UKOOA JIP 2004
Drill Cuttings Initiative
Phase III:

final report
20132900, 26 January 2005

UKOOA JIP 2004 - Drill Cuttings Initiative – Phase III

Final Report

For: UKOOA

Revision no:	1	Reason for issue:	Final report for submission to the DTI		
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Summary:	Phase III was initiated in January 2004 and continues on from the previous phases I and II, which identified and addressed the environmental issues, linked with the legacy of historical drill cuttings piles in the North Sea. Phase III supports UK government obligations to OIC/OSPAR for continued collection of data relating to actual environmental impacts from cuttings piles over time. Phase III is focussing on the long-term impacts from 5 selected cuttings piles on the UKCS. Data from OLF studies of surveys on the Norwegian Continental Shelf between 1990 to 2002 has also been included in the Phase III work.				
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Date of issue:	26 January 2005			Project No:	DNV 20132900

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1.0 INITIATIVE BACKGROUND AND RESULTS FROM PREVIOUS PHASES

Following completion of the UKOOA Phase I JIP on issues related to sea bed accumulations of drill cuttings, Phase II programme was developed to fill some of the major gaps identified. The primary objective of Phase II was to collect sufficient data to enable a Best Environmental Practice (BEP) and Best Available Technology (BAT), as defined by OSPAR, to be determined for the present time. In order to do this, the proposed work comprised both survey work, laboratory testing and offshore trials of lifting and possibly re-injection equipment. A summary report has been prepared by DNV and both this and the full text of all the research reports is available at the UKOOA web site: www.ukooa.co.uk.
The previous phases are summarised in the sections below.

1.1 PHASE I

Phase I of the project was undertaken between April 1999 and February 2000 and was essentially a desk top study to determine what data then existed on the content, effects and potential treatment and disposal methods. This work identified a number of gaps in our knowledge of drill cuttings as well as providing pointers towards equipment that might be developed to lift, treat and dispose of cuttings. The findings of Phase I where summarised as:

- Improved definition of the scale of cuttings piles, but still a paucity of data and inconsistent sampling techniques
- UKCS volumes are estimated at 700,000 m3 in the Central North Sea and 500,000 m3 in the Northern North Sea – both for multi-well installations only.
- Toxic effects are not known, but there where 30,000 mg/kg of Hydrocarbons in the cuttings (3%), compared with a NEC (No effect concentration) for mud shrimps of 10 mg/kg (10ppm).
- Heavy metals do not seem to be leaching or bio-available as long as the pile is not disturbed
- The top 5mm decomposes rapidly
- Opportunistic re-colonisation by bristle worms occurs in 1 year
- The surface layer is continually changing due to erosion, consolidation, Bioturbation, sedimentation etc
- The bulk of a pile remains inert
- Disturbance mechanisms can be modelled
- There is no proven remediation method
- Enhanced bio-remediation too theoretical as yet, but should be kept under review
- Covering is still a potential solution
- Re-injection is technically feasible but maybe operationally limited and of uncertain legal status
- Natural degradation still merits consideration
- Questions about secondary contamination and water volumes if recovery attempted

1.2 PHASE II

In the results of Phase II the identified gaps and the limits of potential environmental insignificance/ significance were investigated. The limits identified by UKOOA were:
if the rate of loss of hydrocarbons to the water column from a cuttings pile is greater than 100 Te/ year, then the potential environmental impact is considered significant.
The potential environmental impact of a cuttings pile is considered insignificant if the rate of loss of hydrocarbons to the water column is less than 10 Te/ year, and the area of seabed at greater than 50mg/kg over time, is less than 500km2year.
Should a scientific investigation of surveying, sampling and analysis (Action Programme in accordance with revised OLF guidelines), and long-term fate modelling suggest that the site is of insignificant potential environmental impact then UKOOA believe that natural degradation would appear to be the best environmental strategy.
In the event that a scientific investigation (the Action Programme, as mentioned above) suggests that the site is of significant potential environmental impact (i.e. >100 Te hydrocarbons/year to the water column) then UKOOA believe that covering or recovery would appear to be the best environmental strategy.
Should the scientific investigation suggest that either or both of the limits of insignificance are expected to be exceeded by a particular site but remain below the significant impact boundary then the best environmental strategy is less clear. Exceeding the limits does not imply that significant environmental impact is taking place, but more that insignificance cannot be demonstrated beyond reasonable doubt within the period of tenure of the operator. A specific assessment of the management options of cover, recover and natural degradation, together with a programme public consultation is recommended for selecting lasting and environmentally sound solutions under these circumstances. This is summarised pictorially below in Figure 2.1: Likely Best Environmental Strategy Outcome.

Figure 1. Likely Best Environmental Strategy Outcome

2.0 PHASE III

2.1 Phase III objectives and tasks

Phase III was initiated in January 2004 and continues on from previous phases, which identified and addressed the environmental issues, linked with the legacy of historical drill cuttings piles in the North Sea.
Phase III supports UK government obligations to OIC/OSPAR for continued collection of data relating to actual environmental impacts from cuttings piles over time.

