Marine Growth Management during Decommissioning

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Content

• Characteristics of marine growth *in situ* offshore and as a waste material

• O&G UK Study 1: Management of marine growth during decommissioning (2011)

• O&G UK Study 2: Comparative assessment of the management options for marine growth during decommissioning (2013)

• Conclusions
Marine Growth Characteristics

- Comprises variety of soft bodied and shelled marine organisms typically found on solid surfaces
- Initial estimated wet weights (in air) at decommissioning *circa* 5% to 15% of jacket weight
- Weights of marine growth received by decommissioning contractors <10% of initial estimate
- Waste category: Non-hazardous animal and vegetal waste (UK) and ordinary waste (Norway)
- Waste organic material decays when wet, stabilises when dry – odour and handling issues
Seaweeds
Mussels
Hydroids
Anemones
Soft corals

Lophelia pertusa

Source: CNRL, 2013
Study 1: Management of Marine Growth During Decommissioning

- Structured survey to identify facilities, equipment and management techniques
- Describe management practices
- Identify opportunities for improvement and further investigation
- Review applicable legislation and establish timeline of historic decommissioning projects
Overview of Management Processes

Starting point: Marine growth attached to jacket in situ offshore

Cutting and lifting of jacket

Transport to land by barge, lift vessel or wet tow

Jacket lifted/skidded onto quayside

Marine growth falls off jacket and lands on ground

Marine growth removed manually (shovels) and mechanically (scrapers/backhoes)

Marine growth collected, stored separately from other wastes and transported offsite

Adherent layer of dried marine growth remains on steel taken to recycler

End Point: Combusted during steel processing

Marine growth sent to landfill (after lab tests)

End Point: Permanent disposal in landfill

Marine growth sent for landspreading (after lab tests)

End Point: Reuse as soil conditioner/fertiliser

Marine growth sent to composting facility (after lab tests)

End Point: Reuse as compost

Marine growth degrades naturally in the marine environment

End Point: Assimilation into marine environment

Marine growth removal at sea: Not considered mainstream method and uncertainty about application
Study 2: Comparative Assessment of Marine Growth Management Options

High level Comparative Assessment with a staged method aimed at providing a representative overall comparison and ranking of the removal options:

1. Consultation with experienced contractors on existing and prospective approaches for removal of marine growth

2. Creation of scenarios (work programmes) for the removal of marine growth from a hypothetical, generic steel jacket:
   - onshore
   - offshore
   - intermediate location
Generic Steel Jacket

- Barge-launched type around 15,000 tonne
- Northern North Sea in *circa* 135 m water depth
- Initial estimate of wet weight of marine growth *circa* 1,500 tonne
- Corresponding figures for the marine growth removed by a decommissioning yard <150 tonne
- Derogation (leaving footings *in situ*) not considered
- Common objective for all options:
  - bulk removal of marine growth
  - removing sufficient growth to ensure quality of the steel adequate for recycling
Option 1: Onshore Removal
- Cutting and lifting of jacket sections
- Transport ashore by barge and tugs
- Lifting and skidding the jacket ashore
- Marine growth removal by mechanical scrapers and manual techniques
- Transport marine growth to end point by skip loader or lorry

End Point: Marine growth decomposes in landfill or as compost

Option 2: Offshore In Situ Removal
- ROVSV with work-class ROVs deployed at jacket location
- Cutting and lifting of jacket sections
- Marine growth removal by ROV with wire strop
- Cutting and lifting of jacket sections
- Transport ashore by barge and tugs
- Lifting and skidding the jacket ashore

End Point: Marine growth degrades naturally in marine environment

Option 3: Intermediate Location Removal
- Cutting and lifting of jacket sections
- Transport by barge and tugs to mooring in fjord, sea loch or other suitable location
- Marine growth removal by fire hoses, water jets, mechanical and manual methods deployed from barge, work boat or tug
- Transport ashore by barge and tugs
- Lifting and skidding the jacket ashore

End Point: Marine growth degrades naturally in marine environment
### CA Stage 3: Assessments

Assessment of the three options were made against the following criteria:

#### Technical feasibility:
- Qualitative assessment based on views of consultees

#### Environmental and societal risk:
- Scenarios created for the types of environmental setting for the three options
- Qualitative (descriptive) assessment of impacts/risks and differentiators

#### Energy usage and emissions:
- Quantitative estimates mainly derived from fuel consumption and conversion factors using method given in Energy Institute, 2000

#### Safety risk as Potential Loss of Life (PLL):
- Calculation of individual PLLs for each work activity by multiplying worker exposure hours by the corresponding Fatal Accident Rate (FAR)
- Summing individual PLLs to provide the total PLL for the option

#### Cost:
- ‘Ball park’ estimates of cost ranges using views of consultees and based mainly on day rates for vessels, vehicles, equipment, labour and disposal
CA Stage 4: Scoring and Ranking

Normalised scores for qualitative assessments:

- 0 = ‘Strongest’ option (most feasible or lowest impact)
- 2.5 = Intermediate performing option
- 5 = ‘Weakest’ option (least feasible or highest impact)

Normalised scores for quantitative assessments:

- 0 = ‘Strongest’ option (lowest energy and emissions, PLL or cost)
- Proportional score between 0 and 5 (rounded) = Intermediate option
- 5 = ‘Weakest’ option (highest energy and emissions, PLL or cost)

