Evaluation of the hazard and risk of chemicals used by the offshore oil and gas industry and the management and reduction of use of those considered to be of greatest environmental concern

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Background to OCNS

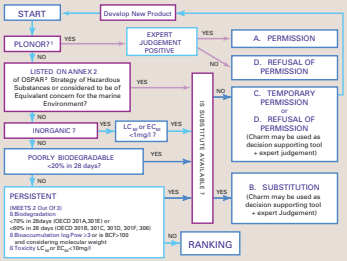
In the UK the Offshore Chemical Notification Scheme (OCNS) is regulated by the Department of Business, Enterprise and Regulatory Reform (BERR), using scientific and environmental advice from Cefas and the Fisheries Research Services (FRS) in Aberdeen.

- **1979:** OCNS first established as a voluntary system, the chemicals were placed into categories depending only on their toxicity.
- **1993:** The 'revised' Notification Scheme was introduced. This used biodegradation, bioavailability and toxicity as its assessment criteria.
- **2002:** OSPAR Harmonised Mandatory Control Scheme (HMCS) for the use and reduction of offshore chemicals. It ranks chemicals according to their Hazard Quotient (HQ), calculated using the CHARM (Chemical Hazard and Risk Management) model.
- **2007:** Cefas become administrators for the Netherlands Offshore Chemical Notification Scheme for State Supervision of Mines (SSM), as the first step towards harmonising the UK and Netherlands offshore chemical registration systems.

Welland gas platform in the southern North Sea

Pre-screening to identify any hazardous properties of the component substances in a product

Chemical suppliers provide test data on the Persistence, Bioconcentration and Toxicity (PBT) in the marine environment for all component substances in their products. All data must meet quality standards, which include compliance with Good Laboratory Practice (GLP), and adherence to internationally recognised protocols.



Hazard Assessment

There are two methods of hazard assessment, CHARM or NonCHARM.

CHARM

Table 1: The OCNS HQ and colour banding

Minimum value	Maximum Value	Category
>0	<1	Gold
≥1	<30	Silver
≥30	<100	White
≥100	<300	Blue
≥300	<1000	Orange
≥1000		Purple

Lowest Hazard → Highest Hazard

The CHARM model calculates the ratio of predicted exposure concentration against no effect concentration (PEC: NEC), and is expressed as a Hazard Quotient (HQ), shown on Table 1. The model uses the following data to make its assessment:

- Use and discharge
- Biodegradation, toxicity and partitioning
- Default values for depth, mud density etc
- Chemical dosage

NonCHARM

Table 2: The toxicity values that assign the initial OCNS letter group

Initial Grouping	A	B	C	D	E	Z
Results for aquatic toxicity data (mg l⁻¹)	<1	>1-10	>10-100	>100-1,000	>1,000	Applicable for zero discharge products, phase out by end of 2006
Results for sediment toxicity data (mg l⁻¹)	<10	>10-100	>100-1,000	>1,000-10,000	>10,000	

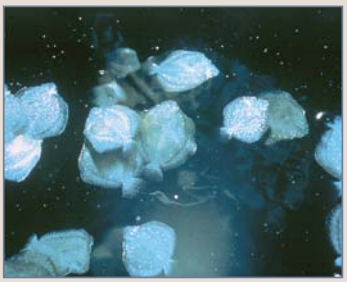
Cefas 2000 Guidelines for the UK Revised Offshore Chemical Notification Scheme

Highest Hazard → Lowest Hazard

Products not applicable to CHARM e.g. inorganic substances, and hydraulic fluids or chemicals used only in pipelines, are products assigned a grouping A – E. Products that only contain substances considered by OSPAR to be environmentally benign in seawater, are termed PLONOR's[1].

Data used in the assessment includes the following:

- Toxicity for initial grouping
- Biodegradation and bioaccumulation for the final grouping however,
- **No** consideration is taken for use and discharge.