The primary objective of previous phases (1999 – 2002) was to collect sufficient data to enable a Best Environmental Practice (BEP) and Best Available Technology (BAT), by method of comparative assessment. In order to do this, the work scopes comprised of survey work, laboratory testing and offshore trials of lifting, as well as and the development use of detailed modelling in order to better understand long-term impacts.

Phase III carries on from this work, focussing on the long-term impacts from 5 selected cuttings piles. The main objective of this work includes the following points:

1. Determine the lifespan of each selected cuttings pile;

2. For each cuttings pile, map the area of contamination and identify changes in these areas over time;

3. Determine PCB, ED (Endocrine Disruptors) and the Total Hydrocarbon (THC) leaching rates from the selected cuttings piles; and

4. Predict (by modelling) the time-integrated levels of THC contamination.

The work was outlined within 4 main tasks:

Task III-1 Offshore survey to be completed on 5 selected cuttings piles - Collection of samples for lab work / analysis and 3D modelling in order to provide input data for fate modelling.

Task III-2 Laboratory work / analysis to determine THC concentrations, TCH leaching rates, presence of PCB, ED. Results will provide input data for the fate modelling.

Task III-3 Fate modelling, using the short- and long-term model developed by BMT as part of Phases I and II, to determine predicted changes in contamination levels and areas of contamination over time.

Task III-4 Summary Report to be completed by DNV & JIP III Participants for submission to the DTI to function as recommendations to the proposed framework at OIC in March 2005.

The selected cuttings piles are; Clyde, Miller, Beryl A, Brent A and Brent S

Figure 2.1. Selected Cuttings Piles for the UKOOA JIP Phase III Programme 2004

2.2 Project Structure

Figure 2.2 below outlines the UKOOA JIP 2004 contract structure.

Figure 2.2. UKOOA JIP Project Contract Structure

3.0 Phase III Programme Results and Conclusions

Phase III Cuttings piles overview

- Five representative cuttings piles sampled; Clyde, Miller, Beryl A, Brent A and Brent S
- Volumes ranged between 2,700-40,000m^3
- Water depths ranged between 81-141m
- Physical pile areas (yolk) range between 0.005-0.012 km^2
- Survey conducted according to the "OLF/OIC/OSPAR Guidelines for characterisation of offshore drill cuttings piles, January 2003"

Input documentation

- RF Factual data from survey and lab tasks
- BMT Modelling data
- OLF Analysis/Results from time series of contaminated area for 10 selected piles on the NCS
- Phase II results for comparison and link into phase III and OIC 2003 document
- OLF/OIC OSPAR Monitoring Guidelines
- SPI (Surface Profile Imaging) photos from the piles

RF Final Report – Results from survey and lab tasks 1(2)

- The average measured THC mass in each cuttings piles ranged between 0.6-7.4% of the pile total mass. (Dry weight measurements)
- THC concentration in the seabed samples in all cases decreased to less than 50mg/kg at 500 m distance from the centre of the cuttings pile
  - Area of contamination ("egg white"), >50mg/kg, ranged between 0.2-0.9km^2
- THC Leaching rate controlled by the pore water flux from the cuttings pile
  - The leaching rates from natural undisturbed piles samples were under the detection limit of experimental measurement techniques

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RF Final Report – Results from survey and lab tasks 2(2)

- PCB (Dutch 7) was measured, but was not detected in any of the samples taken from the piles
- ED/APEs (Endocrine Disruptors/Alkyl Phenols and Ethoxylates)
  - APEs were measured and detected in all samples
  - ED potential was measured and detected in all pile material samples but was not correlated to APEs
  - The measured ED potential is unlikely to have an impact in the surrounding water
- Shear strength, settling speed, density, grain size of the cuttings piles material were also measured as input parameters to the fate model.
- Surface Profile Imaging (SPI) photos did not show any significant smothering effects -cuttings material was found only at some of the innermost stations (i.e. 100m from the pile centre)

OLF Study Report – Norwegian monitoring

- Time series data from the contaminated area (THC>50mg/kg) ('egg white') for representative installations in the Norwegian sector
- Based on environmental data from surveys carried out at 62 installations between 1990 – 2002
- 10 representative cuttings piles ranged in volume between 5,300-34,500 m^3 located at water depths between 70-216 m were selected for detailed analysis
- The area of contamination (THC>50mg/kg) has decreased by 50-90% following cessation (1991) of discharge of OBM (Oil Based Mud)
- The current areas of contamination ('egg white') range between 0.2-1.8 km^2

Summary slide

- Phase III findings on contaminated area are supported by and are similar to the findings from OLF studies on the Norwegian Continental Shelf
- The survey results from Phase III demonstrate that there is no environmental impact requiring immediate remedial action for the 5 representative cuttings piles. Therefore the management options for the drill cuttings pile should be included as part of the final Installation Decommissioning Programme.
- Based on conservative assumptions derived from the field measurement programme of THC content and subsequent oil release rate, all five piles were demonstrated to be in the lower corner of the significance plot and indeed four piles were within the Insignificant Environmental Impact Zone as defined by the Phase II recommendations.

