

Muddied Waters

A Survey of Offshore Oilfield Drilling Wastes
and Disposal Techniques to Reduce the
Ecological Impact of Sea Dumping

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25th May 2000

“A Core Value:

“Exxon believes that excellence in environmental, health, and safety (EHS) performance goes hand in hand with our commitment to high operational standards.

“Both require continuous attention to operations fundamentals, and both are prerequisites for long-term business success.

“Achieving excellence in EHS performance not only contributes to business results by safeguarding people and conserving resources, but also serves as a useful indicator of effective management systems.”

1998 Financial and Operating Review, Exxon Corporation

"We believe Exxon to be among the industry leaders in the extent to which environmental management considerations have been integrated into ongoing business processes."

Lloyd's Register Quality Assurance Ltd. 1998

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Author biography

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List of Abbreviations

ADEC	Alaska Department of Environmental Conservation
API	American Petroleum Institute
BAT	Best Available Technology
BATEA	Best Available Technology economically achievable (<i>US EPA parlance</i>)
BCT	Best Conventional pollutant control Technology (<i>US EPA parlance</i>)
BEP	Best Environmental Practice (<i>UK parlance</i>)
BPT	Best Practicable control Technology currently available (<i>US EPA parlance</i>)
BADCT	Best Available Demonstrated Control Technology (<i>US EPA parlance</i>)
CBI	Confidential Business Information (<i>US parlance</i>)
CEFAS	Centre for Environment, Fisheries & Aquaculture Science
CEPA	Canadian Environmental Protection Act
CHARM	Chemical Hazard Assessment and Risk Management (<i>OSPAR parlance</i>)
CNOPB	Canada-Newfoundland Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
CRI	Cuttings Re-Injection (<i>see also SFI</i>)
CWA	Clean Water Act (<i>US</i>)
DOE	Department of Energy (<i>US</i>)
EC ₅₀	The concentration of a substance that affects 50% of a test population after a specified time;
EINECS	European Inventory of Existing Commercial Chemical Substances;
ELINCS	European List of Notified Chemical Substances;
EPA	Environmental Protection Agency (<i>US</i>)
FPSO	Floating Production, Storage and Offloading Vessel
HOCNF	Harmonised Offshore Chemical Notification Format
IP	Institute of Petroleum (<i>UK</i>)
LC ₅₀	Lethal Concentration of a test substance, killing 50% of organisms exposed to it
NOEC	No Observed Effect Concentration
NPDES	National Pollution Discharge Elimination Standards (<i>US EPA parlance</i>)
NSPS	New Source Performance Standards (<i>US EPA parlance</i>)
OBM	Oil-Based Mud
OCNS	Offshore Chemical Notification Scheme
ooc	oil on cuttings
OPF	Organic-Phase Drilling Fluid (defined by OSPAR as “an organic-phase drilling fluid, which is an emulsion of water and other additives in which the continuous phase is a water-immiscible organic fluid of animal, vegetable or mineral origin”)
OSPAR	Oslo-Paris Convention For The Protection Of The Marine Environment Of The North-East Atlantic
ppm	parts per million
POBM	Pseudo Oil-based Mud
PON	Petroleum Operations Notice (<i>UK parlance</i>)
POTW _s	Publicly-Owned-Treatment Works (<i>US EPA parlance</i>)
PSES	Pre-treatment Standards for Existing Sources (<i>US EPA parlance</i>)

PSNS	Pre-treatment Standards for New Sources (<i>US EPA parlance</i>)
SBM or SDF	Synthetic-Based Drilling Mud/Fluid
SDS	Safety Data Sheet
SEBA	OSPAR's Working Group on Sea-based Activities
SFI	Slurry Fracture Injection [of drilling wastes]
SFT	Statens forurensningstilsyn [<i>Norwegian State Pollution Control Authority</i>]
TSS	Total Suspended Solids
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators' Association
WBM	Water-Based Mud

Summary of Conclusions

1. It is legal, in most jurisdictions, to dump water-based drilling muds (WBM) and WBM-contaminated drill cuttings into the sea, if the dumper has a licence and meets certain conditions, such as reducing the oil content to a stated minimum. In North America and offshore Europe almost all discharges of oil-based drilling muds (OBM) ceased some years ago. The USA still permits synthetic-based drilling mud (SBM) discharges but these are currently being phased out in European waters.
2. The discharge of **any** drilling wastes into shallow, inshore waters, similar to the Sakhalin Shelf, is discouraged by European and North American governments and, in most areas, effectively banned.
3. Quantities of WBMs used are likely to increase, following the failure of SBMs to deliver expected environmental benefits, although the US has not yet accepted European arguments against SBMs.
4. Despite being less noxious than OBMs and SBMs, WBMs have ecological effects that may be more serious, widespread and prolonged than some industry sources would suggest. In particular, the effects of underwater plumes of extremely fine particles are not properly understood and may damage larval stages of commercial fish and shellfish.
5. WBM-contaminated cuttings usually contain additive residues of greater or lesser toxicity, whose exact chemical composition is often secret. These residues are not removed by most existing equipment on offshore exploration and production installations. Their effects on sealife, singly or in combination, are not fully researched. The precautionary principle should therefore apply.
6. Proven technology exists to re-inject and contain contaminated drill cuttings in underground reservoirs, either by installing equipment on each rig, platform or drillship, or by shipping the wastes to a port for onshore re-injection. Alternative disposal methods are available, such as treatment, recycling, incineration and/or landfill onshore. Sea dumping is environmentally damaging, technically unnecessary and, because of unquantified, long-term liabilities, may even be more expensive than offshore re-injection or onshore disposal.
7. Produced water from oil and gas installations can be a significant source of chronic oil pollution and usually also contains heavy metals, low-level radioactivity, traces of drilling fluid additives and poly-aromatic hydrocarbons. Its toxicity to sealife is proven and should be of at least equal concern to WBM-contaminated drill cuttings.

8. Technology also exists (and is almost universally used onshore) to re-inject almost all produced water - and also to clean it to much higher standards than currently apply, in practice, on European and North American offshore oilfields.
9. In the West, oil and gas corporations have generally co-operated with the regulatory process and have to some extent co-opted the regulators. They have influenced governments to modify the rules so that they take into account corporate financial concerns as much as, or more than, what independent environmental scientists would recommend, if not constrained by financial considerations. The Western oil and gas corporations operating in the Russian Federation may be expected to attempt to do the same - and will also exert political influence at a very high level to subvert the efforts by honest public servants to protect the environment. Russian officials, non-governmental organisations and the general public should be aware of and resist this insidious process, which can delay and weaken environmental legislation and enforcement.
10. Russia has an opportunity, on the Sakhalin Shelf, to set new world standards for environmentally benign offshore petroleum production, minimising waste discharges and establishing a rigorous but fair inspection regime to ensure full compliance - something most Western governments have so far failed to do.

Zero-discharge regimes – a personal view

This paper demonstrates that reducing drilling waste and produced water discharges from offshore oil and gas installations is desirable, technically achievable and, in most cases, economically advantageous. There is no technical obstacle, either, to reducing discharges to zero, using modern re-injection, re-cycling and “closed-loop” drilling and waste treatment/disposal systems. Where geology presents insuperable problems for re-injecting wastes, there are other means of dealing with them, such as shipment ashore for processing and disposal. To a great extent, this already happens in countries such as Norway, Denmark and the Netherlands, where electors expect their politicians to deliver on environmental pledges – and punish them at the polls if they do not.

The author is not impressed by arguments about the supposed “non-water quality environmental impacts” of shipping wastes ashore, particularly the oil industry’s vaunted concern about the air pollution from increased energy use by the vessels, road vehicles and industrial plant involved in the process. Unlike the widespread, chronic, subtle and poorly-understood effects of marine pollution, these atmospheric emissions can easily be compensated for by reduced flaring offshore and by other energy-saving and pollution-reduction measures that the oil industry and its client governments could implement if they were so minded. The case advanced by the industry, in its discussions with the US Environmental Protection Agency over SBM discharges, and with the OSPAR countries over the disposal of North Sea drill cuttings piles, appears specious and motivated more by economic self-interest rather than environmental concern. If the industry can reduce to zero its waste discharges to the sea, then that is exactly what it should be told to do.

The role of governments is to enforce reduced- or zero-discharge regulations firmly and fairly, so that there is a true “level playing field” where no corporation can gain financial advantage by dumping more or dirtier waste than its rivals. Too often, governments and international bodies such as OSPAR allow their officials to be enticed into interminable and ever more detailed technical discussions whose main purpose is to soften and dilute regulations, delay and obstruct compliance, and to confuse the public and their elected representatives. In this respect, the behaviour of the UK and US governments in particular is a cautionary tale rather than an example of how to be effective.

It is naïve to imagine, as both British and American politicians do, that a cosy relationship between industry and government can deliver effective regulation when, in fact, there are fundamental divergences of interest: the modern global corporation’s financial structure is incapable of taking fully into account the long-term benefits of environmentally benign industrial activity, however “green-minded” individual executives may be; and the public, for whose environment elected governments act as trustees, cannot afford to allow short-term corporate financial objectives to obstruct desperately-needed environmental improvements. Anyone who believes otherwise will suffer insuperable difficulties in understanding the relationship between industry, government and the environment. We do not necessarily need more conflict between regulators and the regulated but we do need a clearer definition of their respective roles. We also need more money and time spent on enforcement of the law. Private citizens are not allowed to negotiate with their rulers which laws they choose to observe and which they find it personally advantageous to break; nor should the oil and gas corporations be, even if they have become richer and more powerful than many of the governments they attempt to suborn and co-opt.

Russia’s laudable efforts¹ to require minimal or zero discharges on the new Sakhalin Shelf oil and gas fields should be supported and extended, and may well turn out to be a model of fair, affordable, effective regulation, based on sound ecological science and the public interest.

That is, after all, what elected governments are supposed to do.

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¹ Prior to the May 2000 presidential announcement of the proposed dismantling of the State Ecological Committee.

Drilling Waste Streams from Offshore Oil and Gas Installations

Drilling Fluids– What They Are and What They Do:

We all depend to a surprising extent on drilling fluids, despite most of the world's population knowing almost nothing about them. Without drilling muds and their additives, corporations could not drill for oil and gas and we would have hardly any of the fuels and lubricants considered essential for modern industrial civilisation.

Drilling fluids, including the various mixtures known as drilling muds, do the following essential jobs in oil and gas wells:

- Lubricate the drill bit, bearings, mud pump and drill pipe, particularly as it wears against the sides of the well when drilling deviated wells around corners;
- Provide hydraulic pressure to the motor which drives the drill bit at the bottom of the hole;
- Clean and cool the drill bit as it cuts into the rock;
- Lift rock cuttings to the surface and allow cuttings to drop out in the mud pit or shakers to prevent them recirculating;
- Regulate the chemical and physical characteristics of the mixture arriving back at the drilling rig;
- Carry cement and other materials to where they are needed in the well;
- Provide information to the drillers about what is happening downhole – by monitoring the behaviour, flow-rate, pressure and composition of the drilling fluid;
- Maintain well pressure and lubricate the borehole wall to control cave-ins and wash-outs;
- Prevent well blow-outs – by including very heavy minerals such as barites to counteract the pressure in the hole.

Drilling muds are made of bentonite and other clays, and/or polymers, mixed with water to the desired viscosity. Muds transport the other components in drilling fluids down the drill pipe and bring cuttings back up the well. By far the largest ingredient of drilling fluids, by weight, is barite (BaSO_4), a very heavy mineral of density 4.3 to 4.6. It is also used as an inert filler in some foods and is more familiar in its medical use as the “barium meal” taken before X-raying the intestines.

Over the years individual drilling companies, and their expert drillers have devised proprietary and secret formulations to deal with specific types of drilling job. These mud “recipes” are based on long experience, arcane knowledge and special skills. One of the problems in studying the effects of drilling waste discharges is that the drilling fluids are made from a range of over 1,000 ingredients - many of them known, confusingly, by different trade-names, generic descriptions, chemical formulae and regional or industry slang words.

A Shell Oil Company engineer in the US, James P. Ray², has written that, back in 1975, “Most people had little idea of the composition of additives. It was even hard for a mud engineer from one company to really know what another company was calling the same product.”

The Public Domain Problem

In addition to the difficulties of identifying and accurately characterising drilling fluid components, and the infinite variety of mixtures used in different situations, many of the recipes are kept secret by particular companies or individuals. It is usually impossible for a member of the public, such as a journalist or a researcher, to obtain from drilling contractors or oil companies a completely accurate description of the constituents of any given drilling fluid³. Even the encyclopaedic list of drilling chemicals published periodically by the US magazine *World Oil* does not give exact chemical descriptions for all the hundreds of trade-named products listed in its tables⁴. Government agencies in the UK and the US are only able to find out exactly what is in drilling fluids if they keep the information secret from the public in whose name they act as guardians of the environment - and sometimes even from the end users of the products.

The Offshore Chemical Notification Scheme (OCNS), currently operating in the UK under the OSPAR⁵ agreements (see detailed discussion below), imposes the confidentiality rule. This is an extract from the latest “Frequently Asked Questions” section of the OCNS website, designed for the use of offshore operators filling in Harmonised Offshore Chemical Notification Format (HOCNF) paperwork⁶:

[Question:]

I wish to notify a product but the manufacturer will not give me confidential formulation details, what can I do?

[Answer:]

This common problem is easily solved by asking the manufacturer to provide the confidential details directly to CEFAS [the UK Government’s Centre for Environment, Fisheries & Aquaculture Science] referencing your submission. The third party has our assurance that the data will be treated as 'Commercial in Confidence' and will not be released to any other party, or used for any other purpose, without their specific written permission.

² Ray, J. P. 1989. Offshore Drilling Waste Issues. In Engelhardt, F. R. *et al.* (eds). 1989. *Drilling Wastes*. pp. 849-860. Elsevier Science Publishers Ltd, Barking, England.

³ Reddy, S., Santillo, D. and Johnston, P. 1995. *Amendments to the London Convention: Discharges from the Offshore Industry – The Environmental Effects of Oil and Gas Exploration and Production*. Greenpeace International, London.

⁴ World Oil. 2000. *Fluids Tables*. Gulf Publishing Company. Houston, Texas. Website: http://www.worldoil.com/techtables/techttable_detail.asp?TECHTBLID=4&TECHTBLSUBID=4&TECHLINK=105

⁵ The Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic - originally the Oslo and Paris Conventions.

⁶ CEFAS. 2000. *Guidelines for the UK Revised Offshore Chemical Notification Scheme in Accordance with the OSPARCOM Harmonised Offshore Chemical Notification Format*. <http://www.cefasc.co.uk/ocns>. London.

This categorical assurance of secrecy is elaborated in the Guidelines issued by CEFAS, the laboratory authorized by the UK Government's to administer OCNS under OSPAR rules:

Any details entered onto the HOCNF will be held in COMMERCIAL CONFIDENCE, by named individuals only, in the relevant Government departments. They will not be released under any circumstances to any third party without written permission of the supplier⁷.

[The capital letters are the UK Government's, not the author's]

The most recent List of Notified Chemicals from CEFAS names but does not accurately identify some 2,014 products sold to offshore drillers⁸. Most of these are additives and nearly all are simply given as trade names. As many of them are simply different names for the same substances, the actual number of chemicals and compounds in use offshore UK is probably about 1,000. The point is that no-one outside the UK Department of Trade and Industry knows for sure. Government ministers themselves may not know.

In response to questions about the lack of accurate, public domain, identification data for offshore chemicals, an industry expert who spoke on condition of anonymity recently gave the author this explanation:

In very simple terms the situation is as follows. A manufacturer comes up with a new product, which for example will improve certain drilling procedures. He gets into contact with offshore operators (i.e. those companies which actually run the drilling rigs) and explains to them the advantages of his new product. If they are interested, they will ask the national authorities of Contracting Parties whether they can use (and, if necessary, discharge) this new product. In order to permit the use of this new product, the national authorities need certain information as stipulated in the HOCNF [*Harmonised Offshore Chemical Notification Format*]. You will note that some of the information required in the HOCNF has to come from the manufacturer (in particular as regards the composition of the new product), whereas some other information comes from the operator (in particular as regards the use of the new product).

The manufacturer will never show the detailed composition to the operator, because most operators have their own chemical laboratories and it would be easy (and much cheaper) for them to synthesise the product on their own, thus cutting out the manufacturer. This also explains the problem of the synonyms. If the detailed composition, names and synonyms of all offshore chemicals would be freely available, operators would obviously choose the one which is the cheapest. Not knowing what is "behind" a certain trade name prevents them from doing so. To a certain extent you can compare this with the situation in the pharmaceutical industry. Also there you have a multitude of drugs which vary considerably in price, although they basically contain the same active ingredients.

From the above you can see that the whole system is a triangle between manufacturer, operator and national authority. OSPAR legislation is basically a circle around these three key players, setting the framework of international legislation to ensure that the decisions

⁷ *Ibid.* p.18.

⁸ CEFAS, 2000b. *UK Offshore Chemical Notification Scheme – List of Notified Chemicals*. <http://www.cefass.co.uk/OCNS/LNC310300v5>. London

to be taken by the national authorities are harmonised. This means that if the UK authorities decide to permit the use of an offshore chemical with certain restrictions, the same restrictions should be imposed by the Norwegian authorities, if a Norwegian operator wants to use the product.

To ensure this harmonised approach, national authorities exchange information informally and during so-called 'HOCNF contact point meetings'. Because confidential information is exchanged during these meetings, the OSPAR Secretariat is not present, but the system nevertheless seems to work satisfactorily. In this context, your understanding that "no-one but the manufacturers and a few UK government officials is allowed to know exactly what is in all the materials" is not totally correct. In theory, this mechanism to exchange HOCNF-related information should ensure that most national authorities know about the relevant data.

The fact remains, however, that the information is not in the public domain and therefore not capable of independent verification by scientific peer review. The reasons for this are clearly neither technical nor environmental but commercial. It would be interesting to know how many other industries are favoured by governments with such confidential indulgence.

Terminology and the Obfuscating Euphemism

So - we are not allowed to know what, exactly, is in the waste dumped over the side of thousands of drilling rigs, production platforms and drillships. The terminology used to describe the main classes of drilling fluids can also be confusing because it has changed over the years, to keep up with changes in mud technology. These are the terms used by the Oslo-Paris Commission (OSPAR) and the UK Department of Trade and Industry, as of March 2000:

- a. Water-based muds or fluids (WBM);
- b. Organic-phase drilling fluids (OPF), which is the newly-coined collective term (and euphemism) for:
 - i. Oil-based muds (OBM), including Low-toxicity Oil-based Muds (LTOM) and
 - ii. Synthetic-based drilling fluid/mud (SBF or SBM) – formerly known as Pseudo Oil-based Mud (POBM) and also including Emulsion-based Mud.

As discussed below in more detail, the term WBM conceals the fact that the water base may contain hydrocarbons in concentrations of parts-per-thousand⁹, some from additives and some from crude petroleum with which the mud has been in contact down the hole¹⁰.

Whatever the base fluid used, nearly all muds contain at least some of the additives in the List of Notified Chemicals and the Fluids Tables mentioned above. These materials come

⁹ Reddy, S., *et al.* 1995. *op. cit.*

¹⁰ Patin, S. A. 1999. *Environmental Impact of the Offshore Oil & Gas Industry*. Eco Monitor Publishing, East Northport, New York. ISBN 0-967 1836-0-X.

back up the well to the drilling floor¹¹ in a slurry with drill cuttings (rock fragments), crude oil, gas, natural gas liquids, produced water, traces of heavy metals, biocides, surfactants and other, mostly organic, substances. The mixtures entering and leaving a well can be so complicated that the OCNS has a special reporting category called UCMs: “unresolvable complex mixtures”¹². In the early years of offshore drilling, all this material was dumped into the sea.

Pollution problems caused by oil and other contaminants in waste drilling fluids were recognised over 40 years ago in the Gulf of Mexico and, since the development of the North Sea oil and gas fields in the 1970s, have become a major political issue in Western Europe.

Oil-based muds were developed for situations where WBMs could not provide enough lubrication or other desired characteristics. Usually, this would be when a job required directional, or deviated, drilling. In this precision drilling technique, now so essential to the industry, the drill bit can be “steered” downhole so that the well deviates from the vertical by a known and controlled angle. When wells are drilled many thousands of feet below the seabed, the drill bit can end up cutting horizontally through the strata, making accessible isolated pockets of oil and gas that were previously not economic to extract. Such deviated drilling has revolutionised the economics of offshore oil and gas drilling and has become standard procedure on such fields as the Atlantic Margin, off the west coast of Shetland, where many small, discrete reservoirs can now be penetrated with a single well. Although the radii of such curved wells are very large, deviated drilling still requires drilling mud with higher lubrication qualities than the ordinary, water-based mud traditionally used for spudding in and drilling vertical wells – particularly when cutting through layers of very hard rock or when drilling smaller radius holes a long way down. Until the mid-1980s, OBM was routinely used for this kind of difficult drilling.

The realisation that relatively large areas of seabed around hundreds of offshore installations had been smothered, sterilised and/or poisoned, by OBM-contaminated drill cuttings and the crude oil sticking to them, led to a number of international agreements which, by 1996, had outlawed the discharge of oil-based drilling muds containing diesel or mineral oils¹³. How far this has been put into effect is the subject of some debate.

¹¹ The deck of the drilling rig or platforms where the drilling turntable and drilling crews are located

¹² CEFAS. 2000a. *op. cit.* p.20.

¹³ OSPAR. 1992a. *PARCOM Decision 92/2 on the Use of Oil-based Muds.*

See also:

- OSPAR. 1996. *PARCOM Decision 96/3 on a Harmonized Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals;*
- OSPAR. 1997. *PARCOM Decision 97/1 on Substances/Preparations Used and Discharged Offshore;*
- OSPAR. 1999a. *List of Substances / Preparations Used and Discharged Offshore Which Are Considered to Pose Little or No Risk to the Environment (PLONOR).*

Low-toxicity OBMs can be and still are used¹⁴, but only in formulations designed for zero-discharge, where all the used mud is either recycled (usually onshore) or re-injected with cuttings into the rocks below the seabed.

Changing the terminology is a technique sometimes used by industries seeking to delay or weaken regulation. Giving something a new, neutral-sounding name can confuse and soothe lawmakers, government officials and the general public. A classic example of the obfuscating euphemism, originating in the US, is the recent re-naming of drilling muds.

The phrase “oil-based mud” was an accurate description of drilling mud containing diesel oil, commonly used 10 years ago, but had obvious negative connotations and was, indeed, a serious source of pollution, as the North Sea drill cuttings piles testify. At first, the term “synthetic-based mud” or “emulsion-based mud” sounded neutral, or even positive, in relation to OBM, but when it proved (at least in Europe) to be no better than OBM then a new wording was required. Therefore, we are now asked to call both OBMs and SBMs “organic-phase drilling fluids”, on the grounds that the oils formerly used in OBMs and the esters and vegetable oils used in SBMs all have “organic” origins – in that diesel oil and “mineral oils” are refined from crude oil which, millions of years ago, derived from microscopic sea creatures.

“Organic” conjures up entirely different images to “oil-based” and is therefore preferred by industry apologists. The euphemism sounds scientific but conceals from the ignorant the fact that nothing has changed. Likewise, the industry and its friends in government feel no need to change the name of “water-based muds” because “water-based” implies purity - even though WBMs may contain many “organic” substances and also some pollutants derived from crude oil. This kind of semantic engineering is highly advanced (and highly paid) in the global oil and gas industry. In countries where English is not the first language, the necessity for technical translation (into Russian, for example) introduces further opportunities for subtle linguistic obfuscation.

