Evidence-based BAT/BEP Approach to Pipeline Flushing

Pieter voor de Poorte
Agenda

• The Balmoral Area
• Regulatory Requirements for Residual Oil Concentration in Pipelines
• Sources of Oil Discharges from Pipeline Decommissioning Activities
• BAT for Balmoral Area Pipeline Flushing
• Pipeline Flushing Results to Date
• Review of Target Residual Oil Concentration
• Balmoral Area Flushing - Recommended Target Residual Oil Concentration
The Balmoral Area (2016)
The Balmoral Area (2017)
The Balmoral Area (2018)
Regulatory Requirements for Residual Oil Concentration in Pipelines

• 30mg/l is commonly selected as a residual oil-in-water target for pipeline flushing activities, which is based on the regulatory limit for dispersed oil with produced water discharged into the sea during production operations.

• There is no specific regulatory limit for oil discharges resulting from pipeline decommissioning activities, as defined in the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005.

• OPPC Guidance Notes (8.3.5) state that “The figure should be estimated using data from discharges previously made, taking into consideration the best available techniques (BAT) to limit the amount of oil discharged” and “This figure shall be reviewed by the Regulator and, where approved, will form part of the Conditions of the Oil Discharge Permit”
• OPRED Decommissioning Guidance Notes (May 2018) state that:

• 10.6: “Determination of any potential effect on the marine environment at the time of decommissioning should be based upon scientific evidence. The factors to be taken into account should include“... among others ...." the potential for pollution or contamination of the site by residual products from, or deterioration of, the pipeline”

• 10.7: “In order to consider the potential environmental impact it is necessary to evidence the contents of the line and outline the cleaning operations that will be undertaken. In addition to cleaning pipelines to remove hydrocarbons, reasonable endeavours to remove wax and other contaminants, particularly where a line is to be decommissioned in place, will be expected”
Sources of Oil Discharges from Pipeline Decommissioning Activities

• Pipeline Flushing
  – Flush pipelines to remove oil, wax and other contaminants
  – Flushing returns to be processed to less than 30 mg/l concentration before being discharged
  – Select best available technique (BAT) to limit oil discharges

• Pipeline Disconnection
  – Discharge during disconnection activities
  – Quantity of oil present directly proportional to residual oil post flushing

• Pipeline Decommissioning
  – Comparative Assessment to identify whether the pipeline can be left in-situ or should be removed, which includes consideration of residual oil and other contaminants in the pipeline
• Flushing options assessed:
  – Flushing with water only
  – Flushing using mechanical pigs
  – Flushing using foam pigs
  – Flushing using gel pigs

• Early engagement with various stakeholders:
  – Operations Team: Processing flushing returns and impact on process plant, maintaining overboard oil-in-water (OIW) below 30 mg/l
  – FPS: Chemical selection and waiver process
  – EMT: Environmental permit applications
  – OGA: PWA variation applications
BAT identified for Balmoral Area:
- Use of chemical train with gel pigs, propelled by seawater
- Flushing returns to be processed / treated to less than 30 mg/l before being discharged to sea
- Oil to be exported to Forties Pipeline System (FPS)

Pig train:

Round-trip flushing from DSV:

One-way flushing from DSV:
Results from Flushing Rigid 16/21a-3 Pipeline (2016)

- Target 30mg/l – three consecutive readings
- Majority oil removed within 2 hrs of the initial line volume being returned to FPV
- Total duration was 24 hrs 28 mins.
Results from Flushing Flexible 16/21a-33 Pipeline (2017)

- Target 30mg/l – three consecutive readings
- Two characteristic phases – 1st phase repeated spikes likely due to oil retained in carcass being drawn into fluid stream, 2nd phase similar decay curve to rigid flowline
Review of Target Residual Oil Concentration

• Evidence from the flushing activities carried out to date has demonstrated:
  – The chemical train with gel pigs has been effective in cleaning the pipelines
  – A rapid decline in residual oil concentration to 50mg/l, with a longer period required to achieve 30mg/l

• The current Balmoral Area flushing schedule estimates that 286 hrs (12 days) of flushing are required at CoP, to achieve a residual oil concentration of 30mg/l

• Relaxing the residual oil concentration target to 50mg/l, reduces the overall flushing duration to 186 hrs (8 days), with an equivalent reduction in vessel costs and vessel-based emissions
# Comparative Assessment - 50mg/l versus 30mg/l

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>Health and Safety</td>
<td>Lower potential for incidents due to reduced flushing duration</td>
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<tr>
<td>Technical Risk</td>
<td>Reduced technical risk as 50mg/l is easier to achieve</td>
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<tr>
<td>Operational Risk</td>
<td>Lower risk of operational issues (NPT / WoW) due to the shorter flushing duration</td>
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<tr>
<td>Schedule</td>
<td>Reduced flushing duration to achieve 50 mg/l</td>
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<tr>
<td>Costs</td>
<td>35% reduction in costs</td>
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</tbody>
</table>
BEP Assessment - Comparing 50mg/l versus 30mg/l

<table>
<thead>
<tr>
<th></th>
<th>General</th>
<th>50mg/l</th>
<th>30mg/l</th>
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<tbody>
<tr>
<td>Oil discharges from flushing fluids</td>
<td>Majority discharged via Balmoral FPV produced water caisson approximately 3 meters below sea level. Dynamic wind and wave regime will break up and quickly disperse oil over wide area, also rate of degradation will increase as disperses. <em>For reference, in a 24 hour period the volume of produced water discharged from Balmoral FPV is 6,197m$^3$ with an average oil concentration 8.40mg/l, which equates to 52.05kg.</em></td>
<td>Smaller volume requiring treatment and discharge</td>
<td>Larger volume requiring treatment and discharge</td>
</tr>
<tr>
<td>Residual oil in pipelines post flushing</td>
<td>The residual oil will be released from individual pipelines over a wide geographical area over a period of time. The water depth in the area (approx. 140 m) will aid dispersal as the discharge will be dispersed and diluted by sub-surface currents as it passes through the water column.</td>
<td>Larger total mass of residual oil (63.70kg)</td>
<td>Smaller total mass of residual oil (38.22 kg)</td>
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<td>Atmospheric emissions</td>
<td><em>For reference, predicted emissions estimates for vessels at sea in UK waters by 2020 suggest annual CO2 equivalent emissions up to 56,243,000 tonnes.</em></td>
<td>Estimated generated emissions - 393.12 tonnes CO2 equivalent</td>
<td>Estimated generated emissions - 589.23 tonnes CO2 equivalent</td>
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</table>
• 50mg/l is the preferred target residual oil concentration when comparing:
  – Health & safety, technical and operational risk, schedule and cost
  – The environmental impact associated with processing the flushing fluids

• Although 30mg/l would result in less residual oil in the pipelines, overall, the environmental impact associated with either option is not significant compared to the daily oil mass discharged with the produced water from the Balmoral FPV (difference of 25.5 kg versus 52kg discharged daily)

• A residual oil concentration of 50mg/l was applied for and approved for the 2018 Balmoral ABEX DSV campaign, based on the approach laid-out in this presentation

• Premier Oil will be using the same approach for other fields with similar fluid properties