered “worst case” figures for partial removal, and “best case” figures for hypothetical complete removal. Despite this bias, partial removal is the recommended option against this criterion.
- In terms of disturbance to marine animals because of vessel movements and noise, the hypothetical complete removal option will result in significantly greater disturbance than the partial removal option. This is because the duration of the offshore work to achieve complete removal would be greater than the duration to achieve partial removal. The greater duration in the complete removal case is a consequence of the dredging requirements to cut the structural piles at -3m below seabed and the greater number of cuts through piles and sections of the bottle leg assemblies compared with the number of structural cuts in the partial removal case.
- Complete removal would have a greater impact on the seabed than partial removal as it would be necessary to excavate the seabed to cut structural piles and release suction between the mud mats and the seabed. Additionally, when the jacket/sub-structure is removed, the footings will be lifted off the seabed, causing further disturbance. By contrast, partial removal of the jacket/sub-structure does not entail any disturbance of the seabed.

The main residual issues resulting from the partial removal option are risk to fishermen, and the unavailability of the sea and seabed for fishing in the area containing, and immediately around, the part of the jacket/sub-structure that is left in place. Although the additional risk is relatively small, the safety of fishermen is an important concern.

The risk to fishermen will be mitigated by inclusion of any part of the jacket/sub-structure that is left in place on the FishSAFE system [8], and on Admiralty charts.

Marathon Oil will continue to consult with fishing industry bodies and other key stakeholders to ensure that the risk to fishermen from Brae Area decommissioning is reduced to a level that is tolerable and as low as reasonably practicable.

Taking all of these factors into consideration, **the recommended decommissioning option for the Brae Alpha jacket/sub-structure is partial removal.**

4. References

[1] OSPAR: http://www.ospar.org/convention

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

[3] Brae Field Decommissioning Comparative Assessment Process, 9000-MIP-99-PM-RT-00003-000, November 2014, Marathon Oil Decommissioning Services LLC.

[4] Independent Review Committee – Brae Alpha Jacket Removal, Comparative Assessment Verification: Options and Screening Metrics, 9020-XDS-99-PM-RP-00001 000, December 2015, Xodus Group

[5] R2P2 HSE Report; http://www.hse.gov.uk/risk/theory/r2p2.htm

[6] Quantitative Risk Assessment of the Removal of the Brae Alpha Jacket, 9020-RSL-99-SF-RA-00001, April 2015, Marathon Oil Decommissioning Services LLC.

[7] Analysis of Risk to Fishermen Brae Alpha Decommissioning, 9020-RSL-99-PM-RT-00001, April 2015, Marathon Oil Decommissioning Services LLC.

[8] FishSAFE - http://www.fishsafe.eu/en/home.aspx

[9] Kingfisher Information Services - http://www.seafish.org/industry-support/kingfisher-information-services

[10] Terms of Reference: Brae Area Sub-structures Decommissioning Options Comparative Assessment Workshop, 9000-MIP-99-PM-RT-00006-000, Revision 1, 01 March 2016, Marathon Oil Decommissioning Services LLC

[11] Guidelines for Comparative Assessment in Decommissioning Programmes, October 2015, Oil and Gas UK

[12] BP Miller Decommissioning Programme - http://www.bp.com/en_gb/united-kingdom/where-we-operate/north-sea/north-sea-decommissioning/miller.htm

[13] CNR International Murchison Decommissioning Programme - http://www.cnri-northsea-decom.com/Decommissioning-Programme.htm

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[18] Brae Area Decommissioning Overview, 9000-MIP-99-PM-XE-00001-000, Revision 0, November 2015, Marathon Oil Decommissioning Services LLC.

[19] Brae Field Decommissioning: Environmental and Societal Comparative Assessment for Brae Alpha, 9020-XDS-99-EV-RT-00001-000, May 2015, Marathon Oil Decommissioning

[20] Brae Field Decommissioning Services: Basis of Assessment for Brae Field Jacket Comparative Assessments, 9000-MIP-99-PM-FD-00001-000, Feb 2015, Marathon Oil

Appendix 1 Independent Verification Certificate

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29 March 2016

Xodus Reference: A-400053-S00-CERT-002

Independent Expert Verification Statement

Brae Alpha Jacket Removal - Verification of Options and Screening Metrics for Comparative Assessment

This statement has been prepared by Xodus Group Ltd (Xodus) in compliance with the UK Department of Energy and Climate Change (DECC) Decommissioning Guidance Notes on independent expert verification [Ref. 1].

Xodus has been appointed by Marathon Oil Decommissioning Services LLC (MODS) to independently verify that the documentation submitted to support the Comparative Assessment (CA) of the available options for the removal of the Brae Alpha jacket removal is of sufficient detail, clarity, accuracy and completeness such that any conclusions drawn from the studies are made in a sound manner.

Xodus has conducted the review of all supporting documentation with findings presented in the associated report [Ref. 2]. Xodus confirms that the information is adequate for use in the CA process.

Issued:	Caroline Laurenson	Decommissioning Technical Authority
Checked:	Joseph Corcoran	Structural Consultant
Approved:	Caragh McWhirr	Independent Review Consultant Project Manager

References:

1. DECC. Guidance Notes. Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998. Version 6 March 2011 (p64).

2. Brae Alpha Jacket Removal, Comparative Assessment Verification: Options and Screening Metrics, Doc No: A-400053-S00-REPT-002, Rev. A01

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