¹⁴ See the list of “Z-muds” on the CEFAS website: <http://www.cefas.co.uk/ocns>. *Group Z Base Fluids Which May be Used With Approved Group Z Organic phase Drilling-mud Formulations.*

Table 1: Total number of installations in the OSPAR Convention's maritime area, 1984-1998

Country	1984	1986	1990	1991	1992	1993	1994	1995	1996	1997	1998
Germany	1	1	3	3	4	3	2	2	2	2	2
Spain	1	1	1	1	1	1	1.5	9	9	6	5
Ireland	1	1	2	2	2	2	0	0	4	6	3.2
Denmark	7	11	20	20	20	26	37	39	43	46	47
Netherlands	30	45	63	60	88	97	120	118	116	125	125
Norway	13	18	24	25	34	109	90	83	103	83	85
United Kingdom	90	90	79	79	79	81	187	207	275	252	293
TOTAL	143	167	192	190	228	320	438	459	554	520	560

Source: OSPAR, London. May 2000.

The Law on Offshore Wastes Discharges in Different Jurisdictions

OSPAR

The Convention for the Protection of the Marine Environment of the North-East Atlantic (known as the "OSPAR Convention") is the basis for national laws governing the discharge of offshore drilling wastes in the waters of the OSPAR signatory states: Belgium, Denmark (including, for these purposes, the self-governing province of the Faroe Islands), Finland, France, Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom of Great Britain and Northern Ireland. OSPAR regulations thus cover all the oil-producing coastal states of Western Europe. The European Community is also a signatory, as are Luxembourg and Switzerland.

At present it is legal to discharge WBM cuttings in the offshore waters of the OSPAR signatory countries, provided the oil content is less than 1% by weight and the material has passed tests to show that it will bio-degrade over a specified time and will not bio-accumulate.

The OSPAR operating principles for regulating offshore discharges¹⁵ take account of the persistence, toxicity or other noxious properties and tendency to bio-accumulation of the chemicals in drilling wastes. "These criteria," OSPAR states, "are not necessarily of equal importance for a particular substance or group of substances, and other factors, such as the location and quantities of the discharge, may need to be considered."

Annex A of the Paris Convention says:

Part I

The following substances are included in this Part.

- i) because they are not readily degradable or rendered harmless by natural processes; and
- ii) because they may either:
 - a. give rise to dangerous accumulation of harmful material in the food chain, or
 - b. endanger the welfare of living organisms causing undesirable changes in the marine eco-systems, or
 - c. interfere seriously with the harvesting of sea foods or with other legitimate uses of the sea; and
 - d. because it is considered that pollution by these substances necessitates urgent action:

¹⁵ See: OSPAR. 1996. *PARCOM Decision 96/3 on a Harmonized Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals*. Oslo.

- Organohalogen compounds and substances which may form such compounds in the marine environment, excluding those which are biologically harmless, or which are rapidly converted in the sea into substances which are biologically harmless.
- Mercury and mercury compounds.
- Cadmium and cadmium compounds.
- Persistent synthetic materials which may float, remain in suspension or sink, and which may seriously interfere with any legitimate use of the sea.
- Persistent oils and hydrocarbons of petroleum origin.

Part II

The following substances are included in this Part because, although exhibiting similar characteristics to the substances in Part I and requiring strict control, they seem less noxious or are more readily rendered harmless by natural processes:

- a. Organic compounds of phosphorous, silicon and tin, and substances which may form such compounds in the marine environment, excluding those which are biologically harmless, or which are rapidly converted in the sea into substances which are biologically harmless.
- b. Elemental phosphorus.
- c. Non-persistent oils and hydrocarbons of petroleum origin.
- d. The following elements and compounds: Arsenic, Lead, Chromium, Nickel, Copper, Zinc
- e. Substances which have been agreed by the Commission as having a deleterious effect on the taste and/or smell of products derived from the marine environment for human consumption¹⁶.

The OSPAR convention was opened for signature on 22 September 1992 and came into force on 25 March 1998. It replaced the former Oslo and Paris Conventions, but decisions, recommendations and all other agreements adopted under those conventions continue to apply, unless and until they are terminated by new measures adopted under the 1992 OSPAR Convention. The OSPAR Commission Secretariat in London has supplied this brief account of the history and functions of the organisation:

The grounding of the *Torrey Canyon* in 1967, and subsequent release of 117,000 tonnes of oil with disastrous consequences for the environment ... stimulated the signature, in

¹⁶ OSPAR. 2000. *Draft Measures Proposed by the OSPAR Working Group on Sea-based Activities (SEBA), February 2000. Annex 12: List of Substances/Compounds Liable to Cause Taint*. OSPAR. Amsterdam. [Printed as Appendix 11 to this report].

1969, of the Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil (the "Bonn Agreement").

The next important development in the growing general awareness of the dangers of pollution of the seas and oceans came with the agreement and signature of the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (the "Oslo Convention"). Again, as often is the case, it had taken a concrete example to remind the countries concerned that the unlimited deliberate dumping of (industrial) waste into the sea could lead to an unacceptable situation. This example was provided by a Dutch ship, the *Stella Maris* which, having sailed from the port of Rotterdam on 16 July 1971 to dump chlorinated waste in the North Sea, was obliged to return to port on 25 July (without carrying out her mission) because of the combined weight of public opinion and of the Governments of several countries. In February 1972, within eight months of this event, the Oslo Convention was signed, and it entered into force in 1974.

It was also felt necessary at this time to draw up a similar document, dealing not with the prevention of marine pollution by dumping, but instead with the prevention of marine pollution by discharges of dangerous substances from land-based sources, water-courses or pipelines. Negotiations on this topic resulted in the completion of the Convention for the Prevention of Marine Pollution from Land-Based Sources (the "Paris Convention") which was opened for signature in June 1974 and which entered into force in 1978.

The Oslo and Paris Commissions

The Oslo Commission was established to administer the Oslo Convention. Initially, the Commission's task was to regulate and control the dumping at sea of industrial wastes, sewage sludge and dredged material and the incineration at sea of liquid industrial wastes. The dumping of industrial wastes and sewage sludge and incineration at sea have now been phased out.

The Paris Commission was established to administer the Paris Convention. The Commission regulated and controlled inputs of substances and energy to the sea from landbased sources (via the atmosphere, rivers, or direct discharges) and also from offshore platforms. The Commission was involved in a thorough review of the use and manufacture of various substances in order to establish the best environmental practice or best available techniques to prevent pollution. ...

The OSPAR Convention

A meeting of the Oslo and Paris Commissions at Ministerial level was held in Paris on 21-22 September 1992 (MMC 1992). This meeting was attended by Ministers responsible for the marine environment of the 14 signatory states to the Oslo and Paris Conventions, by Switzerland and by a representative of the Commission of the European Communities.

The most important outcome of this Ministerial meeting was the adoption of a new Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention"), together with a Final Declaration and an Action Plan to guide the future work of the Commissions.

Although the OSPAR Convention did not finally enter into force until early 1998, for all practical purposes, the Oslo and Paris Commissions have worked as one entity since MMC 1992.

The new Convention, drafted to merge and modernise the Oslo and Paris Conventions, consists of a series of provisions and, amongst other things:

- a. requires the application of:
 - i. the precautionary principle;
 - ii. the polluter pays principle;
 - iii. best available techniques (BAT) and best environmental practice (BEP), including clean technology;
- b. provides for the Commission established by the OSPAR Convention to adopt binding decisions;
- c. provides for the participation of observers, including non-governmental organisations, in the work of the Commission;
- d. establishes rights of access to information about the maritime area of the Convention.

Contained within the OSPAR Convention, as adopted in 1992, are a series of Annexes which deal with the following specific areas:

- Annex I: Prevention and elimination of pollution from land-based sources;
- Annex II: Prevention and elimination of pollution by dumping or incineration;
- Annex III: Prevention and elimination of pollution from offshore sources; and
- Annex IV: Assessment of the quality of the marine environment.

The Convention also allows the adoption of additional annexes to protect the maritime area of the Convention, and the first new annex was adopted by the 1998 Ministerial Meeting of the OSPAR Commission (MMC 1998). This Annex V contains provisions with regard to the protection and conservation of the ecosystems and biological diversity of the maritime area. The Annex will enter into force once it has been ratified by at least seven Contracting Parties.

As a result of these agreements, the oil-producing states of Western Europe in effect work as a single country for the purposes of controlling offshore waste disposal, although the detailed implementation of the OSPAR regulations is still governed by national laws and European Union directives (with the exception of Norway, which is not an EU member but has, in general, stricter environmental regulations).

At present there are four main OSPAR measures regulating the majority of discharges and emissions from offshore installations:

1. **PARCOM Decision 92/2** on the Use of Oil-based Muds – this was the start of the ban on OBM discharges;
2. **PARCOM Recommendation 92/6** on Best Available Technology for Produced Water Management on Offshore Gas and Oil Installations – this set the 40ppm oil:water content for produced water discharges;

3. PARCOM **Decision 96/3** on a Harmonized Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals – this co-ordinated the different countries' regulations;
4. PARCOM **Decision 97/1** on Substances/Preparations Used and Discharged Offshore – this attempted, unsuccessfully, to make a list of banned substances.

All are currently under review within OSPAR and the legislation is likely to change in 2001, after a 12-month delay caused by disagreements between member states over which substances should be banned, which should be treated as “Preparations Used and Discharged Offshore Which Are Considered to Pose Little or No Risk to the Environment” (PLONOR)¹⁷, and on issues such as toxicity testing and environmental monitoring methods. In February 2000 several new measures were agreed in draft form at OSPAR's Working Group on Sea-based Activities (SEBA 2000), which, if adopted by OSPAR this year, will supersede PARCOM 92/2, PARCOM 96/3 and PARCOM 97/1 on 16 January 2001.

The current negotiations are designed to eliminate the confusion that has arisen as a consequence of the failure to agree a list of banned offshore chemicals under the PARCOM Decisions 94/1¹⁸ and 97/1¹⁹ on “Substances/Preparations Used and Discharged Offshore”. In 1994 the European Community, France, Spain and the United Kingdom lodged reservations that, in the words of one senior observer²⁰ at the talks, “indicate that already then the original concept of this Decision, *i.e.* to stipulate what the substances/preparations shall be subject to strong regulatory control by national authorities (Appendix 1) or shall not be discharged from offshore installations in the maritime area (Appendix 2), was not unanimously supported”.

The OSPAR session that passed the 97/1 resolution made high-minded reference to the precautionary principle and proclaimed that “high risk substances should be strictly regulated and their use phased out, even though there is insufficient information on their occurrence in sea water, sediments and marine biota”. Delegates recognised that “large quantities of chemicals are used and discharged offshore by the industry”. But all they could achieve, in the words of the same senior observer, was “merely an editorial update” with “some substances added to Appendix 1, others deleted”. The proposals do, however, make it clear that users of chemicals will have to tell the authorities (at least in private) what they are. The new guidelines say, in bold type: “Please note that **trade names will not be accepted as compositional information.**”²¹

¹⁷ For details, see: OSPAR. 1999a. *List of Substances / Preparations Used and Discharged Offshore Which Are Considered to Pose Little or No Risk to the Environment (PLONOR)*. 1999-9.

¹⁸ OSPAR. 1994. *Decision 94/1 on Substances/Preparations Used and Discharged Offshore*. Paris Commission. Paris.

¹⁹ OSPAR. 1997. *PARCOM Decision 97/1 on Substances/Preparations Used and Discharged Offshore*. OSPAR. Brussels.

²⁰ An informant who spoke on condition of anonymity. *pers. comm.* April 2000.

²¹ See Appendix 13, below: OSPAR Guidelines for Completing the Harmonised Offshore Chemical Notification Format (HOCNF), as proposed by SEBA, 2000.

Unfortunately, far from being a model for other countries to follow, the PARCOM 94/1 and 97/1 sessions turned out to be examples of the overlap and confusion that can result when politicians put economics before the environment and scientists allow commercial considerations to dilute their professional advice.

The PARCOM 97/1 resolution had two appendices under the heading “List of banned substances”. Appendix 1 listed substances whose use or discharge offshore should be “subject to strong regulatory control by national authorities”:

- Ferric chloride;
- Hydrochloric acid;
- Metasilicate;
- Phosphoric acid;
- Potassium hydroxide;
- Sodium hydroxide;
- Sodium hypochlorite;
- Potassium iodide;
- Formaldehyde;
- Glutaraldehyde;
- Glycerol;
- Diethylenglycol;
- Triethylenglycol;
- Acetone;
- Calcium Stearate.

Delegates went on to decide “the substances/preparations listed in Appendix 2 shall not be discharged from offshore installations in the maritime area”. Three years later, the list of banned chemicals in Appendix 2 reads as follows: “No substances/preparations currently assigned.”

The main reason for the failure to draw up a list of forbidden substances was repeated and sustained objection from national governments, notably the British, following what may be described as the strongest representations by the oil companies who would have to meet the costs of compliance. As in the US, elected politicians permitted and encouraged commercial corporations to influence the process of law-making, in a way unimaginable for private citizens, professional associations, trades unions or environmental organisations²².

There are other, equally curious, facets of OSPAR’s decisions and recommendations. For example, Article 3 of Annex 3 to the OSPAR Convention reads:

1. Any dumping of wastes or other matter from offshore installations is prohibited.
2. This prohibition does not relate to discharges or emissions from offshore sources.

²² For further discussion of this phenomenon, see: Steiner, R. 1993. Government, Industry and Public Management of the Seas in the 21st Century. *Marine Policy*, September 1993, 399-403.

This terminological curiosity is explained by the fact that “wastes” only refers to cleaning materials, such as washing-up liquid and toilet cleaners, and other household chemicals used on board.

By 1996, OSPAR was already moving towards a system of “acceptance criteria for toxicity, biodegradability and bioaccumulation of drilling fluids” which would measure the ecological effects of whole muds and mixtures, rather than individual components, and controlling overall discharge quantities. Decision 96/3 also listed substances liable to cause taint and prescribed uniform testing methods. As in the US and Canada, governments in effect agreed to negotiate improvements with the industry rather than lay down the law and enforce it. The shift from outright bans on named substances to case-by-case controls and self-regulation made for an enormously complicated, bureaucratic process and created extra administration costs for industry, but these costs were lower than the price of total compliance and zero discharge.

The latest proposals before OSPAR, while “recognising that marine pollution by drill cuttings and their associated organic phase drilling fluids (OPF) should be avoided and prevented to the greatest possible extent²³” are silent on discharges of WBM-contaminated cuttings which, apparently, are to be allowed to continue. The draft regulations²⁴, which will form the new OSPAR regime for minimising marine pollution from drilling wastes, set out the following operating principles:

- 3.1.1 Contracting Parties shall ensure that no OPF shall be used for the purpose of drilling in the course of an offshore activity or discharged into the maritime area without prior authorisation from the national competent authority. In reaching a decision on any authorisation, Contracting Parties shall apply to the management of OPF contaminated cuttings:
 - a. the principles of the Harmonised Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals as set out in [the applicable OSPAR Decision];
 - b. Best Available Techniques (BAT) and Best Environmental Practice (BEP) as set out in Appendix 1 of the OSPAR Convention;
 - c. the waste management hierarchy set out in Appendix 1 to this Decision.
- 3.1.2 The use of diesel oil based drilling fluids is prohibited.
- 3.1.3 The discharge of whole organic-phase drilling fluids to the maritime area is prohibited.
- 3.1.4 The discharge into the sea of cuttings contaminated with OBF at a concentration greater than 1% weight/weight on dry cuttings is prohibited.
- 3.1.5 The use of OPF in the upper part of the well is prohibited. Exemptions may be granted by the national competent authority for geological or safety reasons.

²³ OSPAR. 2000. *Draft Measures Proposed by the OSPAR Working Group on Sea-based Activities (SEBA)*, February 2000. Amsterdam.

²⁴ *Ibid.*

- 3.1.6 The discharge of cuttings contaminated with synthetic fluids shall only be authorised in exceptional circumstances. Such authorisations shall be based on the application of BAT/BEP as set out in Appendix 1 of this Decision.

The draft proposals also prescribe “Best Available Techniques” (BAT) and “Best Environmental Practice” (BEP) “within the context of the ‘five Rs’ waste management hierarchy”:

Reduce

The reduction of discharges of OPF-contaminated cuttings is the primary focus of this Decision. Examples of measures to be taken with a view to reducing discharges are e.g. prohibition on use in the upper well section except where technically necessary, horizontal drilling, slim hole drilling.

Re-use

Operators will choose techniques from a range of options e.g. mud treatment plants, shale shakers, centrifuges and washing systems for cuttings, i.e. those technologies that maximise reuse consistent with safe and efficient drilling. Use of mass balance (volumetric) reporting will enable national authorities to check that reuse is being carried out effectively.

Recycle / Recover

In order to avoid discharges to the sea of OPF-contaminated cuttings, recycling/recovery measures should be implemented (e.g. recovery for re-use of the organic phase by distillation onshore or offshore, use of shale shakers and centrifuges).

Residue disposal

The following options for the management of OPF-contaminated cuttings residue should be considered:

- transportation to shore of cuttings for OPF processing (e.g. oil recovery and residue disposal);
- re-injection of cuttings;
- offshore treatment of cuttings with the aim of achieving the target technology standard of 1% weight/weight fluid on cuttings, and the discharge of the cleaned residue;
- when cleaned residues of cuttings contaminated with synthetic fluid cannot meet that standard, national competent authorities may authorise discharge to the sea having regard to the toxicity, biodegradability and bioaccumulation of the drilling fluid concerned and of the hydrography of the receiving environment.

All these principles and techniques could, of course, be applied equally well to WBM cuttings but so far OSPAR has not extended stricter controls on WBMs. However, according the Department of Trade & Industry²⁵, the UK delegation to OSPAR is “currently drafting regulations to govern the use and discharge of offshore chemicals including those used in **all** drilling muds.”

²⁵ DTI spokesman, Aberdeen, May 2000. *pers. comm.*

The scale of the problem is shown in the table below, from which it will be seen that in 1998 only 29% of the 560 installations in OSPAR waters were practising zero discharge operations. Of these, only 45 (8%) were oil installations, the majority being gas platforms (56 – 10%) and seabed wellhead systems (61 – 10.9%). OSPAR clearly has some way to go if it is to deal effectively and comprehensively with all offshore drilling wastes and the UK more than most

Table 2: Offshore installations making zero discharges to the sea and air in OSPAR waters, 1998.

Country	Oil	Gas	Drilling	Sub-sea	Total
Germany	0	0	0	0	0
Spain	0	1	0	4	5
Ireland	0	0	0	1	1
Denmark	32	0	0	0	32
Netherlands	2	12	0	7	21
Norway	10	1	0	20	31
United Kingdom	1	42	3	29	75
TOTAL	45	56	3	61	165

Source: OSPAR, London. May 2000.

United Kingdom

The United Kingdom has by far the largest numbers of offshore installations in the OSPAR area²⁶ and, as might be expected, the largest quantity of reported drilling waste discharges.²⁷ However, the UK also has a far higher percentage of the total OSPAR discharges than its proportion of the drilling activity would suggest, compared with countries such as Norway, Denmark, Germany and the Netherlands, whose reported discharges are lower than the number of installations in their jurisdictions would suggest.²⁸ Either the other countries are not accurately and honestly reporting their discharges, or else they are operating a more rigorous enforcement regime. The latter seems more probable. A major cause of the startling contrasts in environmental performance is the difference in political cultures. While some other OSPAR countries appear to take regulation seriously, the UK for years has been content to talk to industry about it, at length, while not actually enforcing compliance on site. There is no other possible conclusion from a close study of the OSPAR statistics.

At present WBM discharges on the United Kingdom Continental Shelf (UKCS) are regulated under voluntary, “guideline” agreements with industry, through the Offshore Chemical Notification Scheme. However, the Department of Trade and Industry specifically warns applicants that the use of “organic lubricants” (i.e. oils or emulsions

²⁶ See Appendix 1.

²⁷ See Appendices 4, 7 and 8.

²⁸ See Appendices 4,6 and 10.

that don't mix with water) in WBM formulations will be "subject to close scrutiny", even if less than 5% of the total mud weight, and permission is "unlikely" if the individual components are "organic base fluids" already proscribed or restricted under other parts of the OCNS scheme.²⁹

The industry's assessment of current British standards on WBM discharge is summarised by the UK Offshore Operators' Association (UKOOA) as follows:

WBM discharge is allowed, subject to a 5% limit on organic material. All the evidence is that the discharge has no environmental effect, beyond the potential for smothering if currents do not disperse the material. The volumes of WBM used in drilling a well are much higher as this is the fluid used in the largest [diameter] well sections closest to the seabed surface. Containment would be technically difficult as you have to start the well with some fluid and lifting all WBM for transportation or re-injection would be difficult and involve considerable energy usage. It seems almost inevitable the environmental impacts of the cuttings handling would far outweigh any benefits.³⁰

As noted above, this balancing of overall environmental effect, including impacts on the atmosphere and land as well as on sea life, is currently being assessed in the OSPAR committees. The same arguments are being examined in US Environmental Protection Agency's rule-making consultation currently under way (see discussion below).

In general, the United Kingdom follows OSPAR regulations closely although, as mentioned above, the British Government currently proposes new controls on WBMs and is banning discharges of SBMs, going further than some other OSPAR signatories. OBM is currently used offshore but either brought back to shore for disposal or re-injected offshore.

The UK authorities require exhaustive details of every proposed well and operate a system of Petroleum Operations Notices (PONs) to regulate what operators can and cannot do.³¹

Most developments except very minor ones must have an Environmental Statement from the operator. These statements are also normally required in British waters if:

- The distance to the coast from the well is less than 21.6 nautical miles (40 kilometres);
- There is a Special Area of Conservation (SAC) or Special Protection Area (SPA) within 40 kilometres of the well;

²⁹ CEFAS. 2000a. *Guidelines for the UK Revised Offshore Chemical Notification Scheme in Accordance with the OSPARCOM Harmonised Offshore Chemical Notification Format*. <http://www.cefass.co.uk/ocns>. London.

³⁰ UKOOA spokesman, Aberdeen. April 2000, *pers. comm.*

³¹ United Kingdom Department of Trade and Industry, Oil and Gas Directorate. 1999. *Guidance Notes on the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999*. Edition 2, March 1999. HMSO, London.

- There are concentrations of birds regarded as internationally important within 20 kilometres of the well.

They may also be necessary if:

- There is seasonal sensitivity at the proposed time of drilling. This may include the presence within 20 kilometres of concentrations of seabirds or mammals, fish spawning or nursery grounds;
- Operations might significantly affect herring or sand-eel spawning grounds;
- Operations might significantly affect important fisheries (including shell fisheries such as Nephrops);
- There are large or long-lived biological features (such as cold-water corals) within 20 kilometres which might be significantly affected;
- Operations that may significantly impact other users of the sea (for example, the presence within 20 kilometres of fishing grounds or navigation channels);
- There is an international boundary within 20 kilometres.

The guidance for licence applicants in the UK sector is extremely specific:

The environmental impact of the project should be a consideration from its inception and this should be evident from the Environmental Statement. However, the Statement should not be compiled until there is sufficient project engineering detail to enable the environmental impact of the project to be assessed and potential significant impacts to be identified. Where appropriate, variations in performance of specific processes, etc. (e.g. due to differences in supplier specifications) should be covered by providing an envelope of performance within which the project will operate.

The description of the project should be sufficiently detailed to enable the reader to understand its essentials and the source of any discharges to the environment or other environmental impacts. Where the project is a field development, the description should encompass all its elements, such as platforms, production vessels, sub-sea structures, the means of hydrocarbon transportation and infield pipelines, and the envelope of fluid processing, production and emission rates. Where it is envisaged that the project may expand with time, the full extent should be considered where known.