Juvenile turbot (Scophthalmus maximus L.) commonly used for fish toxicity testing

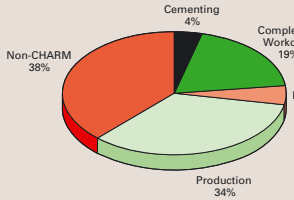


Figure 1: The percentage of products associated with different offshore operations for which an HQ can be calculated using the CHARM model compared to those for which CHARM cannot be used (Cefas, 2005)

- Figure 1 shows that the CHARM model is applied to the majority (62%) of the products registered with OCNS (CEFAS, 2005).
- 38% are NonCHARM and the majority of these (74%) are products consisting entirely of PLONOR[1] chemicals.
- It is advantageous to use the CHARM model wherever possible, as the NonCHARM assessment method does not take account of the quantity of chemicals used and discharged in a specific application.

Environmental risk assessment

A full Environmental Statement (ES) is mandatory for all large projects and any in sensitive or previously unexploited areas.

Small projects do not need a full ES. Operators submit a Petroleum Operations Notice 15 (PON 15) to BERR, which includes a risk-based application to use chemicals.

If the products being used can be put through the CHARM model then a Risk Quotient (RQ) is derived. Chemicals which appear in PON15s that have RQ's >1, RQ's>HQ or carry a substitution warning, require further written justification for their use.

Reported chemical use and discharge

BERR annually reports chemical use and discharge figures to OSPAR.

High use of PLONOR chemicals (Figure 2) may result from increased drilling activity when oil prices are high (PLONOR[1] substances make up the majority of products used in water-based drilling muds).

Substances that are candidates for substitution are present in lower amounts but are often difficult to replace, as they are specifically included for their technical properties and their compatibility with other formulation components.

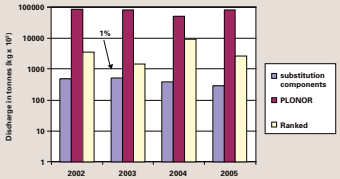


Figure 2: The total discharge (shown on a logarithmic scale) of substances (present in offshore drilling chemicals) that require substitution compared to those that are categorised as PLONOR or have no substitution warnings and are termed 'Ranked' substances: 2002 – 2005

As oil fields mature, increased quantities of produced water may lead to increased chemical use (e.g. corrosion inhibitors). However, selection of least hazardous chemicals and the fact that many chemicals remain coated on surfaces, are used up in chemical reactions or partition to the oil leads to low quantities of those marked for substitution being used and discharged (Figure 3). The requirement for substance rather than product toxicity data by January 2007 has started to identify more substances that combine high toxicity with either poor biodegradation (<20% or 60-70% depending on protocol) or potential to bioaccumulate (log Pow >3).

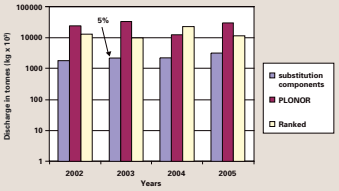


Figure 3: The total discharge (shown on a logarithmic scale) of substances (present in offshore production chemicals) that require substitution compared to those that are categorised as PLONOR or have no substitution warnings and are termed 'Ranked' substances: 2002 – 2005

Other issues in the management of offshore chemicals

- **Phase out of hazardous substances:** e.g. lead 2010, is on OSPAR's list of priority chemicals[2].
- **Substance based test data:** From January 2007 all registered products will have component based toxicity data.
- **Review of substitution warnings:** New approaches to testing (e.g. use of extended biodegradation protocols) are reviewed regularly. Greater attention on methods to assess the potential of surfactants to bioaccumulate.
- **Limit testing:** In March 2005, 'limit' testing was introduced to reduce the number of fish used in toxicity tests. Estimated to reduce the number of fish used in tests by about 75%.

Summary

Offshore oil and gas production is important to the economy but must be managed in a way that protects the marine environment.

The first part of the new Harmonised Mandatory Control Scheme (HMCS) ensures that, based on HQs, the most effective and least hazardous chemicals will be chosen for a given purpose. The second part of the scheme assesses the potential effects that chemical discharge will have upon natural resources in the specific area around an installation. This two-part approach, together with the commitment of the industry to seek alternative chemistries and minimise potential environmental effects, provides a comprehensive management of PBT chemicals.

Acknowledgements

This work is funded by BERR and SSM.

Notes

1 PLONOR (Poses Little Or NO Risk) are substances considered to be environmentally benign in seawater. 100% PLONOR products are given an OCNS E grouping.

2 The 1992 OSPAR Convention is the current instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic.

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