Ranking:

- For each option, scores for individual assessments were totalled
- Options were ranked according to overall totals
### Results: Technical Feasibility Comparison

<table>
<thead>
<tr>
<th>Removal Option</th>
<th>Technical Feasibility</th>
<th>Score</th>
</tr>
</thead>
</table>
| Decommissioning yard | • Feasible and proven  
                      • Used for most decommissioning projects to date  
                      • Well established technique; no development required | 0     |
| In situ offshore      | • Feasible based on pilot trial on offshore conductors  
                      • Development required for full scale application | 5     |
| Intermediate location | • Feasible; not trialled as standalone operation, but previous use during jacket dismantling in fjords  
                      • Development required for full-scale application | 2.5   |

Scoring: ‘Strongest’ option = 0;  Intermediate option = 2.5; ‘Weakest’ option = 5
## Results: Environmental and Societal Impact

<table>
<thead>
<tr>
<th>Removal Option</th>
<th>Environmental and Societal Impact</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning yard</td>
<td>• Landfill capacity occupancy&lt;br&gt;• History of intermittent complaints about odour from decaying marine growth for adjacent communities&lt;br&gt;• Yards’ odour management measures well established and mainly successful</td>
<td>5</td>
</tr>
<tr>
<td>In situ offshore</td>
<td>• Temporary localised impacts caused by deposition of marine growth seabed and dispersal in water column would not be significant&lt;br&gt;• Natural degradation of deposited material</td>
<td>0</td>
</tr>
<tr>
<td>Intermediate location</td>
<td>• Norwegian studies show that disposal of marine growth in open fjords with good water exchange would not cause water quality problems&lt;br&gt;• Site selection is therefore critical&lt;br&gt;• Odour of decaying marine growth on the jacket could potentially be an issue for sheltered sites close to shore</td>
<td>2.5</td>
</tr>
</tbody>
</table>
## Results: Energy Usage and Emissions

<table>
<thead>
<tr>
<th>Removal Option</th>
<th>Energy Usage (GJ)</th>
<th>CO₂ Emissions (tonne)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning yard</td>
<td>1,992 GJ</td>
<td>148 tonne</td>
<td>0</td>
</tr>
<tr>
<td>In situ offshore</td>
<td>64,219 GJ</td>
<td>4,768 tonne</td>
<td>5</td>
</tr>
<tr>
<td>Intermediate location</td>
<td>12,219 GJ</td>
<td>907 tonne</td>
<td>1</td>
</tr>
</tbody>
</table>
## Results: Safety Comparison

<table>
<thead>
<tr>
<th>Removal Option</th>
<th>Safety as Potential Loss of Life (PLL)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning yard</td>
<td>• 5.1 x 10^{-5}</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>• No safety constraints identified</td>
<td></td>
</tr>
<tr>
<td>In situ offshore</td>
<td>• 3.9 x 10^{-3}</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>• No safety constraints identified</td>
<td></td>
</tr>
<tr>
<td>Intermediate location</td>
<td>• 1.7 x 10^{-3}</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Safety concerns would rule out removal operations on a moving barge</td>
<td></td>
</tr>
</tbody>
</table>
## Results: Cost Comparison

<table>
<thead>
<tr>
<th>Removal Option</th>
<th>Cost as ‘ballpark’ range (£ million)</th>
<th>Incremental cost on top of average £25 million for decommissioning a barge launched jacket</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning yard</td>
<td>£0.07m to £0.1m</td>
<td>Embedded cost</td>
<td>0</td>
</tr>
<tr>
<td>In situ offshore</td>
<td>£10m to £15m</td>
<td>40% to 60%</td>
<td>5</td>
</tr>
<tr>
<td>Intermediate location</td>
<td>£2m to £3m</td>
<td>8% to 12%</td>
<td>1</td>
</tr>
</tbody>
</table>
## Total Score and Ranking

<table>
<thead>
<tr>
<th>Removal Option</th>
<th>Differentiators</th>
<th>Total Score</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning yard</td>
<td>• Well-established, proven and fairly standard techniques&lt;br&gt;• Lowest cost is strong positive differentiator&lt;br&gt;• Odour nuisance is relatively weak driver</td>
<td>5</td>
<td>‘Top’</td>
</tr>
<tr>
<td>In situ offshore</td>
<td>• Feasible but requires significant development&lt;br&gt;• Highest cost is strong negative differentiator</td>
<td>20</td>
<td>‘Bottom’</td>
</tr>
<tr>
<td>Intermediate location</td>
<td>• Feasible but unlikely to be used as a stand-alone operation (just for marine growth removal)&lt;br&gt;• Water exchange issues mitigated by careful site selection and monitoring</td>
<td>9</td>
<td>‘Intermediate’</td>
</tr>
</tbody>
</table>
Conclusions

- Overlying deciding factors in the selection of options are costs, logistical, technical and safety risks
- The prevalent practice of onshore removal is unlikely to change due to the method being proven and well established

Onshore removal:
- Odour nuisance may be a disincentive. However, decommissioning yards adopt a proactive approach

Intermediate Location:
- Technical uncertainty, high development and vessel costs are strong disincentives for a standalone removal operation
- However, this option could work as part of a dismantling project

In situ removal:
- Prolonged specialist vessel and equipment operations create substantial cost differential
- Development required to scale-up for complex and variable types of offshore jackets
Thank you