The data provided to identify and assess any significant effects which the project is likely to have on the environment should be presented as interpreted (rather than raw) data with sources referenced.

Care must be taken to ensure the information is up-to-date and relevant to the geographic area of the project.

The discussion of the likely significant effects should be accompanied by an indication of the criteria by which "likely" and "significant" are categorised. It is expected that these criteria will normally consider the significance of an impact under a number of headings including: extent and magnitude; duration; reversibility; sensitivity of the receptor; species rarity, etc.; and compatibility with standards and policy.

Detailed quantification of adverse effects should be made and include, where possible, estimates of the costs resulting from them.

Where a project is liable to give rise to effects which of themselves are not significant but which, when compounded with existing or expected effects from other sources, will have a significant adverse effect, then these should be described.

The opportunity should be taken to mitigate (i.e. avoid, reduce or remedy) adverse environmental effects in the design and operation of the project. The Environmental Statement should identify where and how this will be done. The performance parameters of processes and procedures adopted, such as separation of water from oil, should be described.

Many of the potential significant adverse effects will have been eliminated or reduced by the processes and procedures adopted and these will have been described as explained above. Consent may be refused in cases where the project does not make provision for a comprehensive externally verifiable Environmental Management System to be established for the lifetime of the project and for a mechanism for its periodic review in the light of experience and technological advances. Where such a system is intended its essentials should be described in the Environmental Statement and include provision for monitoring the actual impact of the project on the environment and for auditing of the System's effectiveness.

The Statement should also address the risk and potential impact of failure, accident or malfunction of the procedures and processes (including those related to the reservoir), the precautions to be taken and how these will be incorporated into the project's Environmental Management System.

The non-technical summary should aim to provide an informed lay reader with an accurate account of the development and its impact on the environment. It is recommended that this should precede the more technical sections of the Environmental Statement.

Where significant adverse environmental impacts are identified, a more detailed explanation should be given where any alternatives which might have mitigated or avoided these impacts are not being adopted.

Any cumulative effects of the proposed development should be addressed, both quantitatively and qualitatively. Where there are gaps in data or understanding of environmental processes these should be explained and provision made to fill and act on these, usually in an Environmental Management System.

It is desirable that the Environmental Statement should incorporate the Licensees' stated environmental policy.

The British regulations also implement OSPAR recommendations on “trigger tonnages” for some substances, setting a limit on the annual quantity of chemicals used, above which Government approval must be sought.

The result of all the complex form-filling and statement-writing is that the UK Government has a very clear and detailed idea of what developers say they propose to do. For example: The description of muds and chemicals to be used and their disposal must be covered as accurately as possible. If it is proposed to change any muds or chemicals after a direction has been issued, then the Department must be notified.

Table 3: Trigger Tonnages

Type of chemicals	Group*	Trigger tonnage ³² (above which government must approve use)
Production (including stimulation and injection chemicals)	A	40 tonnes
	B	70 tonnes
	C	150 tonnes
	D	375 tonnes
	E (or Category 0)	1000 tonnes
Drilling (including cementing, completion and workover chemicals)	A	All proposed usage to be notified
	B	3 tonnes
	C	15 tonnes
	D	350 tonnes
	E	4745 tonnes
*These OSPAR categories describe the degree of ecological hazard, with Category A substances considered most damaging to the environment and Category E the least harmful.		

The completed environmental statement is then circulated to environmental authorities, including non-governmental organisations such as fishermen’s organisations and Friends of the Earth, and must also be advertised and made available to the public. At least four weeks are allowed for comments. Then, according to the guidelines:

The Secretary of State will consider the Environmental Statement and any comments received from the environmental authorities or the public before reaching a decision on whether or not to grant consent for a project.

The decision will be published, as will the reasons for the decision and any environmental conditions attached to any consent.

A person aggrieved by the issue of a consent may apply to the Courts for the decision to be quashed within six weeks of the decision being published on the grounds that the requirements of the Regulations were not met.

While the British system appears admirable on paper, in practice such challenges are rare and successful ones even more so, not least because of the legal costs. But the mechanism is there if the public can afford to use it, as Greenpeace did in 1999 when they went to court and proved that the Government had not insisted on a proper environmental

³² CEFAS. 2000a. *Guidelines for the UK Revised Offshore Chemical Notification Scheme in Accordance with the OSPARCOM Harmonised Offshore Chemical Notification Format*. <http://www.cefas.co.uk/ocns>. London.

assessment prior to proposed oil exploration work on the Continental Slope off north west Scotland. Greenpeace's concerns included the worry that plumes of cuttings might smother rare *Lophelia pertusa* corals.

Some years earlier, when the Environmental Statements for the Foinaven and Schiehallion oilfields went out to public consultation in the mid 1990s, the author of this paper raised questions about, among other things, produced water discharges from BP and Shell/Esso's FPSO vessels, anchored in 500m-deep water on the stormy edge of the Continental Shelf. It took over a year, a lengthy correspondence, many meetings and an independent, scientific peer review (together with considerable persistence) to persuade the industry that there were problems and the questions should be addressed.³³

This was the opinion of a group of Greenpeace researchers after a review of the British offshore regulatory regime in the mid-1990s:

... there is no regulatory body to police discharges or check that discharge regulations are adhered to. 'Operational difficulties' do occur and may result in higher quantities of oil based drilling muds having to be discharged. Drilling muds can be discharged from other sources in addition to that with the drill cuttings. As drill [bits] are changed, muds are spilled onto the drill deck and can be washed into the sea. There is also potential for muds to leak from the drilling collar and to mix with reservoir water and be passed out with the produced water discharges.

Models being developed to control chemical pollution are flawed and unlikely to form reliable regulatory tools.³⁴

There is inadequate and incomplete data for the quantities of different drilling muds discharged to the sea with cuttings in UK waters, almost no public information on the actual quantities of WBMs dumped or re-injected and, judging by the official OSPAR statistics, considerable doubt about the fate of large quantities of OBM-contaminated wastes.³⁵ The UKCS sector is undoubtedly the largest polluter of the North Sea from these sources, dumping an estimated 5,005 tonnes of oil on drill cuttings during 1998³⁶ (the only OSPAR country still doing so) and another 3,187 tonnes of oil in produced water (65.7% of the OSPAR total). In the same year, 61% of platforms exceeding the 40mg/l oil-in-water limit for produced water were in UK waters and between them discharged 86% of the oil involved.³⁷ Between 1984 and 1998, OSPAR statistics³⁸ show that the UK Government permitted the reported dumping of a total of 153, 642 tonnes of oil and diesel discharged with drill cuttings, an average of 10,242 tonnes a year. This was 82.6% of the total OSPAR discharge of oil on cuttings of 186,758 tonnes. Because of self-reporting and under-reporting, it is certain that this is a low estimate. There has recently been some improvement but not much:³⁹ despite all the current talk of cleaning up the UK's act, the country remains "the dirty man of Europe". The British Government, which receives a large portion of its state revenues from the oil and gas industry, basically trusts the industry to regulate itself voluntarily, through self-reporting and self-

³³ Wills, J. W. G. 1996. BP Come Clean on Foinaven Pollution Risk. *Press & Journal*, 16 Dec. 1996. Aberdeen.

³⁴ Reddy, S., *et al.* 1995. *op. cit.*

monitoring. The results, as depicted in the official statistics, indicate that this trust is misplaced.

Despite this lamentable record, the British authorities continue to make admirable declarations of principle, such as: “The overriding objective of chemical selection should be to use those chemicals which reduce all discharges of oil and chemicals to the extent that they pose an acceptably small overall risk to the marine environment”⁴⁰, but when they also state publicly that “proposed discharges” of Group A polluting chemicals in UK territorial waters will merely be “strongly discouraged”⁴¹, rather than forbidden, then it seems reasonable to question the Government’s commitment to its duty of safeguarding the marine environment for the public in whose name it operates.

Norway

The Norwegian State Pollution Control Authority (SFT) regulates the use of drilling fluids/muds through discharge permits. Water based muds are tested under OSPAR formats for bio-accumulation potential and bio-degradability and given a discharge permit if judged to be environmentally friendly. Synthetic muds are similarly evaluated and can be given a discharge permit according to their properties, but at present discharge of SBMs is not allowed north of the 62nd parallel. All oil-based muds are injected or taken to shore for treatment. The discharge of solids containing more than 1% oil, by weight, is forbidden – whether the drilling fluid is water-, oil- or synthetic-based.

There is a specific prohibition on the discharge of “pipe dope” – compounds used to join sections of drill pipe, which often contain high proportions of lead and other heavy metals. The regulations also deal explicitly with well testing, workover and cementing – notoriously polluting procedures:

Discharge of oil to water during well testing in addition to discharge via the process plant, is prohibited. Separation fluid contaminated with oil may not be discharged.

The operator must assess and where necessary choose disposal solutions other than burning of the fluid phase in the well stream during well operations (well cleaning, testing, workover, etc.).

The operator shall consider measures that can reduce the discharge of excess cementing chemicals during cementing work, e.g., by choosing methods of disposal other than discharge of the excess or adapt the equipment and routines with a view to minimising the excess volumes.

³⁵ See Appendices 2 and 3.

³⁶ See Appendix 5.

³⁷ See Appendix 10.

³⁸ See Appendix 7.

³⁹ See Appendices 7 & 8.

⁴⁰ see p. 24 of *Guidelines for the UK Revised Offshore Chemical Notification Scheme in Accordance with the OSPARCOM Harmonised Offshore Chemical Notification Format*. (CEFAS. 2000a. *op. cit.*).

⁴¹ *ibid.* p.23.

Norwegian regulations⁴² are just as detailed and specific as those in the UK, but requirements appear to be more stringent and enforcement more rigorous, although there is still considerable reliance on self-regulation and self-reporting by the industry. As of 1 Sept. 1998, Norway's general conditions for permits to discharge offshore (in addition to specific requirements for each installation and/or field) included the following:

- A 40mg/l limit for oil in discharged water, averaged over a month, with a specific prohibition on diluting produced water before a sample is taken for analysis. This appears to suggest that such pre-sampling dilution may have been a problem in the past.
- Water and mud purification plants to be operated to “optimum environmental effect” – in other words, if the equipment makes it possible to do better than the official standard, then that is what should be done.
- Detailed specifications for sampling and laboratory analysis of samples – including “parallel samples” sent to independent laboratories, as a check on the validity of the operator's own testing.
- Annual, independent assessment of each operator's sampling and analytical techniques.
- Detailed records of the quantities of produced water discharged.
- On-line analysers for oil in water are compulsory, with spot checks on parallel samples five times a month, to check that the on-line equipment is properly calibrated.
- Independent samples, once a week, of produced water re-injected.
- Separate sampling and analysis of aromatic hydrocarbon components in produced water, again with parallel samples for independent, monthly checks by infra-red equipment.

Norway uses the standard OSPAR “A” and “B” lists for offshore chemicals and requires that discharge of these “shall be reduced as much as possible, e.g., through recycling”. Operators are required to ensure the purity of the substances they use, with minimum contamination by other chemicals. Discharge of unused chemicals into the sea is expressly forbidden, even if they are on list A or B and their toxicity is therefore well

⁴² See:

- Norwegian State Pollution Control Authority [SFT]. 1998. *Requirements for Ecotoxicological Testing and Environmental Assessment of Offshore Chemicals and Drilling Fluids*. SFT, Oslo;
- Norwegian State Pollution Control Authority [SFT]. 1999a. *Environmental Monitoring of Petroleum Activities on the Norwegian Shelf; Guidelines 99:01*. SFT, Oslo;
- Norwegian State Pollution Control Authority [SFT]. 1999b. *Pollution Control Act, 1981*. SFT, Oslo.

known. All discharges must have a permit and chemicals not on the lists must be separately tested and notified.

The following tables show the A & B lists of offshore chemicals currently permitted in Norway, which is generally considered to be the most stringent regulatory environment in the OSPAR countries:

Table 4: SFT List A chemicals	
Acetic acid	Aluminium silicate
Aluminium sulphate	Ammonium acid phosphate
Ammonium bisulphate	Ammonium chloride
Ammonium hydroxide	Ammonium sulphite
Amylase (25%)/amlylopectin polymer (75%) (only as a preservative for pregelatinised starch with a maximum concentration of 5%*)	Ascorbic acid
Attapulgitte clay	Barite with lowest levels of trace metal impurities (<i>weighting agent</i>)
Barium sulphate	Bentonite (<i>weighting agent</i>)
Butanol	Calcium bromide
Calcium carbonate (<i>weighting agent</i>)	Calcium chloride
Calcium hydroxide	Calcium lignosulphonate
Calcium nitrate	Calcium oxide
Calcium sulphate	Calcium phosphate
Carboxymethyl cellulose	Carboxymethyl hydroxyethyl cellulose
Causticized lignite	Cellulase
Cellulose fibre	Cement grade G
Citric acid	Cornstarch
Cotton seed hulls	Diatomaceous earth
Dicalcium silicate	Dolomite (<i>weighting agent</i>)
Ethanol (rendered undrinkable)	Ethyl cellulose
Ferric sulphate	Ferrous carbonate
Finely divided iron oxide	Formic acid*)
Glass beads	Glycerine
Graphite	Guar gum
Gypsum	2-Hydroxyethyl ether cellulose
Hydroxyethyl cellulose	Hydroxypropyl Guar gum
Ilmenite (<i>weighting agent</i>)	Iron carbonate
Iron lignosulphonate	Iron oxides (<i>weighting agent</i>)
Isopropanol	Kaolin
SFT List A chemicals (continued)	
Lactose	Lecithin
Lightly calcined magnesium hydroxide	Lightly carbonated magnesium hydroxide
Lignin	Lignite
Lime	Limestone

Magnesium chloride	Magnesium hydroxide
Magnesium oxide	Manganese tetraoxide (<i>weighting agent</i>)
Methanol	Mica
Monoethyleneglycol	Nutshells
Olive pits	Polysaccharide
Potash	Potassium bicarbonate
Potassium carbonate	Potassium chloride
Potassium nitrate	Potassium phosphate
Pre-gelatinised potato starch	Propanol
Pyrophosphate	Silica gel
Silica sand	Silicon dioxide
Soda ash	Sodium acetate
Sodium benzoate	Sodium bicarbonate
Sodium bisulphite	Sodium borate
Sodium bromide	Sodium carbonate
Sodium carboxymethyl cellulose (or CMC)	Sodium chloride
Sodium lignosulphonate	Sodium nitrate
Sodium nitrite*)	Sodium phosphate
Sodium silicate	Sodium sulphite
Sodium tetrphosphate	Sodium thiosulphate pentahydrate
Sorbitol	Starch (untreated)
Sugarcane molasses	Tricalcium silicate
Vegetable fibre	Vermiculite
Wood fibres	Xanthan gum

Table 5: SFT List B chemicals	
Acetone	Calcium Stearate
Diethyleneglycol	Ferric chloride
Formaldehyde	Glutaraldehyde
Hydrochloric acid	Metasilicate
Potassium iodide	Potassium hydroxide
Phosphoric acid	Sodium hydroxide
Sodium hypochlorite	Triethyleneglycol

Canada

Canada has similar rules to OSPAR's and, in general, only water-based drilling muds may be discharged to the sea, and then only in certain quantities and after treatment to remove as much crude oil as possible. However, the Canadian regulations appear to be much less prescriptive and detailed than in Norway or the UK, with less stringent enforcement and even more self-reporting and self-regulation than in the best-performing OSPAR countries.

Several Canadian laws govern what can and cannot be discharged into the sea on the Grand Banks of Newfoundland and the Scotia Shelf, the two main areas of offshore oil and gas production to date. This summary was compiled by the Canadian National Energy Board (NEB) and the local offshore petroleum boards in Newfoundland and Nova Scotia:

Offshore Petroleum Legislation

The regulatory frameworks applicable to oil and gas activities in each of Canada's offshore areas are broadly the same. In the Newfoundland offshore area, such activities are administered by the CNOBP under the *Canada-Newfoundland Atlantic Accord Implementation Act*, S.C. 1987, c. 3 and the *Canada-Newfoundland Atlantic Accord Implementation (Newfoundland) Act*, R.S.N. 1990, c. C-2. In the Nova Scotia offshore area, oil and gas activities are administered by the CNSOPB under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, S.C. 1988, c-2 and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act*, S.N.S. 1987, c. 3. The NEB is responsible for the regulation of oil and gas operations in the rest of Canada's offshore areas under the *Canada Oil and Gas Operations Act*, R.S.C. 1987, c. O-7. This legislation collectively shall be referred to as the energy legislation.

Regulations governing drilling and production operations have been promulgated under each Act which contain requirements related to the protection of the environment. The three Boards have also issued the Offshore Waste Treatment Guidelines, 1996.

The selection of chemicals for Canadian offshore petroleum activities currently does not have specific regulatory requirements under the energy legislation or regulations. The Production and Conservation Regulations require that an operator include in its Environmental Protection Plan, a summary of chemical substances intended for use in the operation and maintenance of a production installation. There are no similar requirements for other petroleum related activities. *[Note the contrast with OSPAR's very detailed and specific regulations. JWGW.]*

There are other regulatory requirements of general application in Canada that provide some restrictions on the transportation, handling and use of chemicals, however, these provide limited direction on the discharge of chemicals into the marine environment. Some of the relevant requirements are as follows:

Fisheries Act

Section 36 (3) of the *Fisheries Act* states that "... no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish...". Deleterious is broadly defined in Section 34 of the Act to mean "any substance" or "any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would", if added to any water, "degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water"...

Section 36 (3) of the Act is not contravened if the waste or pollutant is “in a quantity and under conditions authorized by regulations applicable to that water or place made by the Governor in Council...” [i.e. *pollution is legal if officially sanctioned. JWGW.*]

Canadian Environmental Protection Act (CEPA)

CEPA, amongst other things, provides for the notification and control of certain substances. Regulations have been made under sections 26 to 32 of CEPA for the notification of the manufacture or importation of new substances. Any substance that is not on the Domestic Substances List is required to go through this process. A new substance is assessed for toxicity and may have restrictions, controls or prohibitions imposed.

Under CEPA there is also a “Prohibited Substances List”. This is a list of chemicals that are prohibited to be imported, exported or dumped into the ocean under an Ocean Dumping Permit.

Part VI of CEPA provides for the control of ocean disposal. This requires specific authorization prior to dumping or discharging material into the ocean. The definition of dumping, and subsequently the Act, does not include “any disposal that is incidental to or derived from the normal operations of a ship, aircraft or platform” or “any discharge that is incidental to or derived from the exploration for, exploitation of and associated off-shore processing of sea bed mineral resources”...

International Commitments

Canada has signed or ratified a number of international marine conventions, agreements and guidelines, collectively representing its goal of protecting and conserving the environment and living resources in the coastal and offshore marine regions under its jurisdiction. These include the United Nations Law of the Sea Convention (1994), MARPOL 73/78 (the international Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978), Agenda 21 (United Nations Conference on Environment and Development 1992), the Convention on Biological Diversity (1992), and the Organization for Economic Cooperation and Development (OECD)’s Environment Directorate Guidelines on Harmonization of Classification and Labeling... The principles of sustainable development, precaution (i.e. the precautionary principle), and integrated management pervade these instruments. The present Offshore Chemical Selection Guidelines have been prepared within the context and with the recognition of the obligations set forth by this international framework. They also are harmonized to the maximum extent with the methodologies of international bodies as those mentioned above.⁴³

The Canadian offshore petroleum industry is much smaller and more recently developed than the long-established, onshore oil, gas and tar-sands extraction business in the west of the country. The development of Hibernia, in particular, was delayed for many years because of financial and technical problems and eventually required large government

⁴³ Canada - Newfoundland Offshore Petroleum Board, Canada - Nova Scotia Offshore Petroleum Board and National Energy Board. 1999. *Guidelines Respecting The Selection of Chemicals Intended to be Used in Conjunction with Offshore Drilling & Production Activities on Frontier Lands*. St Johns, NF.

subsidies to get it going. The exploitation of offshore oil and gas resources has been seen by Ottawa and the maritime provinces as an important tool for economic development in areas with chronic unemployment. In these political circumstances, it may not be so surprising that the environmental controls seem to be applied with a relatively light touch.

The emphasis offshore Canada is on partnership between government and industry, rather than confrontation between regulators and regulated. This voluntary approach can work, if both parties are sincere in their commitment to environmental responsibility, and there is some evidence that this is so in the Newfoundland sector of Canada's continental shelf. For example, no conventional OBM has been used there since the mid-1980s, when about 10 exploration wells were drilled with it.⁴⁴ By agreement, the drilling mud used offshore Newfoundland is mainly Petro-Canada's IPAR-3 fluid, based on low-toxicity, synthetic isoparaffin. Also, the first oilfield developed, Hibernia, is currently (May 2000) converting to cuttings re-injection after successful trials showed good receiving formations.⁴⁵

The Canadian system of regulation contrasts markedly with the situation over the border in the US, where confrontation between industry, regulators such as the Environmental Protection Agency, and pressure groups is more frequent and vociferous.

United States

A recent court judgment on drilling waste discharges demonstrates this three-cornered struggle that has been going on for decades and shows no signs of ending. Late in 1999 the *Journal of Commerce* reported:

A federal appeals court has "rebuffed" a challenge to federal offshore discharge rules by both environmentalists and coastal oil and gas producers by upholding current federal rules.

The Fifth US Circuit Court of Appeals in New Orleans last week upheld current US EPA rules barring discharges of any polluted water or sand generated in the drilling process, as the agency interpreted the 1972 Clean Water Act.

Industry groups, including the American Petroleum Institute and Phillips Petroleum, challenged that the rules are "arbitrary and capricious way to interpret the act." Environmentalists, led by Greenpeace, objected to the EPA's decision to relax the rules

⁴⁴ For details of drilling wastes research in Canadian waters, see:

1. Yunker, M. B., Drinnan, W. R. and Smyth, T. A.. 1990[?] Dispersion and Fate of Oiled Drill Cuttings Discharged from Two Exploration Wells near Sable Island, Canada. *Oil and Chemical Pollution*;
1. Canadian Marine Drilling Ltd. 1990. *SSDC/MAT Environmental Protection Manual*. Canmar;
1. Mushenheim, D. K., and Milligan, T. G. 1996. Flocculation and Accumulation of Fine Drilling Waste Particulates on the Scotian Shelf (Canada). *Marine Pollution Bulletin* 32:740-751;
1. Thomas, D.J. et al. 1984. *Offshore Oil and Gas Production Waste Characteristics, Treatment Methods, Biological Effects and their Application to the Canadian Regions...* Environment Canada, Ottawa.

⁴⁵ Canada-Newfoundland Offshore Petroleum Board representative, April 2000. *pers. comm.*

for producers in Cook Inlet, Alaska, because of a lack of "convenient disposal sites" near their offshore operations.

The panel of judges rejected both challenges, saying the agency's decision was a reasonable interpretation of the law.⁴⁶

In theory, zero discharges are universal in US waters. As in Europe, operators require a licence to discharge any wastes but, once granted, such a licence makes legal what would otherwise be an illegal practice. With the exception of Alaska, the EPA does ban all discharges of drilling fluids and drill cuttings – whether WBM, SBM or OBM - within three miles of the shores of the United States, following a decision in Louisiana 10 years ago, after local authorities and citizens' environmental groups had voiced concern at acute and chronic pollution of river deltas, bayous and near shore waters.⁴⁷

It is possible to argue an environmental case for allowing these near shore discharges in Cook Inlet, a bay that is flushed by huge tides and whose waters, at least in the northern part, are unusually turbid, with a very large burden of glacial silt, meltwater and muddy ice floes. In contrast to the Sakhalin Shelf, smothering of seabed fauna and flora by drilling discharges is unlikely to be a major factor in such an unstable, high energy environment as Cook Inlet, where any contaminants are likely to be dispersed and diluted very quickly indeed - or buried under the thick layers of glacial silt that are deposited every day. However, the exemption applies to Alaskan coastal waters of **all** kinds, whether turbid or clear, not to just Cook Inlet. The EPA decision is based on considerations of industry finance and logistical convenience rather than environmental factors, although both industry and regulators have recently advanced the argument that the air pollution caused by shipping such wastes hundreds of miles for reprocessing and disposal would outweigh the elimination of local water pollution around the installations.