4.0 Site Investigation Findings – Summary Posters

UKOOA JIP Drill Cuttings Initiative Phase III 2004: Site Investigation Findings, Clyde Summary

Site seabed and cuttings pile survey results used to obtain model input parameters

Clyde	
Pile volume (m^3)	30,167
Physical Pile area (km^2) yolk	0.0126
Contaminated area (km^2) white	0.785
Water depth (m)	81
THC level max (mg/kg) *	150,000

* Maximum measured THC levels from sediment samples conservatively assumed for whole physical pile

Fate modelling used to determine environmental persistence of the cuttings pile

Reductions in the contaminated area (light yellow in figure above) are rapid, but slow for the physical pile itself

Determine oil release profile and plot seabed improvement graph

Plot results on environmental significance graph developed in UKOOA JIP Phase II

UKOOA JIP Drill Cuttings Initiative Phase III 2004: Site Investigation Findings, Miller Summary

Site seabed and cuttings pile survey results used to obtain model input parameters

Miller	
Pile volume (m^3)	9,535
Physical Pile area (km^2) yolk	0.0095
Contaminated area (km^2) white	0.393
Water depth (m)	103
THC level max (mg/kg) *	77,000

* Maximum measured THC levels from sediment samples conservatively assumed for whole physical pile

Fate modelling used to determine environmental persistence of the cuttings pile

Reductions in the contaminated area (light yellow in figure above) are rapid, but slow for the physical pile itself

Determine oil release profile and plot seabed improvement graph

Plot results on environmental significance graph developed in UKOOA JIP Phase II

If the rate of loss of hydrocarbons to the water column from a cuttings pile is greater than 100 Te/ year, then the potential environmental impact is considered significant

If the cuttings pile falls in between these two thresholds a comparative assessment of the management options would be required

The potential environmental impact of a cuttings pile is considered insignificant if the rate of loss of hydrocarbons to the water column is less than 10 Te/ year, and the area of seabed at greater than 50mg/kg over time, is less than 500 km^2 year

UKOOA JIP Drill Cuttings Initiative Phase III 2004: Site Investigation Findings, Beryl A Summary

Site seabed and cuttings pile survey results used to obtain model input parameters

Beryl Alpha	
Pile volume (m^3)	39,741
Physical Pile area (km^2) yolk	0.0101
Contaminated area (km^2) white	0.687
Water depth (m) MSL	116
THC level max (mg/kg) *	50,000

* Maximum measured THC levels from sediment samples conservatively assumed for whole physical pile

Fate modelling used to determine environmental persistence of the cuttings pile

Reductions in the contaminated area (light yellow in figure above) are rapid, but slow for the physical pile itself

Determine oil release profile and plot seabed improvement graph

Plot results on environmental significance graph developed in UKOOA JIP Phase II

If the rate of loss of hydrocarbons to the water column from a cuttings pile is greater than 100 Te/ year, then the potential environmental impact is considered significant

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UKOOA JIP Drill Cuttings Initiative Phase III 2004: Site Investigation Findings, Brent A Summary

Site seabed and cuttings pile survey results used to obtain model input parameters

Brent Alpha	
Pile volume (m^3)	12,325
Physical Pile area (km^2) yolk	0.00783
Contaminated area (km^2) white	0.876
Water depth (m) MSL	141
THC level max (mg/kg) *	80,000

* Maximum measured THC levels from sediment samples conservatively assumed for whole physical pile

Fate modelling used to determine environmental persistence of the cuttings pile

Reductions in the contaminated area (light yellow in figure above) are rapid, but slow for the physical pile itself

Determine oil release profile and plot seabed improvement graph

Plot results on environmental significance graph developed in UKOOA JIP Phase II

If the rate of loss of hydrocarbons to the water column from a cuttings pile is greater than 100 Te/ year, then the potential environmental impact is considered significant

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UKOOA JIP Drill Cuttings Initiative Phase III 2004: Site Investigation Findings, Brent S Summary

Site seabed and cuttings pile survey results used to obtain model input parameters

Brent South	
Pile volume (m^3)	2,702
Physical Pile area (km^2) yolk	0.00516
Contaminated area (km^2) white	0.196
Water depth (m) MSL	140
THC level max (mg/kg) *	30,000

* Maximum measured THC levels from sediment samples conservatively assumed for whole physical pile

Fate modelling used to determine environmental persistence of the cuttings pile

Reductions in the contaminated area (light yellow in figure above) are rapid, but slow for the physical pile itself

Determine oil release profile and plot seabed improvement graph

Plot results on environmental significance graph developed in UKOOA JIP Phase II

If the rate of loss of hydrocarbons to the water column from a cuttings pile is greater than 100 Te/ year, then the potential environmental impact is considered significant

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Appendix I CONTRACTOR REPORTS

Both contractor reports are included on a CD due to large document sizes.

- RF- Rogalandsforskningen (Task III-1 and Task III-2, Survey and Lab analysis)
- BMT Cordah (Task III-3, Modelling)