EPA's account of the decision says:

In response to comments [from industry] disputing the feasibility of injecting drilling wastes into the geologic formations present in Cook Inlet, EPA reviewed information in the record and sought additional information on this issue from industry and State and

⁴⁶ Lucentini, J. 1999. Clean Water: Court Upholds Rules on Offshore Discharges. *Journal of Commerce*, 12 December 1999. A Louisiana State law of January 1997 required zero discharge of produced water to open bays.

See also:

1. United States Environmental Protection Agency (EPA). 1996a. Brower Stops Discharge of Billions of Pounds of Oil and Gas Well Pollutants into Gulf of Mexico, Alaska Coastal Waterways. *EPA Environmental News R-152*. Washington D.C.;
1. United States Environmental Protection Agency (EPA). 1993. Final Modification of the NPDES General Permit for the Western Portion of the Outer Continental Shelf (OCS) of the Gulf of Mexico (GMG290000). *Federal Register Vol. 58, No. 231, 12/3/93*, pp. 63964-63986. Washington, D.C.;
1. United States Environmental Protection Agency (EPA). 1998. Final NPDES General Permits for the Eastern Portion of Outer Continental Shelf of the Gulf of Mexico (GMG280000) and Record of Decision. *Federal Register 63:200 (55717-55762) 10/16/98*. Washington D.C.

⁴⁷ World Oil. 1991. Louisiana Plans to Ban Produced Water and Cuttings Discharges in Twelve Coastal Parishes. *World Oil 212:15*. Gulf Publishing Company. Houston, Texas.

Federal authorities. Based on the limited data available to date, EPA believes that the information in the record indicates that certain sites in Cook Inlet may not be able to inject sufficient volumes of drilling wastes to enable compliance with zero discharge as EPA has defined the technology....⁴⁸

A recent paper⁴⁹ by the EPA and US Department of Energy (DoE) explained that facilities in Cook Inlet are “subject to the same standards as offshore wells” more than three miles out:

Facilities located more than 3 miles from shore and all Alaskan facilities may discharge drilling fluids and drill cuttings but must meet the following restrictions:

- No discharge of free oil, diesel oil, or oil-based fluids and cuttings.
- The 96-hr LC-50, a toxicity measurement, must use at least 30,000 ppm⁵⁰.
- Barite used to make the drilling fluid must not contain more than 1 mg/kg mercury and 3 mg/kg cadmium.

The Clean Water Act requires that all wastewater discharges be authorized through a National Pollutant Discharge Elimination System (NPDES) permit. The most recent NPDES permit for the Outer Continental Shelf (Nov. 2, 1998), recognizes that SBMs are distinct from OBMs, although it lacks specific permit language authorizing or prohibiting SBM-cutting discharge.

The effect of this is to allow almost all discharges of WBM more than three miles from shore (with the Alaskan exception). This is very similar to the situation in European waters.

The lesson of the American experience of regulating drilling waste discharges seems to be that, in its desire to reach workable compromises with industry, the EPA has strayed from easily-understood bans on certain types of discharges into thickets of almost impenetrable technical verbiage that make it hard, even for experts, to understand what is allowed and what is not.

The US has now developed a complicated (and, to an outsider, bewildering) array of different regulatory criteria designed to reflect the pollution-prevention capabilities of various offshore platforms, depending on whether they are old ones with outdated technology, refurbished with enhanced equipment, or brand new installations with the latest 21st century systems. The intent was to take a realistic view of what was possible and practicable in the field. This approach is mandated by the Clean Water Act, which insists that measures to protect the environment must be “cost-reasonable” and take into

⁴⁸ United States Environmental Protection Agency (EPA). 1999b. Final NPDES General Permit for Oil and Gas Exploration, Development and Production Facilities in Cook Inlet, Alaska. *Federal Register* 64:46 (11885-11908). 3/10/99. Washington, D.C.

⁴⁹ Veil, J.A., Daly, J.M., Johnson, N. 1999. EPA Speeds Regs for Offshore Synthetic-based Mud. *Oil and Gas Journal*, 97(37):78-85.

⁵⁰ In other words, a waste discharge, at a concentration of 30,000 parts per million (3%) or more, should kill no more than half of a test population of selected marine creatures exposed to it for four days.

account the effect of environmental regulations on “the overall industry financial health”⁵¹.

The extraordinarily detailed, prescriptive regulations create reams of paperwork, vastly exceeding even the OSPAR system. The effluent limitations guidelines are based on a plethora of acronyms, such as:

...new source performance standards (NSPS) for direct dischargers based on “best practicable control technology currently available” (BPT), “best conventional pollutant control technology” (BCT), “best available technology economically achievable” (BAT), and “best available demonstrated control technology” (BADCT)...⁵²

Some brief extracts from a recent EPA rulemaking proposal may give an idea of the Byzantine complexities of a system which appears to put the interests of business on at least an equal footing with those of the environment the Government is charged to defend:

B. Summary of the Final Coastal Guidelines

This rule establishes regulations based on “best practicable control technology currently available” (BPT) for one waste stream where BPT did not previously exist, “best conventional pollutant control technology” (BCT), “new source performance standards” (NSPS), “best available technology economically achievable” (BAT), “pretreatment standards for existing sources” (PSES), and “pretreatment standards for new sources” (PSNS). Drilling fluids, drill cuttings, and dewatering effluent are limited under BCT, BAT, NSPS, PSES, and PSNS. BCT limitations are zero discharge, except for Cook Inlet, Alaska. ... For both PSES and PSNS, EPA is establishing zero discharge limitations in all coastal subcategory locations.

Produced water and treatment, workover, and completion fluids are limited under BCT, BAT, NSPS, PSES, and PSNS. For BCT, EPA is establishing limitations on the concentration of oil and grease in produced water and treatment, workover, and completion fluids equal to current BPT limits. The Daily Maximum limitation for oil and grease is 72 mg/l and the Monthly Average limitation is 48 mg/l. For BAT and NSPS, EPA is establishing zero discharge limitations, except for Cook Inlet, Alaska.

The EPA’s definition of Best Practicable Control Technology Currently Available (BPT) may be of particular interest to regulators in other countries when dealing with discharge applications from American companies used to working under the EPA rules:

BPT effluent limitations guidelines apply to discharges of conventional, toxic, and non-conventional pollutants from existing sources. BPT guidelines are generally based on the average of the best existing performance by plants in a category or subcategory. In establishing BPT, EPA considers the cost of achieving effluent reductions in relation to the effluent reduction benefits, the age of equipment and facilities, the processes

⁵¹ United States Environmental Protection Agency (EPA). 1996b. Oil and Gas Extraction Point Source Category; Final Effluent Limitations Guidelines and Standards for the Coastal Subcategory; Final Rule. 40 CFR Part 435. *Federal Register* 61:242. (66085-66130). 12/16/96. Washington D.C.

⁵² *Ibid.*

employed, process changes required, engineering aspects of the control technologies, non-water quality environmental impacts (including energy requirements), and other factors as the Administrator deems appropriate. ... Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category.

Similarly, with Best Conventional Pollutant Control Technology (BCT) and Best Available Technology Economically Achievable (BAT), there is a very strong financial factor in the equation:

The 1977 amendments to the CWA established BCT as an additional level of control for discharges of conventional pollutants from existing industrial point sources. In addition to other factors ... the CWA requires that BCT limitations be established in light of a two part "cost reasonableness" test...

In general, BAT effluent limitations guidelines represent the best existing economically achievable performance of facilities in the industrial subcategory or category. The CWA establishes BAT as a principal national means of controlling the direct discharge of toxic and nonconventional pollutants. The factors considered in assessing BAT include the age of equipment and facilities involved, the process employed, potential process changes, non-water quality environmental impacts, including energy requirements, and such factors as the Administrator deems appropriate. The Agency retains considerable discretion in assigning the weight to be accorded these factors. An additional statutory factor considered in setting BAT is economic achievability across the subcategory. Generally, the achievability is determined on the basis of total costs to the industrial subcategory and their effect on the overall industry financial health. As with BPT, BAT may be transferred from a different subcategory or category. BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.

Even when it comes to Best Available Demonstrated Control Technology For New Sources (BADCT), economics take precedence:

New facilities have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. Under NSPS [New Source Performance Standards], EPA is to consider the best demonstrated process changes, in-plant controls, and end-of-process control and treatment technologies that reduce pollution to the maximum extent feasible. In establishing NSPS, EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements...⁵³

Inviting Regulation

Despite the high public profile and considerable influence of the environmental lobby in the US, the EPA has had to frame its regulations in a political dialogue where federal and state administrations and legislatures routinely offer privileged access, special facilities

⁵³ United States Environmental Protection Agency (EPA). 1996b. *op. cit.*

and extraordinary favours to corporations, far beyond what is available to ordinary citizens of the United States. A similar but less blatant situation has existed in the UK since the early 20th century. The process has been summarised by, among others, Owen and Braeutigam⁵⁴, who advised corporations to:

- *Invite Regulation*: ‘No industry offered the opportunity to be regulated should decline it.’ Regulation is seen as a means of protecting industry from competition from outside and within the industry. Inviting regulation gives you the opportunity to control it.
- *Make strategic use of information*: ‘Agencies can be guided in the desired direction by making available carefully selected facts. Alternatively, the withholding of information can be used to compel a lawsuit for “production” when delay is advantageous’. Other methods of delay include over-responding to an agency request. When it is difficult to delay in responding to a particular request for information, ‘the best tactic is to bury it in a mountain of irrelevant material’. Alternatively, provide information and then question its reliability and commence a series of studies to slow things down...
- *Make strategic use of innovation*. This ‘can be a crucial element in winning the regulatory game. A well-timed announcement of an innovation or technological breakthrough can moot a difficult issue which threatens to go against the firm. At a minimum, the terms of the debate may change sufficient to require the decision process to begin anew’.
- *Lobby the agency effectively*. ‘Effective lobbying requires close personal contact between the lobbyists and government officials. Social events are crucial to this strategy. The object is to establish long-term personal relationships transcending any particular issue...An official contemplating a decision must be led to think of its impact in human terms, and not institutional or organizational terms. Officials will be much less willing to hurt long-time acquaintances than corporations’.
- *Co-opt the experts*. Identify the leading experts in relevant fields and hire them as advisers or consultants, or give them research grants. ‘This activity requires a modicum of finesse; it must not be too blatant, for the experts themselves must not recognize that they have lost their objectivity and freedom of action’...
- *Trade-off the agencies*. ‘Play one agency against another’, i.e. state versus federal, or one state versus another. Goals and interests of agencies often diverge; for instance, conservation versus development and ‘one can court the assistance of one agency in dealing with another’.

This may appear a very cynical view of the regulatory process but, after more than 25 years of observing British and American oil corporations dealing with successive British and American Governments (and usually succeeding in their objectives), the author can state that it is, nonetheless, an accurate assessment.

⁵⁴ Owen and Braeutigam. 1978. *The Regulation Game – Strategic Use of the Administrative Process*. Cambridge, MA. Cited in Steiner, R. 1993. *op. cit.*

In drawing up and enforcing effective legislation to protect the environment in relatively pristine areas such as the Sakhalin Shelf, it is therefore essential that lawmakers, government officials and the general public are aware of the persuasion and public relations techniques commonly employed by global corporations. This does not mean that the employees of these corporations are bad people, but it does mean that the public authorities should only employ the most rigorous, scrupulously independent experts to assess what corporations say about the feasibility and desirability of anti-pollution measures that cost them money. It is important to pay particular attention to precise translation of foreign oil and gas corporations' proposals, to avoid confusion by the kind of soothing, emollient language that is often found, for example, in environmental impact statements.

To return to the EPA: despite the limitations of excessive wordy legislation and undue influence by industry, the agency has a creditable list of achievements. For example, a recent rulemaking was expected to reduce discharges of conventional pollutants, in major waste streams of produced water, drilling fluids and cuttings, by "2,780,000 pounds [1,260 metric tonnes] per year, non-conventional pollutants by 1,490,000,000 pounds [675,859 tonnes] per year, and toxic pollutants by 228,000 pounds [103 tonnes] per year, assuming a baseline of current permit requirements. (The statutory term "toxic pollutant" refers to a substance identified as belonging to one of the 65 families of chemicals listed in the CWA as toxic...)"⁵⁵ These kinds of improvement are worth having, even if the language of regulation is dense and stultifying.

Against such achievements, and the partial clean-up of the Louisiana coastline, must be listed the continuing problem in Cook Inlet and, assuming no change in regulations, in Bristol Bay and other offshore petroleum prospects on the Alaskan coast. For, as the US regulators admit:

Based on industry projections given to EPA, an average of 89,000 bbls [14,148,000 litres] drilling fluids and cuttings are generated each year (bpy) in the Inlet. Pollutants present in these wastes include chromium, copper, lead, nickel, selenium, silver, beryllium and arsenic among the toxic metals. Toxic organics present include naphthalene, fluorene, and phenanthrene. Total Suspended Solids (TSS) make up the bulk of the pollutant loadings, part of which is comprised of the above mentioned toxic pollutants. TSS concentrations are very high due to the nature of the wastes.⁵⁶

To its credit, the EPA is encouraging operators in Cook Inlet and elsewhere to improve the technology of solids control equipment, such as shale shakers and cyclones, to remove contaminated drill cuttings:

Enhanced solids control systems, also known as closed-loop solids control operations, remove solids from the drilling fluid at greater efficiencies than conventional solids removal systems. Increased solids removal efficiency minimizes the buildup of drilled solids in the drilling fluid system, and allows a greater percentage of drilling fluid to be recycled. Smaller volumes of new or freshly made fluids are required as a result. An

⁵⁵ United States Environmental Protection Agency (EPA). 1996b. *op. cit*

⁵⁶ *ibid.*

added benefit of the closed-loop technology is that the amount of waste drilling fluids can be significantly reduced.

Onshore in the US, there is no longer any question of where to put wastes. For example, BP Amoco's new Northstar project will use down-hole injection for all cuttings, muds, fluids and produced water.⁵⁷

Thanks to the Freedom of Information Act, there is generally more openness about government information in the US than in Britain but, on the question of access to the detailed chemical composition of drilling fluids, it appears that information can be and is withheld from the public, being classified by the EPA as "Confidential Business Information" (CBI)⁵⁸. A determined researcher with the time and resources might well test this with a series of FOIA applications, but such an undertaking is beyond the scope of the present study.

Despite the industry's obvious influence with the US authorities, not least in limiting the controls on drilling waste discharges, most American public opinion remains firmly against offshore oil and gas exploitation on the US Continental Shelf, outside the Gulf of Mexico states and Alaska⁵⁹. The scale of local opposition makes expansion offshore California unlikely and the development of reserves on the narrow Pacific shelf off Oregon and Washington State unthinkable. Opponents have been far more successful in curbing global hydrocarbon corporations in the country where the oil industry began than they have been in jurisdictions such as Norway and the United Kingdom, normally thought of as "greener" and less pro-industry. The European experience is in fact more similar to Texas, Louisiana, Mississippi, Alabama and parts of Florida, which have prospered from oil for decades while trying, belatedly, to minimize the ecological damage from chronic oil spills and drilling wastes. Meanwhile, the states of the eastern seaboard, where most of the USA's remaining unexploited deposits of oil, gas and condensates lie, continue to ban offshore development – in contrast to maritime Canada, where Nova Scotia and Newfoundland have offered the corporations financial incentives. The historical reasons for this curious situation are mostly based on popular fears of pollution – particularly damage to fisheries - recently described in detail by Freudenberg and Gramling.⁶⁰ These fears, and the federal, state and corporate response to them, are of interest when considering the arguments for and against hydrocarbon extraction (and the environmental controls imposed on it) from areas such as the Sakhalin Shelf.

⁵⁷ ADEC informant, *pers. comm.* 2000.

⁵⁸ For details of US law on CBI, see: U.S. Code of Federal Regulations, Title 40, Part 2. Washington D.C. <http://www.epa.gov/epacfr40/chapt-I.info/subch-A/40P0002.pdf>

⁵⁹ Even in that notoriously pro-development state, local support is growing for the international campaign against new drilling in Arctic coastal waters.

⁶⁰ Freudenburg, W.R. & Gramling, R. (1994b). *Oil in Troubled Waters: Perceptions, Politics and the Battle over Offshore Drilling*. State University of New York Press, Albany. ISBN 0-7914-1882-0.

Environmental Effects of Drilling Waste Discharges

In the 1980s the consensus among Western scientists studying the environmental effects of drilling waste discharges was that effects were mainly local and minor. This view was summarised by the American researcher Jerry Neff of the Battelle Research Laboratory in Duxbury, Massachusetts, with an authoritative paper⁶¹ in Donald Boesch and Nancy Rabelais' influential book, *Long-Term Environmental Effects of Offshore Oil and Gas Development*, published in 1987:

Most of the major ingredients of drilling fluids have a low toxicity to marine organisms. Only chrome and ferrochrome lignosulphates and sodium hydroxide are slightly toxic. A few specialty chemicals sometimes added to drilling fluids to solve certain problems are toxic. These include diesel fuel, chromate salts, surfactants and paraformaldehyde biocide...

...[tests for] chronic and/or sub-lethal effects of drilling fluids have been performed with at least 40 species of marine animals. In most cases, sublethal responses in marine animals were observed at drilling mud concentrations only slightly lower than those that were acutely lethal. In some species, sublethal responses were observed at drilling fluid concentrations up to two orders of magnitude lower than acutely lethal concentrations. Sensitive species included reef corals, lobster larvae and scallop embryos and larvae. Recruitment of planktonic larvae to sandy sediments in laboratory microcosms was decreased by high concentrations of drilling mud mixed with or layered on the sediments. Based on laboratory studies of acute and chronic/sublethal toxicity of drilling muds and field observations of rates of dilution of drilling muds in the water column, it is concluded that water column organisms will never be exposed to drilling fluids long enough and at sufficiently high concentrations to elicit any acute or sublethal responses. Where drilling fluid solids settle on the bottom, there could be localised adverse impacts on the benthos, through chemical toxicity, change in sediment texture, or burial...

[emphases added. JWGW]

...The severity of the impact of drilling fluids and cuttings on the benthos is directly related to the amount of material accumulating on the substrate, which in turn is related to the amount and physical characteristics of the materials being discharged, and to the environmental conditions at the time and site of discharge, such as current speed and water depth. In high energy environments, little mud and cuttings accumulate and impacts on the benthos are minimal and of short duration. In low energy and depositional environments, more material accumulates and there may be reduction in abundance of some benthic species.

Other authors take a less sanguine view. The Russian scientist Stanislav Patin has recently published a comprehensive study⁶² which points out that, despite moves to increase re-injection and shipment ashore for disposal, up to 80 per cent of drilling wastes

⁶¹ Neff, J. M. 1987. Biological Effects of Drilling Fluids, Drill Cuttings and Produced Waters, in Boesch, D. F. and Rabelais N. N. (eds.). 1987. *Long-Term Environmental Effects of Offshore Oil and Gas Development*, pp. 469-538. Elsevier Applied Science Publishers, London.

⁶² Patin, S. A. 1999. *Environmental Impact of the Offshore Oil & Gas Industry*. Eco Monitor Publishing, East Northport, New York. ISBN 0-967 1836-0-X. This work cites numerous Russian sources not usually referred to by Western writers on the subject.

and chemicals still enter the sea, one way or another:

Produced, ballast and injection waters, as well as drilling cuttings and fluids polluted by hundreds of different chemicals, often go directly overboard at the production site. The majority of available studies of liquid and solid wastes of the offshore oil and gas industry give very different estimates of their toxicities. They are difficult to compare, due to the variability of the chemical composition of these discharges. (p.255.)

Patin says water-based drilling muds, while preferred over OBMs or SBMs for obvious environmental reasons, can still damage marine life. Leaving aside the question of toxicity, WBMs deposited on seabed sediments may smother benthic animals and, if in the form of very fine particles suspended in the water, can interfere with respiration in small marine animals and pelagic fish:

. . . small (pellet) fractions gradually spread over large distances. Particles less than 0.01mm in size can glide in the water column for weeks and months. As a result, large zones of increased turbidity are created around drilling platforms. These phenomena, on an even larger scale, happen during the laying of underwater pipelines, construction of artificial islands, bottom dredging, and some other activities that accompany offshore oil production operations. At the same time, the increased turbidity can pose a certain risk. In Russia, "Rules for water protection" [1991] do not allow increasing the suspended matter in fisheries water bodies over 0.25-0.75mg/l higher than the background natural levels. As direct observation in areas of exploratory drilling on the eastern shelf of Sakhalin showed⁶³, the persistent plumes of increased turbidity disturb the balance of production-destruction processes in the surface (photic) layer of seawater. It can also cause disturbances at the ecosystem level. Experimental evidence shows the negative effects of pellet suspension (particles with a size of 0.005-0.01mm) on marine organisms. A short-term increase in concentration of such suspension above the level of 2-4 grams per litre caused quick adverse effects and death to fry of salmon, cod and littoral amphipod^{64,65}.
[emphasis added. JWG]

Neff characterised water-based drilling fluids used on the US Continental Shelf as "specially formulated mixtures of clays and/or polymers, weighting agents, lignosulfates and other materials suspended in water", with barium, chromium, lead and zinc often present at "substantially higher" levels than in natural marine sediments:

Acute lethal toxicity of more than 70 used water-based drilling fluids has been evaluated in more than 400 bioassays with at least 62 species of marine organisms from the Atlantic and Pacific Oceans, the Gulf of Mexico and Beaufort Sea. Nearly 90% of LC50 values were above 10,000ppm drilling mud added, indicating that the drilling muds are practically non-toxic. Only two LC50 values were below 100ppm. The most toxic drilling

⁶³ Sapozhnikov, V. V. 1995. Modern Understanding of the Functioning of the Bering Sea Ecosystem. In *Complex Studies of the Ecosystem of the Bering Sea*. pp. 387-392. VNIRO, Moscow.

⁶⁴ Shparkovski, I. A. 1993. Biotesting Water Environment Quality with the Use of Fish. In *Arctic Seas: Bioindication of the State of the Environment, Biotesting and Technology of Pollution Destruction*. pp. 11-30. Izd-vo KNTS RAN. Apatiti.

⁶⁵ Matishov, G. G., Shparkovski, I. A. and Nazimov, V. V. 1995. Impact of Bottom Deepening Activities on Barents Sea Biota During the Development of the Shtokmanovskoe Gas Condensate Field. *Doklady RAN* 345r:138-141. Moscow.

muds are those that contain high concentrations of hexavalent chromium, diesel fuel or surfactant.⁶⁶

Although the main components of WBMs may be relatively harmless when heavily diluted in the sea, Patin says that, like other muds, they commonly contain additives that can be extremely toxic, even in low concentrations:

Using water-based formulations does not fully eliminate the environmental hazards... Some comparative studies showed that water-based fluids do not always meet strict ecological requirements⁶⁷. In particular, they can include some toxic biocides and heavy metals in their composition. Besides, in contrast with oil-based muds, these fluids display a higher capacity for dilution in the marine environment. Finally, large volumes of water-based muds are usually disposed of overboard, while muds on the oil base are largely recycled. At the same time, the experimental and field studies show that acute toxic effects of water-based drilling muds can be manifested only at high concentrations⁶⁸. Such concentrations can be found only in direct vicinity to the discharge point (within a radius of several meters).⁶⁹

Comparative studies^{70,71,72} showed that marine organisms were more sensitive to the suspended particulate phase of drilling muds than to the liquid phase. This indicates that suspended particles in drilling fluids may contribute substantially to their toxicity. [p.259]
[emphasis added. JWGJW]

The larger and heavier particles in all drilling muds tend to reach the seabed more quickly, as one would expect, and here the accumulations of this artificially produced sediment alter the ecology in two ways – by changing the particle size of the benthic sediments and by smothering animals that cannot move out of the way in time. As Norwegian researchers put it in a recent paper: “Immediately after discharge, the benthic community is eliminated under the discharge piled and is impoverished in the surrounding area, with the impact decreasing with distance⁷³.”

⁶⁶ Neff, J. M. 1987. *op. cit.* p.520.

⁶⁷ Sorbye, E. 1989. Technical Performance and Ecological Aspects of Various Drilling Mud. In *Proceedings of the First International Conference on Fisheries and Offshore Petroleum Exploitation*, pp. 1-18. Bergen.

⁶⁸ Patin, S. A. 1998. *A New Approach to Assessment of the Environmental Impact of the Offshore Oil and Gas Industry: Water Resources*. Moscow.

⁶⁹ Patin, S. A. 1999. *op. cit.*

⁷⁰ National Research Council Panel on Assessment of Fates and Effects of Drilling Fluids and Cuttings in the Marine Environment. 1983. *Drilling Discharges in the Marine Environment*. National Academy Press Marine Board, Commission on Engineering and Technical Systems, National Research Council. Washington, D.C.

⁷¹ Neff, 1987, *op. cit.*

⁷² Swan, J., Neff, J. M. and Young, P. C. (eds.) 1994. *Environmental Implications of Offshore Oil and Gas Development in Australia – the Findings of an Independent Scientific Review*. Australian Petroleum Exploration Association Ltd., Sydney.

⁷³ Det Norske Veritas. 2000. *Technical Report – Drill Cuttings Joint Industry Project. Phase I Summary Report. Revision 2: 20th January 2000*. DNV doc. order No. 29003500. Oslo

Patin cites research by Kozak and Shparkovski⁷⁴, who found that water-based clay fluids effected changes in respiration rates and heartbeat in salmon fry exposed to concentrations of between 2 and 15 milligrams per litre (mg/l) for a couple of minutes and led to “reduced survival” in cod and flounder exposed to concentrations of 5 mg/l for 10 to 30 days. Shparkovski *et al.*⁷⁵ had earlier reported “threshold changes in respiratory and cardiac activities” in cod, salmon, haddock and rays exposed for two to five minutes to 15-40mg/l concentrations of “water-based clay-bentonite fluids”. Another Russian research paper⁷⁶ described 50% mortality in salmon fry and amphipods exposed for between 48 and 96 hours to 5-22mg/l concentrations of water-based lignosulfonate and ammonium drilling fluids. On the other hand, “chronic tests” of copepods, amphipods, bivalves and cod fry exposed to “water-based muds” at 10-103mg/l produced “no observed effect”.⁷⁷

Patin says the composition of drilling fluids is so variable and the circumstances of their use so different that there is “an extremely wide range of concentrations that cause different toxic effects” ranging from “practical absence of toxic effects to lethal toxicity”. He divides drilling fluid components into three main groups, based on their ecotoxicological hazard:

- Group I includes the main components of water-based drilling muds – such as bentonite and other clays, barite and lignosulfonates. These are of “low and moderate toxicity”, declining rapidly in effect with distance from the point of discharge.
- Group II, of “intermediate toxicity” but much smaller volume, comprises surfactants, lubricants, circulation additives, oil and oil products, solvents, emulsifiers, thinners and spotting fluids.
- Group III includes highly toxic materials present in small quantities, such as heavy metals, scavenging agents, defoamers, descalers, corrosion inhibitors, bactericides and biocides.

Summarising various toxicological studies on the effects of the components of water-based drilling fluids, Patin supports the view that barite (barium sulphate) has “no observed effects” at concentrations of less than 2mg/l in standard chronic tests.

⁷⁴ Kozak, N. V. and Shparkovski, I. A. 1991. Testing Drilling Muds and their Components with the Use of Fish from the Barents Sea. In *Theses of the Second All-Union Conference on Fisheries Toxicology*. 1:272-273.

⁷⁵ Shparkovski, I. A., Petrov, V. S. and Kozak, N. V. 1989. Physiological Criteria [for] Assessment of the Ecological Situation During Drilling on the Shelf. In *Theses of the First All-Union Conference on Fisheries Toxicology*, 2:199-200. Riga.

⁷⁶ Borisov, V. P., Osetrova, N. V., Ponomarenko, V. P. and Semenov, V. N. 1994. *Impact of Offshore Oil and Gas Developments on the Bioresources of the Barents Sea*. VNIRO, Moscow.

⁷⁷ Kosheleva, V. V., Novikov, N. A., Migalovski, I. P., Gorbacheva, E. A. and Lapteva, A. N.. 1997. *Responses of marine organisms to environmental pollution during oil and gas development on the shelf of the Barents Sea*. PINRO, Murmansk.

The SBM Controversy

Because of the widely recognised problems with OBMs, governments and environmentalists at first welcomed proposals to formulate alternative muds, based on emulsions and polymers of various kinds, that could do the essential heavy work of OBMs but not cause gross pollution of the environment. The thinking behind these synthetic-based drilling fluids, or SBMs, was summed up by the American oil company Unocal's promotional material on "Environmental Stewardship" in its Health, Environment and Safety Report for 1995:

In an effort to minimize drilling impacts on the environment, Unocal engineers have developed an innovative drilling fluid using synthetic-based fluids... Oil-based and synthetic-based fluids are preferred over water-based fluids in most applications for their ability to drill a gauge hole, thereby minimizing drilling problems.

In an effort to minimize impacts on the environment, Unocal's engineers are testing various fluid systems in their drilling operations. Unocal's drilling department in the Gulf of Thailand has successfully utilized an economical synthetic-based drilling fluid developed in-house by Unocal scientists. Plans are underway to apply the fluid in drilling all oil and gas wells in Thailand and Indonesia. This same drilling fluid meets current permit guidelines for discharge of drill cuttings in the Gulf of Mexico, and has been accepted by EPA and the Department of Interior's Minerals Management Service. The synthetic drilling fluid that Unocal is testing has several distinct environmental advantages over conventional diesel and mineral oil-based drilling fluids. Synthetic-based fluids are free of inherent contaminants, unlike conventional oil-based drilling fluids. As a result, they are more benign environmentally, as demonstrated by aquatic toxicity testing. A health-based risk assessment was recently performed to further confirm the reduced environmental impact of this innovative drilling fluid.⁷⁸

The "inherent contaminants" referred to were the traces of radioactivity and toxic heavy metals in barite and other minerals, which can vary according to the mine producing the material and the extent of processing prior to packaging and sale.

Making no reference to current European thinking on synthetic-based fluids, the EPA recently summarised its own views on synthetic substitutes for OBMs:⁷⁹

Since about 1990, the oil and gas extraction industry developed SBFs with synthetic and non-synthetic oleaginous (oil-like) materials as the base fluid to provide the drilling performance characteristics of traditional oil-based fluids (OBFs) based on diesel and mineral oil, but with lower environmental impact and greater worker safety through lower toxicity, elimination of polynuclear aromatic hydrocarbons (PAHs), faster

⁷⁸ Unocal. 1996. Environmentally sensitive drilling fluids. *1995 Health, Environment and Safety Report*. Website: <http://www.unocal.com/responsibility/95hesrpt/drill.htm> El Segundo, CA.

⁷⁹ United States Environmental Protection Agency (EPA). 2000 (April) *Notice of Data Availability; Effluent Limitations Guidelines for the Oil and Gas Extraction Point Source Category* [draft public consultation document on proposed new rules governing offshore discharges of SBM/SBF]. CFR Part 435. Washington, D.C. See also: United States Department of the Interior (DOI), Minerals Management Service (MMS). 2000. *Clean Water Act - Technological Advancements*. Website: <http://www.mms.gov/envd-bea/cwa/technology.htm> Washington D.C.

biodegradability, lower bioaccumulation potential, and, in some drilling situations, less drilling waste volume.

EPA's information to date, including limited seabed surveys in the Gulf of Mexico, indicate that the effect zone of the discharge of certain SBFs is within a few hundred meters of the discharge point. These surveys also indicate that the sea floor may significantly recover in one to two years. EPA believes that impacts are primarily due to smothering by the drill cuttings, changes in sediment grain size and composition (physical alteration of habitat), and anoxia (absence of oxygen) caused by the decomposition of the organic base fluid. The benthic smothering and changes in grain size and composition from the cuttings are effects that are also associated with the discharge of WBFs and associated cuttings. Based on the record to date, EPA finds that these impacts, which are believed to be of limited duration, are less harmful to the environment than the non-water quality environmental impacts associated with the zero discharge requirement applicable to OBFs. Moreover, EPA prefers SBFs over OBFs as there are operational accidents that lead to spills and loss of drilling fluid to the environment.

[emphasis added. JWGW]

The EPA SBF Proposal, published on February 3, 1999 (64 FR 5488), identified possible methods to control SBF discharges associated with cuttings (SBF-cuttings) in a way that reflects the appropriate level of technology. EPA proposed using stock limitations on the base fluids from which the drilling fluids are formulated. This would ensure that substitution of synthetic and other oleaginous base fluids for traditional mineral oil and diesel oil reflects the appropriate level of technology. In other words, EPA wants to ensure that only the SBFs formulated from the "best" base fluids are allowed for discharge. Parameters that distinguish the various base fluids are the polynuclear aromatic hydrocarbon (PAH) content, sediment toxicity, rate of biodegradation, and potential for bioaccumulation.

EPA also proposed that SBF-cuttings should be controlled with discharge limitations, such as a limitation on the toxicity of the SBF at the point of discharge, and a limitation on the mass (as volume) or concentration of SBFs discharged. The latter type of limitation would take advantage of the solids separation efficiencies achievable with SBFs, and consequently minimize the discharge of organic and toxic components. Additionally, EPA proposed that SBF discharges not associated with cuttings (e.g., incidental spills, accumulated solids, deck drainage) should meet zero discharge requirements, as this is the current industry practice due to the value of these drilling fluids.

[emphasis added. JWGW]

Research by Norwegian and British Government scientists and by the UK Offshore Operators' Association, UKOOA (which includes Exxon's UK subsidiary, Esso) suggests, however, that the early promise of most SBMs has not been fulfilled:

SBM tests in the UK suggested these fluids, with the possible exception of one, were no better than OBM and seabed studies confirmed this. UK industry voluntarily agreed a reduction strategy and phase out to allow time for infrastructure to be developed to dispose of the cuttings. This phase-out stops at the end of 2000, after which no SBM's will be discharged [in UKCS waters]. There is still some uncertainty over one of the

SBMs (esters), which may biodegrade quite quickly, but it is looking as though the UK will phase it out also... The PARCOM sea based activities committee (SEBA) made a recommendation that is more relaxed than the UK position as it continues to allow discharge of SBMs in some circumstances. The technical aspects are very similar to OBM in terms of disposal options.⁸⁰

The view of the British Government's Centre for Environment, Fisheries & Aquaculture Science (CEFAS) is summarised in their latest (March 2000) guidelines⁸¹:

Since the biodegradation of most synthetic drilling fluids was found to be unacceptably low, the Department of Trade and Industry, in conjunction with other Government departments, acted with operators to reduce discharges of these fluids to zero by 31 December 2000. In order to achieve this, all operators were asked to draw up a company specific phase-out strategy demonstrating how each company intended to reduce its SM discharges by approximately 20% each year, using a 1996 baseline. Companies are making greater reductions than targeted and the objective of zero discharge by end 2000 should be achieved.

The same point was made by OSPAR's Working Group on Sea-Based Activities (SEBA), meeting in Amsterdam on 14 – 18 February 2000⁸², which noted "the report (SEBA 96/5/1) that recently developed synthetic drilling fluids are likely to persist when discharged into the marine environment at high concentration on drill cuttings where anaerobic conditions develop;"

This highlights a major difference of opinion between Europe and the US, where the Environmental Protection Agency is currently proposing to allow limited discharges of treated SBM, on the grounds that, overall, this will cause less pollution than re-injection or shipping ashore for treatment, partial reclamation and landfill disposal – all of which involve high energy demands for transport and processing.⁸³

Like UNOCAL, the US Department of Energy (DOE) is still extremely positive about the supposed environmental benefits of Synthetic-based muds. In a DOE-funded paper⁸⁴ for the Society of Petroleum Engineers/EPA Exploration and Production Environmental Conference in Austin, Texas, as recently as March 1999, John Veil of the Argonne National Laboratory and his co-authors from the EPA and DOE said: "SBMs contain no polynuclear aromatic hydrocarbons, exhibit lower toxicity and bio-accumulation

⁸⁰ UKOOA spokesman, *pers. comm.* April 2000.

⁸¹ CEFAS. 2000a. *Guidelines for the UK Revised Offshore Chemical Notification Scheme in Accordance with the OSPARCOM Harmonised Offshore Chemical Notification Format*. <http://www.cefasc.co.uk/ocns>. London.

⁸² OSPAR. 2000. *Draft Measures Proposed by the OSPAR Working Group on Sea-based Activities (SEBA), February 2000*. Amsterdam.

⁸³ United States Environmental Protection Agency (EPA). 2000 (April) *Notice of Data Availability; Effluent Limitations Guidelines for the Oil and Gas Extraction Point Source Category* [draft public consultation document on proposed new rules governing offshore discharges of SBM/SBF]. CFR Part 435. Washington, D.C.

⁸⁴ Veil, J.A., Daly, J.M., Johnson, N. 1999. EPA Speeds Regs for Offshore Synthetic-based Mud. *Oil and Gas Journal*, 97(37):78-85.

potential, and biodegrade faster than OBMs”. They also believed SBM cuttings were “less likely than OBM cuttings to cause adverse sea-floor impact”.

The language used in the paper suggests that Veil and his colleagues were asked to consider economic as well as environmental factors. For example: “...although SBMs cost more than OBMs, the nature of SBM-based drilling fluids may permit associated cuttings to be discharged onsite”. They also reported: “The industry has been eager to use SBMs, particularly in the Gulf of Mexico, where drilling has moved into deep water. Current federal regulatory requirements, however, do not adequately address the discharge issue of SBM-based cuttings, and some SBMs continue to be hauled onshore for processing and reuse after the well is drilled.”⁸⁵

The EPA’s main concern appears to be not that SBM/SBF is undesirable, as European research concluded several years ago, but that the American methods used to measure and detect its toxicity, bio-degradability and bio-accumulation potential are not sufficiently refined. The problem identified here is that the toxicity tests currently prescribed by the US Government for testing WBMs do not give accurate results for SBMs: because oil can dissolve in SBM, the “sheen test” used to determine whether a discharge is or is not causing a slick, may be ineffective; when WBM bio-assay tests are used, “most SBMs demonstrate very low toxicity, due to the inability of SBM to disperse in water”; and, because SBMs tend to concentrate in seabed sediments rather than remaining suspended in the water, standard tests on particles suspended in the water column do not show up the contaminants in SBM.

The authors concluded that if independent research were available on the toxicity of the components in SBMs, “it may be unnecessary to perform sediment toxicity tests at the point of discharge, and toxicity levels may be controlled through the base fluid and controls on crude oil contamination”.

Whether the EPA will come to similar conclusions as the UK and Norway, once it has developed new monitoring techniques, remains to be seen. But it is noteworthy that the same corporations currently discharging synthetics offshore US are simultaneously moving very rapidly to meet the phase-out deadline for SBM offshore UK.

“Non-Water Quality Environmental Impacts”

By February 1999 the oil industry appeared to have convinced the EPA that not only should the industry’s commercial concerns be given due prominence in considering new legislation to regulate discharges, but also that the measures proposed should be placed in a wider environmental context. This allowed them to argue that dumping certain substances in the ocean would be less environmentally damaging, overall, than hauling it to shore for proper treatment, and to persuade EPA, in effect, to abandon zero-discharge as a pollution control mechanism.

⁸⁵ The unstated implication is that this is expensive and thus a problem. It is, but is it an environmental science problem?

This ingenious (critics might say ingenuous) intellectual contrivance is neatly summarised in Veil's paper:

In February 1999, the EPA proposed a regulation on SBMs that considered two options: a discharge option and a zero-discharge option. The EPA chose the discharge option for the proposal because it believes that the water quality impacts of appropriately controlled SBM discharges are less harmful to the environment than the non-water quality environmental impacts (fuel use, air emissions, etc.) that would occur if zero discharge had been selected. The EPA also believes the discharge option will encourage the further use and development of SBMs as a pollution-prevention technology. The proposed regulations present control measures the EPA thinks are adequate and appropriate.

Once again, the industry had volunteered for regulation and then talked the regulatory authorities into agreeing that what was economically best for the industry was also environmentally best for everyone. Similar arguments are currently being advanced by the industry to OSPAR on the other side of the Atlantic, but here they have a problem - European research does not back the contention that SBMs are "a pollution-prevention technology" or that they "exhibit lower toxicity" than OBMs. Consequently the 12% of SBM that can remain on drill cuttings even after being processed by the primary and secondary shale-shakers on drilling installations⁸⁶ is not acceptable under the proposed new European standards. Nonetheless, it appears that some OSPAR officials and European politicians⁸⁷ are partly convinced by these arguments although, as noted, the UK is taking a "greener" line than usual on this issue.

Although this discussion has been about SBMs, very similar arguments can be advanced when discussing disposal options for cuttings contaminated with WBMs. Almost universally, these are still dumped over the side after treatment which does not remove all the contaminants, including crude oil.

The Effects of Discharges of Drilling Fluid Additives

According to Patin, ferro-chrome lignosulfonate, a common drilling mud additive used as a thinner and deflocculant, has reported effects on survival and physiological responses of fish eggs and fry; the filtration control additive CMC (carboxy-methyl-cellulose) can cause death in fish fry at high concentrations (1,000-2,000mg/l) and physiological changes at 12-50 mg/l, whereas at the low concentrations (1-20mg/l) used in standard chronic tests it has no observed effects. Other additives used as defoamers, descalers, thinners, viscosifiers, lubricants, stabilisers, surfactants and corrosion inhibitors all have reported effects on marine organisms, ranging from minor physiological changes to reduced fertility, lower feeding rates and higher mortality, depending on the concentrations. Some of the corrosion inhibitors, for example phosphoxit-7, EKB-2-2 and EKB-6-2, are "characterised not only by high toxicity ... but by their ability to cause

⁸⁶ Veil, J. A., *et al.* 1999. *op. cit.*

⁸⁷ OSPAR. 2000. *op. cit.*

genetic and teratogenic damages as well⁸⁸. Such properties were also revealed for a number of surface-active substances (surfactants) from a group of neonols – AF9-6, AF9-10, and others⁸⁹.” [emphases added. JWGW.]

In 1995 Greenpeace published the following “typical analysis for heavy metal content of SOLTEX” [the commercial name of a common drilling fluid additive], which they had obtained from “a confidential source”:

Table 6: Soltex components

Components of SOLTEX	Concentration (mg/kg)
Antimony	6.0
Arsenic	0.4
Barium	16.0
Cadmium	0.6
Chromium (total)	1.2
Cobalt	2.0
Copper	1.3
Fluoride	200.0
Lead	3.0
Mercury	0.2
Nickel	11.0
Vanadium	16.0
Zinc	2.1

The SOLTEX in question was being used in relatively shallow waters in the Celtic Sea off the west coast of Britain, between Wales and Ireland. As Greenpeace explained:

“The exact chemical composition of many of the additives are closely guarded secrets by competitive manufacturers. In the recent exploration drilling off Pembrokeshire, Wales, the oil company Marathon discharged a total of 896 tonnes of drilling muds. Both Marathon and the Department of Trade and Industry only provided the trade name of chemicals. An example of how misleading this can be is with the additive known commercially as “SOLTEX”. Marathon described SOLTEX as Lignite (non-asphaltic) and further described it

under a common name as cellulose-based ... Irrespective of the exact concentration of heavy metals, it is disturbing that the product can be described simply as cellulose based, with no reference made to the fact that it contains toxic substances.”⁹⁰

Greenpeace listed dozens of other toxic and caustic additives, including the “particularly hazardous” arsenic, asbestos, compounds of chromium and zinc, organophosphates, potassium hydroxide and lead (a major ingredient of the “pipe dope” drillers use as a jointing compound in drill pipes).

SOLTEX is used as a shale control inhibitor with either WBM or OPF. It is also listed as an additive in the drilling muds (all apparently water-based) currently being used by Sakhalin Energy Investment Company at its Molikpaq platform offshore Sakhalin, in which Marathon is a partner and operator. Other Molikpaq additives to WBM, and their uses, are shown in the accompanying table.

⁸⁸ Petukhova, G. A., Tupitsina, L. S., Bulovatskaya, S. E. and Gerasimova, E. L. 1991. The Assessment of the Genetic Toxicity of Corrosion Inhibitors. In *Theses of the Second All-Union Conference on Fisheries Toxicology*, 2: 97-98.

⁸⁹ Migalovski, I. P., Migalovskaya, V. N., Kosheleva, V. V. and Kasatkina, S. V. 1991. Impact of Surfactants on the Different Stages of Ontogeneses of Marine Fish under Experimental Conditions. In *Theses of the Second All-Union Conference on Fisheries Toxicology*, 1:46-48.

⁹⁰ Reddy, S., et al. 1995. *op. cit.*

Table 7: Additives used by SEIC at the Molikpaq platform

Name of substance, as given by SEIC	Manufacturers named by OCNS <i>List of Notified Chemicals</i> or <i>World Oil Tables</i>	Trade name As in OCNS <i>List of Notified Chemicals</i> or <i>World Oil Tables</i>	Function	Use in WBM or OBM?	OCNS Group* PLONOR?
CF-Desco (CF Ligno)	<i>No entry in OCNS Appendix 1</i>		Thinner/dispersant	WBM	? PLONOR
STAPLEX 500 (Glycol)	M-I Drilling Fluids UK Limited	Staplex 500 Shale Stabilizer C850	Shale stabilizer	WBM	E
	Aubin Ltd	Glycol-based Gel	Shale stabilizer		E
IDF-FLR (Pac Reg.)	M-I Drilling Fluids UK Limited	IDF-FLR* C121	Viscosifier	Either	E
IDF-FLR-XL (Pac LV.)	M-I Drilling Fluids UK Limited	IDF-FLR* XL C122	Fluid loss additive	Either	E
SMX (Guar Gum)	Baroid Ltd	GUAR GUM	Viscosifier for spud muds	WBM	E + PLONOR
IDVIS D (XC Polymer)	Baroid Ltd	XCD Polymer	Viscosifier	Either(?)	E
	M-I Drilling Fluids UK Limited	Idvis* C124	Viscosifier		E
	M-I Drilling Fluids UK Limited	XC POLYMER	“		E
Bicarb. of soda	Baroid Ltd	SODIUM BICARBONATE	“		E
Soltex	Drilling Specialities Company	SOLTEX	Shale control inhibitor	Either	D
DEFOAM-A	Baker Hughes	INTEQ WO DEFOAM	Defoamer	WBM	B
	Baroid Ltd	Barabrine Defoam	“	?	A
	BW Group plc	BW Defoam Green	“	?	E
	BW Group plc	BW Defoamer	“	?	C
	M-I Drilling Fluids UK Limited	Defoamer C552	“	?	E
	Scotoil Chemical Systems	Defoam Green	“	?	E
1. DUOVIS	M-I Drilling Fluids UK Limited	DUOVIS (Xanthan gum)	Viscosifier	Either	E
2. “TACKLES”	M-I Drilling Fluids	TACKLE Liquid low M.W. polyacrylate		WBM	Not on OCNS list

Sources: OCNS Lists; World Oil Tables.

It is noticeable that most are identified only by trade names, whereas the OSPAR list of substances which are either banned, subject to special regulation or whose discharge is considered to Pose Little Or No Risk to the environment (PLONOR) give only the generic or chemical names⁹¹. This makes the information inaccessible to the general public. It takes an expert to decipher what is being used, why, and what its likely effects might be.

In the US the Environment Protection Agency, like OSPAR, publishes generic and chemical names, usually without trade name equivalents. The following table shows the latest (April 2000) generic list of additives in use with SBM in US waters. Some are also used with WBM.

Table 8: Synthetic Based Fluid (SBF) Typical Composition⁹²

Function	Generic Name	Concentration
Continuous phase (base fluid)	LAO IO Paraffin Ester	55-70 vol.%
Emulsified phase	CaCl ₂ or NaCl brine	20-35 vol.%
Emulsifier	Amine or fatty acid	8-20 lb/bbl (of whole mud)
Oil wetting agent	Amine or fatty acid	8-10 lb/bbl
Weight material	Barite Calcium carbonate	50-350 lb/bbl (depends on final mud density needed)
Filtration control	Amine Clay Amine Lignite	2-15 lb/bbl
Viscosifier	Amine Clay Dimer/trimer fatty acid	0.5-7 lb/bbl
Alkalinity control	Lime	1-6 lb/bbl
Activity (shale) control	Calcium chloride (preferred) or sodium chloride	20-35 wt.% in the water phase only

⁹¹ OSPAR. 1999a. *List of Substances / Preparations Used and Discharged Offshore Which Are Considered to Pose Little or No Risk to the Environment (PLONOR)*. 1999-9. Included as Appendix 12 to this report.

⁹² Source: US Environmental Protection Agency, Washington D.C. office. *pers. comm.* April 2000.

An old but still useful source of public domain information on drilling mud additives is a document produced a quarter of a century ago by the Industrial Marketing Research Association⁹³. It lists the main ingredients of drilling mud in 1975 as follows:

Table 9: IMRA Table of Drilling Fluid Components

Name of chemical	Function	“Examples of quantities used” per annum per rig
Barytes	Weighting material	4,500 tons
Bentonite	Weighting material	400 tons
Attapulgate	Weighting material	150 tons
Sodium tetraphosphate	Dispersant/thinner	3 tons
Sodium pyrophosphate	Dispersant/thinner	2 tons
Causticised metal lignite	Dispersant/thinner	10 tons
Ferrochrome lignosulphate	Dispersant/thinner	100 tons
Pre-gelatinised starch	Filtrate reducer	2 tons
Polysaccharide	Filtrate reducer	100 tons
Carboxy-methyl cellulose (“CMC”)	Filtrate reducer	120 tons
Soluble polyacrylate	Filtrate reducer	25 tons
“Temperature resistant product”	Filtrate reducer	2 tons
Polymeric fluid loss reagent	Filtrate reducer	65 tons
Aluminium stearate	Defoamer	2 tons
Alcohol defoamer	Defoamer	30 drums
Mica	Lost circulation material	10 tons
Walnut shell	Lost circulation material	10 tons
Asbestos	Lost circulation material	10 tons
“Mixture”	Lost circulation material	10 tons
Potassium chloride	Inhibition/shale shakers	1,000 tons
Encapsulating polymer	Inhibition/shale shakers	45 tons
Biopolymer	Viscosifier	2 – 50 tons
Potassium hydroxide	pH control	1 – 10 tons
Caustic soda	pH control	125 – 150 tons
Salt	Sodium source	1 ton
Gypsum	Calcium source	<220 tons
Calcium chloride	Calcium source	4 tons
Lime	Calcium source	20 – 150 tons
Sodium carbonate	Hardness/cement remover	26 tons
Sodium bicarbonate	Hardness/cement remover	10 – 12 tons
Chlorinated phenols	Bactericides	1 ton
Unidentified	Emulsifier	2 drums
Unidentified	Surfactant	2 – 10 drums
Unidentified	Lubricant	10 drums

⁹³ Industrial Marketing Research Association (IMRA). 1975. *Chemicals in Oil Exploration and Recovery*. London. See Appendix 1.

The Effects of Discharges of Drill Cuttings

If oil and gas exploration rigs and production installations are allowed to dump drilling wastes unchecked, the effects on marine life can be extensive and biologically significant. Over the past 40 years in the UK and Norwegian sectors of the North Sea, for example, about 1.3 million cubic metres of drill cuttings and associated wastes have built up on the seabed in 102 individual “cuttings piles” with an estimated mass of from 2 to 2.5 million tonnes. The largest pile contains over 66,000m³ of material and weighs about 100,000 tonnes⁹⁴. The ecological effects extend for several kilometres from some platforms and can be detected up to 10km from discharge points. These cuttings piles smother seabed life and remain toxic for many years, mainly because of the hydrocarbons they contain.

Although the discharge of cuttings contaminated with OBMs and SBMs is now effectively banned, or about to be banned, in Western Europe, WBM may still be discharged with cuttings and additive residues here and in most jurisdictions, including North America, provided they are treated to prevent the formation of surface slicks from crude oil entrained in the wastes. According to the US Department of Energy, “WBMs produce short-term, minor impacts on the seabed, whereas OBM cuttings introduce long-term, more severe impacts”⁹⁵. According to UKOOA⁹⁶, WBM is relatively harmless because it “contains water as its primary lubricant/coolant and no oil”. In some situations “additives may have organic properties but these are only allowed in very small quantities”. As a result, UKOOA believes there is no residual oil on the cuttings. Any salts or minerals coming from the mud are “not biologically available as they are in non organic forms coming generally from the barite used as the cutting medium”. A review of the literature suggests that WBMs may not be as benign as this suggests.

While the areas of affected seabed are much smaller where only water-based muds have been used⁹⁷, the ecological effects are still significant because, as discussed above, WBM drilling wastes may contain free oil, dissolved aromatic hydrocarbons, heavy metals, radionuclides⁹⁸, biocides and other additives. Thus, WBM wastes can poison marine life as well as smothering it with artificial sediments or suffocating it with plumes of

⁹⁴For fuller details, see: Det Norske Veritas. 2000. *op. cit.*; and Grant, A. 2000. *Toxicity and Environmental Risk Assessment of Drill Cuttings Piles*. University of East Anglia, Norwich.

⁹⁵ Veil, J.A. *et al.* 1999. *op. cit.*

⁹⁶ UKOOA spokesman, April 2000, *pers. comm.*

⁹⁷ Grant, A. 2000. *ibid.*; and Olsgard, F., and Gray, J.S. 1995. A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. *Marine Ecology Progress Series* 122: 277-306.

⁹⁸ Minerals such as barite and bentonite, and some drilling chemicals, may contain minute amounts of radium. For example, in 1999 a cargo of 800 tonnes of calcium chloride powder, destined for use in North Sea drilling muds, triggered a radioactivity detector at Shell’s Aberdeen supply base. The material contained 1 becquerel per gram of radium²²⁶, which brought it under the control of the 1993 Radioactive Substances Act. The contamination proved to have come from Swedish phosphate ore used in the production process. The cargo was returned to Sweden. See website: <<http://www.ifi.co.uk/ebnc>> Information for Industry (IFI). 2000. *Environment Business News Briefing*. 13/1/00. London.

superfine suspended particles⁹⁹. It is therefore vitally important, even when no OBMs or SBMs are used, to minimise the discharge of drilling wastes if at all possible. If this is not done, offshore oilfields will eventually face the same problems as the countries around the North Sea: how can the production platforms be removed without disturbing the cuttings piles and releasing buried toxins to the sea; how can the cuttings themselves be removed, treated and disposed of without causing further ecological disruption; and would it be better, in some circumstances, to leave them where they are and let nature take its course?

To illustrate the scale of the problem in the North Sea (an area about half the size of the Sea of Okhotsk), it has been estimated that removing all the cuttings could impact the ecology over an area of some 4,000 km² if pollutants from the piles were released into the water column at a concentration of 3%. At 5ppm dilution the area of impact could be 246,000km². The costs of removal, treatment and disposal are estimated at a minimum of UK£384m [US\$614]. Industry working groups are studying more than a dozen detailed proposals for dealing with the problem and minimising its impact¹⁰⁰.

On top of these ecological, technical and economic challenges, the industry faces the potentially enormous financial cost of unquantified legal liabilities (for example: what price might the fishing industry's lawyers place on the semi-permanent loss of formerly valuable fishing grounds or the contamination of remaining fish stocks by pollutants from the cuttings piles?) Knowing what we know now, clearly it is in no-one's interests – not the local people's, not their government's and not the oil companies' – to allow a North Sea scenario to develop in newly developing offshore oil and gas fields such as the Sakhalin Shelf.

After reviewing the literature on drill cuttings, Patin (1999. *op. cit.*) wrote:

...cuttings discharges from offshore oil activities can cause effects that are more hazardous due to cutting contamination by oil and toxic components of drilling muds. Even after separation and cleaning in special units, drilling cuttings still contain a wide array of organic and inorganic traces especially when oil-based fluids are used. Drilling cuttings usually go overboard the offshore oil platforms in thousands and tens of thousands of tons. Hundreds of tons of oil and dozens of tons of chemical for each drilled well can enter the marine environment with these discharges. This raises serious concerns about the possible eco-toxicological disturbances in areas of offshore production...

...obviously, the composition of cuttings will vary a lot even when drilling a single well, which might explain the absence of any generalized information about this issue...

Most researchers believe that the main toxic agents in drilling cuttings are oil and oil products. These accumulate in the solid phase of drilling cuttings when crude oil and drilling fluids contact cuttings during oil extraction. According to some national and

⁹⁹ Such a suspended plume is a plausible contributory cause of mass deaths of pelagic fish, such as the June 1999 Piltun Bay incident in Sakhalin, but more research is needed before this can be established. JGWG

¹⁰⁰ For details, see website: <http://www.ukooa.co.uk/issues/index.cfm?page=drillcuttings/>: United Kingdom Offshore Operators' Association. 1999a. *Drill Cuttings Joint Industry Project*. UKOOA, London.

international standards [GESAMP, 1993], the permissible content of oil in discharged drilling cuttings should not exceed 100g/kg. Even if this requirement were observed during actual industrial operations, this concentration is much higher (100-1,000 times) than the thresholds of acute and sublethal toxic effects of oil-polluted bottom sediments...

Toxicological data on produced drilling cuttings (before their discharge) are not available except some mention of low toxicity of the particles of these cuttings, suspended in the water, in concentrations of about 500mg/l... The attention of researches has been concentrated on assessing the ecological effects of oil-containing drilling cuttings after they are discharged and distributed in bottom sediments around the offshore oil platforms. Here, the levels of oil pollution are hundreds and thousands of times higher than any background characteristics. These levels can cause obvious disturbances in the structure and functions of benthic communities up to 10km away from the place of discharge...

A recent literature review by Norwegian scientists¹⁰¹ underlined the dangers of allowing cuttings piles to develop, even if they contain mainly WBM wastes: "Higher concentrations of heavy metals such as chromium, copper, nickel, lead, zinc, barium and hydrocarbons were observed in association with the cuttings than those seen in natural North Sea sediments," they reported. In contrast to Neff's earlier findings¹⁰² that there was little evidence of bioaccumulation of heavy metals from drilling wastes, the Norwegians described "biogeochemical pathways such as adsorption and desorption, particularly from oxyhydroxides of iron and manganese and adsorption into organic matter of the assimilation into the gut of benthic infauna". This view is backed by other studies, one of which¹⁰³ said: "...these [heavy] metals will be rendered largely immobile by the formation of insoluble metal sulfides in the anoxic conditions that prevail within [cuttings] piles¹⁰⁴."

While not denying Patin's warnings about hydrocarbon pollution of the seafloor, the Norwegian research did, however, point out that once hydrocarbons are buried in seabed sediments, whether they originate in WBM cuttings or OBM cuttings, not much happens to them if left undisturbed: "Hydrocarbons within the [cuttings] piles remain relatively unchanged with time as a result of depleted oxygen, low ambient temperature, type of drilling fluids used and lack of significant bio-turbation. They do not leach out in any substantial quantities over time but will stay bound to the sediment particles trapped within pore water and degrade slowly."

¹⁰¹ Det Norske Veritas. 2000. *Technical Report – Drill Cuttings Joint Industry Project. Phase I Summary Report. Revision 2: 20th January 2000*. DNV doc. order No. 29003500. Oslo.

¹⁰² Neff, J. M., Hillman, R. E. and Waugh, J. J. 1989. Bioaccumulation of Trace Metals –from Drilling Mud Barite by Benthic Marine Animals. In Engelhardt, F. R. *et al.* (eds). 1989. *Drilling Wastes*. pp. 461-480. Elsevier Science Publishers Ltd, Barking, England.

¹⁰³ Grant, A. 2000. *Toxicity and Environmental Risk Assessment of Drill Cuttings Piles*. University of East Anglia, Norwich.

¹⁰⁴ Di Toro, D. M., Mahony, J. D., Hansen, D. J., Scott, K. J., Hicks, M. B., Mayr, S. M. and Redmond, M. S. 1990. Toxicity of Cadmium in Sediments – the Role of Acid Volatile Sulfide. *Environ. Toxicol. Chem* 9:1487-1502. and Di Toro, D. M., Mahony, J. D., Hansen, D. J., Scott, K. J., Carlson, A. R. and Ankley, G. T. 1992. Acid Volatile Sulfide Predicts the Acute Toxicity of Cadmium and Nickel in Sediments. *Environmental Science Technology* 26:96-101.

Another recent study of cuttings piles around the North-West Hutton oilfield between Shetland and Norway¹⁰⁵ found widely varying pollutant thresholds at which ecological effects occurred and concluded:

More fundamentally, there is no agreement on which components of the drill cuttings are responsible for the environmental effects. As in some cases, effects have been observed at very low hydrocarbon levels, some authors have suggested that it is not plausible that effects are due to hydrocarbons.^{106,107} Concentrations of hydrocarbons are usually correlated with concentrations of a number of metals and with sediment grain size and organic carbon content. Measures of environmental effect may be more strongly correlated with these other environmental variables than they are with hydrocarbon concentration¹⁰⁸. ... This uncertainty over what is responsible for observed ecological effects clearly causes some fundamental difficulties in determining dose-effect relationships.

The indisputable fact remains, however, that the precautionary principle strongly suggests minimising all discharges from oil and gas production platforms.

The Effects of Discharges of Produced Water

Almost all offshore oilfields produce large quantities of contaminated water that can have significant environmental effects if not handled properly. The UK Offshore Operators' Association explains the phenomenon as follows:

Oil and gas reservoirs have a natural water layer (called formation water) that, being denser, lies under the hydrocarbons. Oil reservoirs frequently contain large volumes of water, while gas reservoirs tend to produce only small quantities. To achieve maximum oil recovery, additional water is usually injected into the reservoirs to help force the oil to the surface. Both formation and injected water are eventually produced along with the hydrocarbons and, as an oil field becomes depleted, the amount of produced water increases as the reservoir fills with injected seawater.

At the surface, produced water is separated from the hydrocarbons, treated to remove as much oil as possible, and then either discharged into the sea or injected back into the wells. In addition, some installations are able to inject produced water into other suitable geological formations.

After treatment, produced water still contains traces of oil and, because of this, discharge into the sea is strictly controlled by legislation. Under the terms of an international

¹⁰⁵ *Ibid.*

¹⁰⁶ Davies, J.M., and Kingston, P. F. 1992. Sources of Environmental Disturbance Associated with Offshore Oil and Gas Developments. In Cairns, W. J. (ed.). 1992. *North Sea Oil and the Environment*. Elsevier Applied Science. London.

¹⁰⁷ Kingston, P. F. 1992. Field Effects of Platform Discharges on Benthic Macrofauna, *Proceedings of the Royal Society of London B316:545-565*. London.

¹⁰⁸ Olsgard, F., and Gray, J.S. 1995. *op. cit.*

convention¹⁰⁹ which takes into account the need to safeguard the marine environment, the permitted level of oil in produced water that can be discharged from an installation is 40 ppm, averaged over a month. Operators must analyse the oil-in-water level twice each day and report the results to the regulatory authorities.¹¹⁰

Anything above 100ppm must be reported as an oil spill. Interviewed for this study, a UKOOA spokesman said: “Regular scientific reviews have concluded environmental impacts are insignificant from discharges at these concentrations.”

The UK Department of Trade and Industry explains the legal mechanism: “In the UK we regulate oil discharges through the Prevention of Oil Pollution Act, 1971, which requires operators of offshore installations to apply for an exemption to allow the discharge of produced water. Any exemption granted stipulates that overboard discharge must not exceed 40 parts per million. Additionally, the UK offshore industry has voluntarily accepted a target of 30 parts per million on a company annual average basis from January 1999.”¹¹¹

It is clear that the figure of 40ppm was what was technically feasible when the limit was agreed, as distinct from what may be environmentally desirable. At onshore installations, such as the Sullom Voe oil and gas terminal in Shetland, the oil companies have more space for large, heavy equipment, sand filters, settlement ponds and long process times to reduce the oil in water concentration of dirty ballast and other effluents to as low as 4ppm. At Sullom Voe, however, the receiving water is a tidal sound with strong currents, making mixing and dispersion much more rapid than, for example, the Sakhalin Shelf, where currents are slower, as they are in most seabed areas around the world.

UKOOA says performance has improved over the years:

Currently UKOOA has a 30ppm company annual average commitment¹¹² that is being achieved. Whilst industry was able to achieve an average for 1998 of 22ppm (and 1999 provisional figures are slightly lower) the problems experienced by some installations suggests technology has not advanced significantly since the OSPAR decision was taken. Also, one of the methods of achieving the reduction has been to increase the use of chemicals which also brings its own environmental issues, in both the creation and

¹⁰⁹ At its first meeting (The Hague, 1978), the Paris Commission (later the Oslo-Paris or OSPAR Commission) confirmed its acceptance of the provisional target standard for discharges from offshore oil installations of 40 ppm (PARCOM 1/17/1, §101). The Commission recalled that in interpreting this standard, it was important that all new platforms be equipped with the best practicable means for separating oil from discharged water and reducing the average oil content of a discharge to within the range of 30 to 50 ppm. The 40 ppm was therefore a mean to be aimed at – not a maximum to be complied with. The Commission adopted (PARCOM 1/17/1, §104) the following recommendation from the Oil Working Group to supplement the provisional target standard: “Each national authority should set limits on the total amount of waste water permitted to be discharged from each platform. This limit should be fixed for each platform individually, *taking into account its known treatment capacity.*” [emphasis added].

¹¹⁰ United Kingdom Offshore Operators’ Association. 1999b. *1999 Environmental Report*. Website: <http://www.ukooa.co.uk/issues>. London.

¹¹¹ DTI spokesman, Aberdeen, 2 May 2000, *pers. comm.*

¹¹² This came into effect in January 1999 as a voluntary target agreed with between the oil companies and the UK Department of Trade and Industry. *JWGW*.

disposal of the material. Some facilities are re-injecting produced water but care needs to be taken to ensure the environmental balance is correct as this increases the energy consumed and results in increased atmospheric emissions. UK requires two measurements (using a prescribed test method) each day and up to 3% of the measurements can be above the 40ppm but must be below 100ppm. Anything above 100ppm must be reported as an oil spill. Regular scientific reviews have concluded environmental impacts are insignificant from discharges at these concentrations.¹¹³

It should be noted that although the UK Government specifies the test methods and makes periodic checks on calibration of equipment and the qualifications of inspection contractors and their personnel, there is no regular system of random, unannounced visits by Government inspectors to offshore installations in the UK sector and therefore no truly independent verification of these measurements. As is the norm in other relationships between the petroleum industry and the UK Government, a great deal is taken on trust. It is impossible for the lay person to determine whether or not that trust is justified.

A similar industry/government relationship exists in US coastal waters, where the EPA set toxicity limits in 1993 that prescribed a 29ppm monthly average “oil and grease” content for produced water, with a daily maximum of 42ppm¹¹⁴.

UKOOA’s view is: “Discharges of oil in produced water cannot be compared with large oil spills because the small amounts of oil are dispersed within the sea and do not form a surface slick”¹¹⁵ but it is a commonplace observation among people who have flown regularly over the North Sea that nearly all installations usually have faint but visible streaks of sheen extending for hundreds of metres downwind of them, even when their water treatment plants are the best available. On calm water a visible sheen can form at 25ppm. Offshore, the flow of produced water must be almost continuous, whereas at an onshore tanker terminal it can be intermittent, allowing batch treatment and recirculation. As a result, offshore water treatment must rely on equipment such as electrostatic precipitators, plate separators, gas flotation units, centrifuges, hydrocyclones, filter membranes and skim piles to get as much oil as possible out of the water. Gravity treatment is still the main part of the process¹¹⁶ but there is neither space¹¹⁷ nor time to allow treated water to lie for days in settlement ponds where oil can be skimmed off and biological agents can help to purify it. Produced water discharged offshore may therefore be up to 10 times oilier than the discharges from Sullom Voe or the Valdez Marine Terminal in Alaska.

¹¹³ UKOOA spokesman. April 2000. *pers. comm.*

¹¹⁴ For discussion of this, see: American Petroleum Institute. 1995. Proceedings: *Workshop to Identify Promising Technologies for the Treatment of Produced Water Toxicity*. Health and Environmental Sciences Departmental Report No. DR351. Parsons Engineering Science, Fairfax, Virginia.

¹¹⁵ *Ibid.*

¹¹⁶ American Petroleum Institute. 1995. *op. cit.*

¹¹⁷ For example, see *ibid.*: “a footprint of 3 feet by 3 feet was suggested ... as a site that would not require major structural changes to existing facilities [in the Gulf of Mexico]. Offshore platforms are also limited to a maximum weight capacity of approximately 250 lbs per square foot.” North Sea platforms are generally larger and have more space but the restrictions are still real. JWG.W.

On Floating Production, Storage and Offloading vessels (FSOs or FPSOs) the movement of the anchored ship in the swell can upset water treatment processes and lead to discharges considerably above the average levels. This problem is particularly acute when storms generate very large waves, which happens on average for at least 60 days a year in the northern North Sea.

There is more in produced water than water and oil. In 1987, Neff¹¹⁸ described produced water for ocean discharge as containing up to 48 parts per million (ppm) of petroleum, because it had usually been in contact with crude oil in the reservoir rocks. There were also elevated concentrations of barium, beryllium, cadmium, chromium, copper, iron, lead, nickel, silver and zinc, and “small amounts of the natural radionuclides, radium²²⁶ and radium²²⁸ (“very little” of which became attached to nearby sediments) and “up to several hundred ppm of non-volatile dissolved organic material of unknown composition”. Produced water was “diluted very rapidly”, with higher salinity or concentrations of hydrocarbons or metals, or decreases in dissolved oxygen, usually not seen more than 100-200m from the point of discharge.

Neff was unequivocal about the risks, or lack of them: “Because of rapid mixing with seawater, most physical/chemical features of produced water (low dissolved oxygen and pH, elevated salinity and metals) do not pose a hazard to water column biota.” He added, however, “in shallow, turbid waters, elevated concentrations of hydrocarbons may be detected in surficial sediments up to about 1,000m from the discharge”; that the aromatic hydrocarbons and metals in produced water were toxic; and that “the toxicity of the soluble organic fraction of produced water is not known”.

He continued: “More than 88% of the 54 bioassays performed to date ... gave results indicating that the produced water was practically non-toxic. The most toxic produced water samples had been treated with biocides.” Neff noted that, although there were “practically no laboratory studies on Sublethal or chronic effects of produced water in marine organisms”, eight experimental field studies around development and production platforms had demonstrated accumulation of petroleum hydrocarbons bottom sediments and “severely depressed” benthic fauna within 150-200m of the platforms. The cause was oil in produced water.

Throughout the 1990s evidence accumulated that produced water might be less benign than it appeared. For example, a 1992 conference on produced water showed clear effects on sea urchins¹¹⁹ and abalone¹²⁰ and in the same year a Dutch study raised concerns about

¹¹⁸ Neff, 1987, *op. cit.*

¹¹⁹ Krause, P. R., Osenberg, C. W. and Schmitt, R. J. 1992. Effects of Produced Water on Early Life Stages of a Sea Urchin: Stage-Specific Responses and Delayed Expression. . In Ray, J. P. and Engelhardt, F. R. (eds.) 1992. *Produced Water – Technological/ Environmental Issues and Solutions*. Plenum Press. New York.

¹²⁰ Raimondi, P. T. and Schmidtt, R. J. 1992. Effects of Produced Water on Settlement of Larvae: Field Tests Using Red Abalone. In Ray, J. P. and Engelhardt, F. R. (eds.) 1992. *Produced Water – Technological/ Environmental Issues and Solutions*. Plenum Press. New York.

produced water effects in the shallow waters of the Netherlands coastal shelf¹²¹.

In 1994 the London-based Oil Industry International Exploration & Production Forum (E&P Forum) published a detailed report, *North Sea Produced Water: Fate and Effects in the Marine Environment*. The European Environment Sub-committee responsible for the report included two representatives of Exxon and one each from Amerada Hess, Amoco, BP, Chevron, Conoco, Elf and Texaco. They calculated that the average oil content of produced water discharged in 1991 from all North Sea production platforms was 34mg/l, less than the Paris Commission (PARCOM) target monthly average of 40mg/l. In that year the total discharge volume was 160 million cubic metres, 95% of it from oil installations and 5% from gas. These discharges were estimated to contain about 52,600 tonnes of organic compounds and about 1,000 tonnes of heavy metals.

The E&P Forum figure for 1988's dispersed oil in produced water was "approximately 4,100 tonnes" compared with an estimated total of 136,000 tonnes of oil discharged into the North Sea from all sources. The study gave no 1991 figure for the total of dispersed oil in produced water but at the stated 34mg/l it would be about 5,440 tonnes. In 1994 produced water volumes were "expected to increase steadily and then level out in 1998 to about 340 million cubic metres per year". In the past, some authors have questioned the accuracy of the total oil-in-water figures provided by the industry and the UK Government¹²² but, if we extrapolate these E&P Forum figures and assume that the industry managed to keep average oil content down to 34mg/l or less, this means that the total quantity of oil discharged with North Sea produced water could have increased to about 11,560 tonnes by 1998, a 182% increase in 10 years. However, produced water volumes tend to increase dramatically as older oilfields (like those in the northern North Sea) pass their peak production, so the actual total was considerably lower. As UKOOA puts it,¹²³ "the gradual decrease in the concentration of oil in water arises mainly from improvements in the technology used for separating small quantities of oil from water".

Greenpeace authors would dispute this and have quoted a figure of 45%, in some Norwegian waters, for the proportion of oil in the sea that comes from offshore installations. They contend that, because produced water volumes increase as oilfields age, the total amount of oil discharged with it will also increase.¹²⁴

Despite this, the most recent UKOOA summary says: "In 1998, the industry total average oil in produced water was 22ppm, reflecting a trend of improvement since 1992." UKOOA has also published the following table for the UK sector of the North Sea:

¹²¹ Slager, L. K. et al. 1992. *Environmental Aspects of Produced Water Discharges from Oil and Gas Production on the Dutch Continental Shelf. Part III. Environmental Effects*. Free University of Amsterdam. ISBN 90-5192-021-0.

¹²² e.g. Vik, E. A., Berg, J.D., Bakke, S. & Lundh, T., 1991. Review of Offshore Chemical Selection, Use and Operating Procedure to Minimise Environmental Impact. *Water Science and Technology* 24 (10) 135-142. and Reddy et al. 1995. *op. cit.*

¹²³ United Kingdom Offshore Operators' Association. 1999b. *1999 Environmental Report*. Website: <http://www.ukooa.co.uk/issues>. London.

¹²⁴ Reddy, S., et al. 1995. *op. cit.*

Table 10: Produced Water Discharges, North Sea.¹²⁵

Year	Number of installations	Water quantity (millions of tonnes)	Oil levels (ppm)	Oil quantity (tonnes)
1996	59	210	27	5,706
1997	64	234	25	5,764
1998	67	253	22	5,690

It is important to note that the reporting and monitoring system for discharges of produced water (and, indeed, all other offshore discharges) is based almost entirely on self-reporting, at least in the UK sector of the North Sea. Unannounced visits by government inspectors to platforms are almost unheard of and, because helicopter access to the installations is controlled by the oil industry, almost impossible to arrange. Some inspectors may be stationed on individual platforms for periods of time, but permanent on-site inspection does not happen. The monitoring and reporting of discharges therefore fails the most elementary test of scientific impartiality and independence. This is not intended as a criticism of the oil industry; it is simply to state the facts. All data collected under such circumstances must of necessity be regarded as unverifiable, to say the least. This central problem has not been addressed by OSPAR, nor indeed by the British Government, whose Department of Trade and Industry is responsible for regulating the oil industry, and also for commercial promotion of the industry and its suppliers. Not surprisingly, there are extremely close contacts between oil company staff and civil servants. These relationships, it is assumed, stop well short of corruption but it is noticeable that there is a “revolving door syndrome” in the UK offshore industry, whereby national and local government officials formerly responsible for regulating and promoting the oil industry leave the public service and appear shortly afterwards as highly-paid employees of the oil industry and its trade associations¹²⁶.

The Russian practice of stationing independent, expert inspectors on such installations as Molikpaq appears, by comparison, a much more rigorous and scientifically reputable approach – assuming that there is no attempt by commercial interests to intimidate or suborn the inspectors. When such very large sums of money are involved in projects, that is always a possibility. If harassment, corruption and environmental law-breaking can happen on the North Slope of Alaska (*vide* the Doyon Drilling scandal at the Endicott oilfield, discussed above) then it might be attempted on the Sakhalin Shelf if, for example, there were a pressing need to get rid of quantities of toxic waste at night or during a storm. It is assumed that the Russian regulatory authorities are well aware of the necessity to guarantee the independence (and personal safety) of offshore inspectors, and that they will make every effort to do so.

¹²⁵ See also Appendix 8, which includes displacement water.

¹²⁶ The author has personal knowledge of several such “reincarnations” over the past 28 years and can supply names in confidence.

Former civil servants who now work for the oil industry (and even some who have not yet made the career move) often remind us how important it is to keep things in proportion when discussing marine pollution. They are right to do so. The E&P Forum study referred to above found that only about 4% of the total oil spilled into the North Sea came from produced water discharges. Although dwarfed by oily run-off from the land into rivers and estuaries, or the large quantities of bilge oil still dumped into the sea by ships of all sizes (fishing vessels being particularly notorious culprits in this regard), the offshore oil and gas installations' contribution is still significant and justifies measures to reduce it further, as the industry's continuing statements of concern about the problem appear to demonstrate.

The 1994 E&P Forum report concluded that produced water discharges in the North Sea had "a low potential for biological impacts" because of low concentrations and low toxicity of the pollutants, rapid dilution and rapid reaction with seawater. "All produced waters can be classified as 'practically nontoxic' according to the European Community addepted [*sic*] hazard rating," the authors stated. "Produced water appears to exhibit no toxic effects in the field... In the far field there is no discernible impact."

The dilutions required for No Observed Effect Concentration (NOEC) were achieved at "from 10 to 100 metres" from discharges and within five minutes. As a result, acute toxic effects on living things were "unlikely to occur" because exposure times were too short. "Through a number of complex mechanisms, the components of produced water are removed from the water column," the authors explained. "The fate of soluble organic components is biodegradation while insoluble components are subject to transport and sedimentation..."

They did, however, acknowledge that more research was required on the amounts, fates and effects of toxic heavy metals in produced water – which, according to the E&P Forum estimates, contributed about 3.3% of the total heavy metal input from human activities. Another suggested research topic was how the characteristics of produced water change as a field ages, and also the fate and effects of the lighter hydrocarbons in dispersed oil.

UKOOA holds a similarly reassuring opinion:

In addition to laboratory tests which show that produced water is not toxic to marine life, the profuse growth on submerged structures and the large populations of fish that inhabit the waters below offshore installations provide ample evidence that produced water discharges do not adversely effect marine life... Long term or chronic effects are also very unlikely given the miniscule levels of contaminants in produced water discharged.¹²⁷

Greenpeace authors, on the other hand, point out that conventional measures of oil in produced water, such as those used to date by OSPAR, "take no account of the aromatic hydrocarbons, including the very toxic polynuclear aromatic hydrocarbons (PAHs)"

¹²⁷ United Kingdom Offshore Operators' Association. 1999b. *1999 Environmental Report*. Website: <http://www.ukooa.co.uk/issues>. London.

which are dissolved in produced water and are unlikely to be removed by treatment before discharge.¹²⁸ The oil carried in produced waters is more toxic than in the petroleum itself, they argue, because these fluids are “enriched in aromatic hydrocarbons which are the most soluble and toxic fractions of crude oil”.¹²⁹ As a result, the oil content of produced waters from oil platforms could be under-estimated by half.

In the US, where the American Petroleum Institute acknowledged the problem of “dissolved organics” in produced water, such as the carcinogens benzene, toluene and xylene¹³⁰, the EPA had specified in 1993 that technology used to clean up produced water must also remove aromatic hydrocarbons as far as possible. According to the E&P Forum¹³¹, North Sea produced water prior to 1994 typically contained aromatic hydrocarbons in the following concentrations:

Table 11: Aromatic Hydrocarbons in North Sea Produced Water, pre-1994

Compound	Concentration
Benzene	4 – 5 ppm
Toluene	0.01 – 2 ppm
Xylenes	1 – 7 ppm
Napthalene	66 ppb
Biphenyl	4 ppb
Dibenzothiophene	0.5 ppb
Fluorene	<2ppb
Phenanthrene	<2ppb
Acenaphthene	<2ppb
Acenaphthylene	<2ppb
Fluoranthene	<2ppb
Anthracene	<2ppb
Pyrene	<2ppb
Benzo(a)pyrene	<2ppb
Perylene	<2ppb

Several times in this study, Greenpeace highlights apparent contradictions between official figures and independent research results. For example:

It is often stated that impacts of production waters in the marine environment are negligible due to the dilution factors. A recent report by the UK Offshore Operators’ Association (UKOOA, 1994) stated that “no detectable environmental impacts have arisen from this practice [disposal of produced water], because the minute amounts of oil are rapidly dispersed and biodegraded”. However, research is increasingly showing significant environmental effects of such discharges. Planktonic larvae can be adversely affected by produced water plumes, even from discharges in high energy, open coast environments¹³²... Osenburg’s results ... also suggest that important biological effects can occur over large spatial scales, despite the discharge into a high energy environment.

With the move to inshore exploration and production in increasingly shallow water [around the UK] the potential effects of produced water need to be fully assessed.
[emphases added. JWGWW]

¹²⁸ Reddy, S. *et al.* 1995. *op cit.*

¹²⁹ Quoting Lysyj, I. G., *et al.* 1981. Effectiveness of Offshore Produced Water Treatment. In *Proceedings of the 1981 International Oil Spill Conference*, pp.63-67. American Petroleum Institute, Washington, D.C.; and Neff, J. M. 1987. Biological Effects of Drilling Fluids, Drill Cuttings and Produced Waters, in Boesch, D. F. and Rabalais N. N. (eds.). 1987. *op. cit.*

¹³⁰ American Petroleum Institute. 1995. *op. cit.*

¹³¹ E&P Forum. 1994. *North Sea Produced Water: Fate and Effects in the Marine Environment*. Report No. 2.62/204. E&P Forum, London.

¹³² Raimondi & Schmitt. 1992. *op. cit.*

In his review of progress towards that reassessment, the Russian eco-toxicologist Stanslav Patin¹³³, mentioned above, appears to disagree with UKOOA, and with the E&P Forum's view that "the environmental aspects of produced water are well understood". Writing 12 years after Neff's 1987 paper, Patin drew attention to the relative lack of data on produced water, compared with the literature on other oilfield wastes:

In contrast with drilling fluids, the eco-toxicological studies of produced waters are rather limited. At the same time, the amounts of produced water discharges can be enormous. Everyday volumes of produced waters discharged from a single platform can reach 2,000-7,000m³ and total hundreds of thousands of tons a year... The oil content in these discharges usually varies within the range of 23-37mg/l¹³⁴. [p.279]

Patin summarised more recent research on produced water components:

[they may] include solutions of mineral salts along with oil, gas, low-molecular-weight hydrocarbons, organic acids, heavy metals, suspended particles and numerous technological compounds (including biocides and corrosion inhibitors) of changeable and often unknown composition used for well development and production. Prior to discharge, produced waters can be combined with injection water, deck drainage, and ballast and displacement waters that complicates the chemical composition of these discharges even more...

...it is not surprising that the toxicity of these discharges also varies within very wide limits. The values of LC₅₀ in acute experiments range from 10⁻²% to 30%. The high toxicity of some produced waters is probably explained by the presence of the most toxic substances in their composition, for example heavy metals, biocides and other similar compounds. [p.284]

Patin went on to discuss studies¹³⁵ that revealed an increased sensitivity of zooplankton organisms (copepods and others) exposed to produced water. They were "especially vulnerable at the embryonic and larval stages of their development" when lipophilic hydrocarbons could disrupt growth.

He agreed with Neff and the E&P Forum that "field observations of the distribution of produced waters discharged from offshore platforms ... reveal the rather rapid dilution ... 100m from the point of discharge, produced waters can be diluted 1,000 or more times", but drew a slightly different conclusion:

The rapid dilution of produced waters is usually used as evidence to prove the limited and insignificant environmental impact of these discharges. However, hydrological conditions in different areas and even at the same place at different periods could be extremely

¹³³ Patin, 1999, *op. cit.*

¹³⁴ Law, R. J. and Hudson, P. M. 1986. *Preliminary Studies of the Dispersion of Oily Water Discharges from the North Sea Oil Production Platforms*. ICES C.M.1986/E:15.

¹³⁵ Described in detail in Gamble, J. C., Davies, J. M., Hay, S. J. and Dow, F. K. 1987. Mesocosm Experiments on the Effect of Produced Waters from Offshore Oil Platforms in the Northern North Sea. *Sarsia* 72(3-4):383-387.

diverse and must be taken into account. For example, the rate of dilution in shallow waters or areas with limited water circulation can be lower than the rate ... for the open sea. Besides, and this is critically important, the long-term biological effects of low concentrations of produced waters have not been studied yet. Research in this direction may radically change the presently dominating concept about the insignificance of ecological disturbances in the marine environment caused by produced waters. [p.285]

These findings appear to reinforce the idea that the hydrocarbons in produced water may have a greater effect than has sometimes been thought on hydrocarbon levels in the sea near oil platforms. This is of particular relevance to the shallow, biologically productive waters of the Sakhalin Shelf. Only one northern North Sea oilfield is close to the coast (Beatrice¹³⁶, 12 miles out in the Moray Firth). Discharges from most UK platforms are diluted and dispersed by winds and currents over about 100 miles of open sea before they can reach sensitive coastlines. This is not the case in eastern Sakhalin.

¹³⁶ Davies et al. (1984, p.72) discuss the environmental effects of 24 wells drilled at Beatrice from 1978 to 1986, 11 of them with “low-toxicity, oil-based muds” and the rest, presumably, with WBM. They found that biological effects “appeared to be largely caused by organic enrichment, except in the cuttings pile beneath the platform, where physical smothering was responsible for the impoverishment of the fauna”. They also reported “lower species diversity” around the platform but, 20 months after drilling ceased, there were “dramatic reductions” in hydrocarbon concentrations close to the platform, “typically of one order of magnitude”. This reference also contains a useful table, for the period 1981-1986, on the proportions of discharged oil attributable to North Sea platform oil spills, produced water and oil on cuttings – giving an indication of the extent of contamination that can occur when discharges are lightly regulated. *JWG*.

Table 12: Examples of Effects of Produced Water

(after Patin, 1999: Table 48 - Summarized Results of Toxicological Studies of Produced Waters Discharged in the Sea)

Concentration	Test duration	Test organisms	Effects	Reference
Dilution to 25 ìg/l	Hours and days	Larvae of Atlantic cod (North Sea)	Reduced survival	Davies et al., 1981
0.15% with 5-15 ìg/l of oil	100 days	“Natural zooplankton” (North Sea)	Reduced survival at population level	“
5%	48 hours	Larvae/embryos of oyster <i>Crassostrea gigas</i> (North Sea)	50% mortality	Somerville et al., 1987
10%	24 hours	Copepod <i>Calanus Finmarchus</i> (North Sea)	50% mortality	“
5%	10 days	Hydroid <i>Campularia Flexuosa</i> (North Sea)	50% decrease in population growth	“
5-6%	15 minutes	Luminescent bacteria (North Sea)	50% decrease in photoluminescence intensity	“
5-6%	48 hours	Daphnia <i>Daphnia magna</i>	Immobilization of 50% of test organisms	“
10%	24 hours	Trout <i>Salmo gaidneri</i>	50% mortality	“
0.1-0.3%	60-130 days	Natural communities of plankton in mesocosms (North Sea)	Reduced abundance of copepod larvae, disturbances of trophic structure, biochemical changes in fish larvae	Gamble et al., 1987
3-30%	96 hours	(Gulf of Mexico) Invertebrates and fish	50% mortality	Middleditch, 1981
1-10%	Chronic tests	(California Shelf) Macrophytes <i>Macrocystis pyrifera</i>	Reduced ability of zoospores to settle on the bottom	Lewis & Reed, 1994
20-70mg/l	1-2 days	Fish eggs, fry and larvae (Caspian Sea)	Death of juveniles at 60-70mg/l; larvae at 35-40mg/l; eggs at 20-25mg/l.	Alekperov, 1989
2-30mg/l	“Several days”	Invertebrates (Caspian Sea)	Death of crustaceans at 30mg/l; reduced survival at 2mg/l.	“

Minimising Waste Discharges and Their Effects

There are several ways to reduce the volume of drilling waste produced and to minimise its effects on the sea:

Using less toxic alternatives is a favoured solution in both Europe¹³⁷ and North America, where governments and industry are continually searching for improved and less harmful offshore drilling fluids. SBMs, most of which failed to satisfy European standards, were such an attempt to deal with the problem at source and the US may yet prove that some forms of SBMs really are an environmentally acceptable alternative to OBMs. For WBMs, improvements to the purity of stock chemicals, and measurement of their toxicity prior to mixing into the drilling fluid, are among the most promising prospects for environmental improvement in cases where waste discharge is unavoidable.

Cleaning onboard prior to discharge is also a rapidly-developing technology. The crude shale-shakers and sieves once employed to separate solids from drilling fluids after use have been superseded by much more efficient equipment that can greatly improve the separation of mud from cuttings and oil from produced water. Technology exists, but has not yet been widely adopted offshore, that can very largely remove the residual pollutants in cuttings and, particularly, in produced water. The obstacles are financial rather than technical. Whether such equipment is installed and used offshore is, of course, a matter for government enforcement.

Shipment of wastes ashore for recycling, landfill and/or incineration is one of the options being considered for dealing with the very large accumulations of contaminated drill cuttings in the North Sea. It is already used to dispose of some ongoing waste streams and thus prevent the build-up of new drill cuttings piles on the seabed. While making a contribution to both the environment and the local economies of North Sea coastal regions,¹³⁸ the air pollution, landfill space demands and energy costs associated with transporting, processing and disposing of the material seem likely to influence governments in favour onsite re-injection technology as a more practical and cost-effective method – wherever geological conditions are suitable.

¹³⁷ OSPAR. 2000. *Draft Measures Proposed by the OSPAR Working Group on Sea-based Activities (SEBA), February 2000. Annex 7(6.5b): Draft OSPAR Decision 2000/? on a Harmonised Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals*. OSPAR, Amsterdam. See also: CEFAS. 2000. *Guidelines for the UK Revised Offshore Chemical Notification Scheme in Accordance with the OSPARCOM Harmonised Offshore Chemical Notification Format*. <http://www.cefas.co.uk/ocns>. London.

¹³⁸ In the UK, for example, new equipment to process cuttings and other wastes shipped ashore from North Sea fields has recently been installed in Peterhead, Aberdeen and Shetland (where one firm has been handling contaminated cuttings waste for over 10 years). See, for example: Burgess & Garrick. 2000. *Waste Management*. Website: <http://www.burgess-garrick.co.uk/about.htm> Lerwick.

Re-injection Offshore

Cuttings re-injection (CRI) is a waste disposal technique where drill cuttings and other oilfield wastes are mixed into a slurry with water and pumped at high pressure down an injection well. Sometimes it is necessary to grind up the particles in the slurry to make them finer. The hydraulic pressure can also be used to break open layers in the rock to make subsequent injection easier and to contain the wastes in a defined area – hence the term slurry fracture injection commonly used in the US and Canada, where the technique was pioneered.¹³⁹

One of the clearest explanations of CRI is by the British company Well Performance Technology Ltd¹⁴⁰, which describes it as “a cost effective means of complying with environmental legislation concerning discharges of oily wastes” and says it has “proven to be viable in many different areas and formations around the world, with the most activity in the North Sea, Alaska, Gulf of Mexico and Venezuela”:

Re-injection of drill cuttings normally involves collection of the waste from solids control equipment on the rig, followed by transportation to a cuttings processing station. Cuttings are slurried in this unit by being milled and sheared in the presence of water, usually seawater. The resulting slurry is then disposed of by pumping it into a dedicated disposal well, or through the open annulus of a previous well into a fracture created at the casing shoe set in a suitable formation. Operations are usually batch by nature and carried out at low pump rates (2.0 - 8.0 bpm). These kinds of operations have been carried out all over the world, with disposal into many different types of strata.

On logistical and cost grounds the means of disposing of waste cuttings from [offshore] platform based operations can usually be narrowed down to one of two choices. These

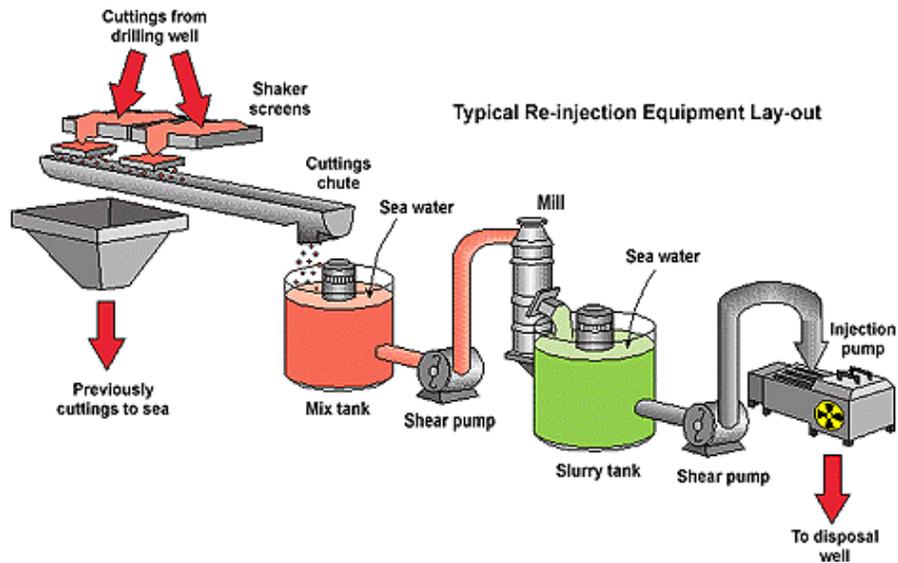
¹³⁹ For accounts of early work on re-injection, see:

1. Beak Consultants and Imperial Oil Limited 1974. *Disposal of waste drilling fluids in the Canadian Arctic*. APOA project no.73. APOA, Calgary.
1. Dome Petroleum Limited 1974. *Interim guidelines for waste management in exploratory drilling in the Canadian north*. Dome Petroleum Ltd., Calgary.
1. French, H. M. 1980. Terrain, Land Use and Waste Drilling Fluid Disposal Problems, Arctic Canada. *Arctic* 33:794-806.
1. Friesen, G. 1980. Drilling Fluids and Disposal Methods Employed by Esso Resources Canada Limited to Drill in the Canadian Arctic. *Proceedings of a Symposium: Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista, Fla.*: pp. 53-69. American Petroleum Institute. Washington, DC.
1. Lam, L. 1982. Report on Offshore Oil and Gas Drilling Fluid Disposal in the Canadian North Technical Report No. 3.6. *A Survey of Methods of Waste Fluid Treatment and Disposal for Canadian Offshore Drilling*. Canadian Superior Oil Ltd.
1. Canada Dept. of Indian Affairs and Northern Development, Environment Canada, Canada Dept. of Fisheries and Oceans, Industry/Government Working Group on Disposal of Waste Fluids from Petroleum Exploratory Drilling in the Canadian North, and Arctic Petroleum Operators Association. 1982. *Report on offshore oil & gas drilling fluid disposal in the Canadian North*. Yellowknife, N.W.T.
1. Hillman, S.O. 1983. Drilling Fluids: Disposal in the Alaskan Beaufort Sea. *Issues of the 80's: Twelfth Annual Arctic Environmental Workshop held at Fairmont, British Columbia, May 8th-11th, 1983*, p.162-166.

¹⁴⁰ See the WPT website at < <http://www.wpt.enta.net/Cuttings.htm> > for more details.

are either re-injection into a dedicated disposal well, which if newly drilled can be re-completed as a producer at a later date, or re-injection through the annulus of a well drilled prior to the current live well. Drilling and cuttings disposal into the same well is possible but to date, because of well control concerns, it is not a preferred option with operators.

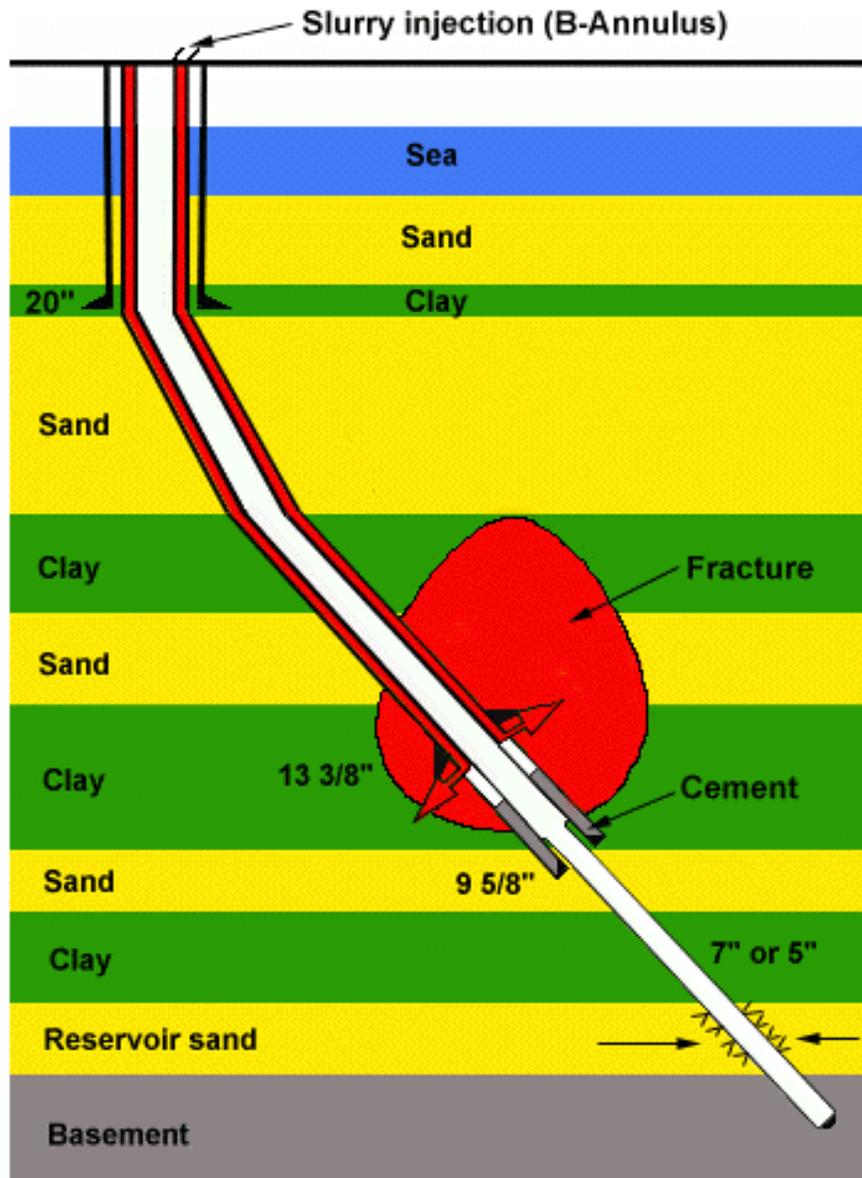
Fig. 1 Typical Re-injection Equipment Layout



Graphic by Well Performance Technology Ltd.

Sequential annulus injection is invariably the preferred means of disposing of cuttings, particularly in offshore locations. This is because of its flexibility and that it avoids the cost of drilling a dedicated disposal well. For cost reasons, dedicated re-injection wells are usually only practical on land or in shallow water. They do have advantages, however, including ease of cleaning out with coiled tubing in the event of plugging, can be designed to accommodate high volumes of waste, the ability to inject larger sized solids and a reduced risk of tubing plugging. Even so, unless annular cuttings re-injection is not viable, for example because of lack of annular access to a suitable deposition horizon, drilling a dedicated disposal well is usually ruled out on cost grounds. Thus, annular re-injection of waste cuttings is invariably the method of choice. Typically the 13 3/8" by 9 5/8" annulus is selected as the disposal location.

Annular Re-Injection of Waste Cuttings



Graphic by Well Performance Technology Ltd.

One of the first oil companies to make extensive use of cuttings re-injection was BP. The company had opened up its Alaska North Slope oilfields by using “reserve pits” – a euphemism for holes in the ground where drillers dumped almost anything. Within a few years BP had a serious environmental problem on its hands, as poisonous wastes began to leach out of the pits and spread across the tundra on top of the permafrost.¹⁴¹ Although it was out of sight from most people, the pollution in the Arctic wilderness north of the

¹⁴¹ United States Department of the Interior (DOI), Fish and Wildlife Service (FWS). 1987. Effects of Prudhoe Bay Reserve Pit Fluids on Water Quality and Macroinvertebrates of Arctic Tundra Ponds in Alaska. *US DOI Biological Report 87(7)*. Washington D.C.

Brooks Range was not out of mind. As controversy grew about the oil industry's plans to drill in the Arctic National Wildlife Refuge (ANWR) critics pointed to the mess at the reserve pits as evidence that BP's environmental credentials were suspect. This caused serious public relations problems for BP and its compradors in the Alaska State Legislature and business community. During the late 1980s and early 1990s the company cleaned up the pits, volunteered its services to deal with other organisations' waste dumps (some dating from World War II and earlier) and, to some extent, salvaged its reputation among American environmentalists. The results certainly looked impressive and showed what an organisation like BP could achieve when management and workers were given the resources to do a thorough job.^{142,143,144} By 1993 the E&P Forum could boast: "In Alaska the injection of cuttings and waste fluids has led to much smaller drilling pads, and therefore less impact from the rig rites, and less heavy traffic transporting materials across the tundra."¹⁴⁵ There were also economic benefits because the reserve pits had been costing about \$2,000,000 per well, whereas grinding and downhole injection cost about \$500,000 per well thereby saving about \$1,500,000 per well.¹⁴⁶

BP was also in the forefront with CRI offshore. In January 1991 BP engineers injected 5,700 barrels of drilling wastes 5,100 feet below the bottom of the Gulf of Mexico, in tests at the Ewings Bank platform. In the Norwegian sector of the North Sea, BP was involved in a case study on the Gyda oilfield from July 1991¹⁴⁷. In September that year BP did a test injection of 1,500 barrels of waste from the Clyde platform in the UK sector. Other case studies on CRI were carried out in the early 1990s by Conoco in the southern North Sea (January - March 1992) and the Gulf of Mexico (Block EC56, December 1991 - January 1992), by Statoil on the Norwegian Gullfaks field (October 1991) and by Amoco, also in the Norwegian sector, on the Valhall oilfield (January 1992).¹⁴⁸ These, however, were all described as case studies, tests or experiments.

By 1993 CRI was such a well-established technique offshore that- the E&P Forum produced detailed guidelines¹⁴⁹ for operators planning to use it for OBM wastes and oil-contaminated drill cuttings. The document gave examples of the kinds of problems staff might encounter and, in addition to practical advice, laid down recommended procedures for monitoring and reporting re-injection work. The working group that drew up the guidelines included two representative of Exxon, alongside experts from Agip, Amoco, BP, Chevron, Elf, Enterprise Oil, Statoil, Texaco and Total.

¹⁴² Taylor, S. 1998. *Status of North Slope Environmental Protection* (video presentation), BP Exploration, Anchorage.

¹⁴³ Minton, R. C. and Secoy, B. 1992. *Annular Re-injection of Drilling Wastes*. IADC/SPE Paper 25042. Society of Petroleum Engineers, Richardson, Texas.

¹⁴⁴ Brasier, F. 1992. Injection Control Regulations - Federal Framework and Alaska Regulations. *Proceedings of a Seminar on Subterranean Disposal of Drill Cuttings and Produced Water*. Stavanger.

¹⁴⁵ E&P Forum. 1993. *Guidelines for the Planning of Downhole Injection Programmes for Oil Based Mud Wastes and Associated Cuttings from Offshore Wells*. Report No. 2.56/187. E&P Forum, London.

¹⁴⁶ ADEC informant, *pers. comm.*. 2000.

¹⁴⁷ Molland, G. 1992. Re-injection of Cuttings on Gyda. *Proceedings of a Seminar on Subterranean Disposal of Drill Cuttings and Produced Water*. Stavanger.-

¹⁴⁸ E&P Forum. 1993. *op. cit.*

¹⁴⁹ *Ibid.*

They agreed that re-injection had “a successful history to date, particularly in Alaska and the Gulf of Mexico” but in Europe it had “only recently been evaluated”. They described a Drilling Engineering Association project, with 12 operator sponsors, that had “been involved in developing the concept” between 1990 and 1993 and added:

Injection has been adopted by operators in the Norwegian and UK sectors of the North Sea, and is seen as a viable route to oily waste disposal.

The adoption of this approach to the disposal of oilfield wastes is particularly attractive since it means that the overall environmental impact of operations is minimised. Injection offers a cost effective disposal option with minimal energy utilisation.

This view is confirmed by a review of the extensive literature on the subject in the public domain.¹⁵⁰

The development of CRI may have solved some problems but it could create others. It quickly became clear that, in the absence of regulatory oversight and responsible management, what appeared to be an environmentally benign method of waste disposal in Alaska could easily be used to dump toxic wastes illegally¹⁵¹. In 1998 a widely publicised case led to a fine of a million dollars on Doyon Drilling, Inc., a drilling contractor for BP Exploration, Alaska (BPXA), fines of \$25,000 dollars on three Doyon employees, and a year in jail for a fourth. The case raised serious questions about waste re-injection and emphasized the requirement for independent policing.

Investigations by the Alaska Oil and Gas Commission, the Environmental Protection Agency, the US Departments of Labor and Justice, and BPXA showed that a “whistleblower” employee had been telling the truth when he complained that, on 16 January 1995, Doyon illegally ordered him to dump two dozen 55-gallon barrels of Class

¹⁵⁰ For example, see the following:

1. Lal, M. and Thurber, N. 1989. Drilling Wastes Management and Closed-Loop Systems. In Engelhardt, F. R. *et al.* (eds). 1989. *Drilling Wastes*. pp. 213-228. Elsevier Science Publishers Ltd, Barking, England.
1. Dusseault, M.B., Bilak, R.A., and Rodwell, G.L. 1997. Disposal of dirty liquids using Slurry Fracture Injection, SPE 37907, *Proc. 1997 SPE/EPA Expl. and Prod. Env. Conf.*, Dallas, TX, March 3-5, 1997, pp. 193-202.
1. Dusseault, M.B., Bilak, R.A., Bruno, M.S. and Rothenburg, L., 1995. Disposal of granular solid wastes in the Western Canadian sedimentary basin by Slurry Fracture Injection, Paper presented at the *International Symposium of Scientific and Engineering Aspects of Deep Injection Disposal of Hazardous and Industrial Wastes*, Berkeley, CA, May 10-13, 1994.
1. Dusseault, M.B. and Bilak, R.A., 1993. Disposal of Produced Solids by Slurry Fracture Injection, Paper presented at the *4th Pet. Conf. of the S. Saskatch. Sec., Pet. Soc. of CIM.*, Regina, Sask., Oct 18-20, 1993.
1. Sipple-Srinivasan, M. 1998. U.S. Regulatory Considerations in the Application of Slurry Fracture Injection for Oil Field Waste Disposal. *International Petroleum Environmental Conference (IPEC) '98*, Albuquerque, N.M.
1. Sipple-Srinivasan, M., Bruno, M., Bilak, R., and Danyluk, P. 1997. Website: Field experiences with oilfield waste disposal through Slurry Fracture Injection, SPE 38254, *Society of Petroleum Engineers' 67th Annual Western Regional Meeting*, Long Beach, CA.

¹⁵¹ Alaska Forum for Environmental Responsibility. 1997. *Poisoning the Well: Whistleblower Disclosures of Illegal Hazardous Waste Disposal on Alaska's North Slope*. AFER, Valdez, Alaska.

I waste, including used oil, solvents, paints, paint thinners, hydraulic fluid, and glycol, into a Class II waste disposal well on the Endicott oilfield in northern Alaska.

In the US, underground injection wells are regulated by the Environmental Protection Agency (EPA). Class I wells are for disposal of industrial hazardous materials and have a steel casing surrounded by cement that extends to the bottom of the well, which is subject to sophisticated and continuous monitoring. Class II wells are specific to the oil and gas industry, under the general rule that nothing may be injected back down the well that has not originated from it. Thus, Class II fluids are generally mud, water and additives. Acceptable Class II wastes include crude oil, condensate from crude oil lines, well treatment fluids, and produced water.

The whistleblower refused this order, and others that continued until August 1995. He was victimized by his fellow workers, received death threats and was fired illegally. After the Department of Labor's investigator concluded that Doyon management had largely ignored the whistleblower's concerns, that he was harassed and intimidated by his co-workers, and that management did little to stop the harassment, Doyon settled out of court, paid the victim's legal fees and later agreed to spend \$2 million on "developing a model environmental compliance program and comprehensive environmental training program for employees".

Commenting on the case, the Alaska Forum for Environmental Responsibility said: "Despite key differences between Class I and Class II wells, the first of two separate but related incidents at Endicott indicates that BPXA managers and staff did not have a firm grasp of the distinction. This apparent 'confusion' was fostered by a lack of record-keeping and lax regulatory oversight. Despite its assurances to the contrary, evidence suggests that BPXA and/or its contractors had, in fact, been disposing of Class I industrial wastes down Class II wells for at least two years, and possibly up to five years."

On 25 September 1995, BPXA's own investigation of one of the Endicott incidents found as follows:

- Used oil, solvents, glycol, paint thinners and possible Chevron 325 stoddard solvent ... were disposed of via annular injection from 1993 to August 1995.
- [rig] crew members understood the practice to be waste disposal, not freeze protection. The practice only occurred at night.
- BPXA and Doyon maintained inadequate documentation of injected materials.
- BPXA personnel claimed they were not aware of the improper disposal practices.

In February 2000, over seven years after the illegal dumping began, a federal judge imposed a \$500,000 criminal fine on BPXA and put it on probation for five years for failing immediately to report the dumping. The judge also agreed a deal with prosecutors that BP should pay \$15 million for a five-year "environmental management program" to oversee its US exploration and production. BP had already paid \$6.5 million in civil penalties for what the *Anchorage Daily News* described as "one of the worst

environmental crimes in the history of North Slope oil development". The scandal had thus cost BP some \$22 million, in addition to its own administration costs. The federal investigation continues.¹⁵²

The Alaska Forum concluded that the malpractice might never have come to light but for the courageous employee, a respectable, conscientious man who suffered severe stress and lost a 22-year career in the oil industry as a result. The forum was concerned about how long it took to prosecute the case and feared that improper disposal of solvents and other toxic materials might be "standard operating procedure" on the North Slope. The Endicott incidents showed that "industry self-monitoring" did not work and suggested "a failure of regulatory oversight by state and federal agencies charged with enforcing environmental laws".

In 1995, at the same time as the Endicott whistleblower was trying to get Doyon Drilling to take his concerns seriously, the company's general manager, Randy Ruedrich, testified to the US Senate Energy and Natural Resources Committee about how improvements in drilling technology allowed Arctic oil development in an environmentally sound manner. Ruedrich made no mention of hazardous waste disposal. Representatives of ARCO and BPXA made similar statements. In a press release after the 1998 fine and plea-bargain with the US Department of Justice, Doyon said: "As a Native corporation, Doyon has a deep reverence for the land and a cultural philosophy that treasures the environment."

Whatever the concerns about record keeping, supervision and auditing of downhole disposal, continuing research in the 1990s confirmed the feasibility and suitability of properly organized and regulated CRI, both onshore and offshore, with several important papers published on the detailed techniques required¹⁵³.

In November 1997 senior representatives of the American Petroleum Institute, the Exploration & Production forum, the major oil companies and their drilling, geophysical and shipping contractors met in the Dutch city of Leiden, under the auspices of the United Nations Commission on Sustainable Development, and debated offshore environmental practices with Greenpeace and the World Wide Fund for Nature, under the chairmanship of Cynthia Quarterman, Director of the US Minerals Management Service. After what the trade magazine *Drilling Contractor*¹⁵⁴ described as "sometimes contentious" discussions, the meeting agreed a "remarkably benign conclusion":

Each drilling project should be considered on a case-by-case basis to determine the appropriate drilling techniques to be used according to the environmental sensitivity of the area, the health and safety issues raised, the project economics, the potential effects

¹⁵² Spiess, B. 2000. BP Settles for \$15.5 Million: Company Also Faces Probation in Dumping of Toxic Waste. *Anchorage Daily News* 2 February 2000, Anchorage AK.

¹⁵³ See, for example: Bruno, M.S., Bilak, R.A., Dusseault, M.B., and Rothenburg, L. 1995. Economic disposal of oil field wastes through Slurry Fracture Injection, IADC/SPE 29646, *Proc. West. Reg. Mtg. SPE*, Bakersfield, CA, March 8-10, 1995, pp. 313-320. Society of Petroleum Engineers, Richardson, Texas; and Cripps, S.J. 1998 *Disposal of Oil-based Drill Cuttings. Report for UKOOA*. Rogaland Research, Stavanger.

¹⁵⁴ *Drilling Contractor*, Jan. 1998. pp. 68-69.

on the local community and any other relevant considerations. Once a drilling technique has been identified, the drilling fluids and disposal method and, if necessary, disposal treatment should also reflect these considerations. Under no circumstances should one consideration outweigh all others [emphasis added. JWG].

Having thus excluded the possibility of choosing a drilling waste disposal method on purely environmental grounds, the session on drilling practices went on to agree to the equally benign proposition that “industry should promote improvements of drilling techniques, which minimize waste production; of drilling fluids, which improve drilling performance and lower toxicity; and of drilling fluids and cuttings treatment and disposal methodologies”.

The “overall conclusion” of this expensive, four-day international conference might serve as a classic example of fine-sounding but empty management-speak, the kind of pious, politically-correct language which makes it hard to have what a normal person might recognise as a thought, let alone formulate concrete, practical ways to achieve the desired object:

Incentives should be given to the industry to take responsibility in achieving agreed environmental goals. A goal-based approach requires the identification of environmental impacts from E[xploration] & P[roduction] activities, agreement on environmental objectives for a specific area or region and the establishment of plans on how the objectives should be reached. This approach provides industry with more flexibility, responsibility and accountability. Some complementary prescriptive measures are still required in order to address some specific issues. Measures in one country may not necessarily be appropriate in other areas or countries [emphasis added. JWG].

Interestingly, while the companies continuously lobby and campaign for a “level playing field” in the global economy, allowing them to move capital freely to wherever labour and resources are least expensive, they emphatically do not want a level playing field for global environmental standards on drilling waste disposal and other sensitive topics. Acknowledging that they may have to spend money to ensure they make less mess in the seas around richer countries with politically influential environmental movements¹⁵⁵, the oil companies apparently hope to continue saving money by causing more pollution in poorer countries, where environmentalists tend to be less numerous, less effective and less popular - and where the western media are not particularly interested. When BP is criticised for its environmental record in Colombia, or Shell for its performance in Nigeria, the answer given by their public relations officers is invariably that the companies are obliged only to observe and obey the laws of the country in which they are operating. If those laws are less stringent than those applying to the coastal waters of the UK, the Netherlands or the USA, they argue that is a matter for local politicians, not for the oil companies. Significantly, perhaps, this argument has not been deployed so readily in the case of the oil industry’s resistance to the Russian Federation’s strict laws limiting environmental pollution on the Sakhalin Shelf.

¹⁵⁵ In the UK, for example, the Royal Society for the Protection of Birds has over one million members - considerably more than all the British political parties put together – and is a political force to be reckoned with.

When faced with firm decisions by host governments to clean up their act, the oil companies have the skills and resources to move very quickly, as seen in the discussion above about BP's onshore experience with the Alaska North Slope reserve pits. About six months before the Leiden meeting, Shell UK Exploration & Production (Shell Expro) had commissioned a well-known drilling contractor, KCA Drilling, to identify and install "the best and most economical method of total containment", to meet the UK Department of Trade and Industry's target of ending the discharge of drilling muds based on mineral oil (OBMs) by 31 December 2000.

As *Drilling Contractor* reported in September 1999¹⁵⁶, KCA quickly found that cuttings re-injection (CRI)¹⁵⁷ was the preferred option, compared with the more expensive and polluting method of shipping cuttings ashore for treatment and disposal. In July 1997 an engineering team visited the Cormorant, Tern Alpha and Dunlin Alpha oil and gas production platforms in the North Sea, midway between Shetland and Norway. Their design took into account the anticipated problems with the size, weight and power requirements of equipment to grind drill cuttings into a fine slurry and to pump the resulting liquid into sandstone far beneath the seabed. The UK Government approved the project and contractors Swaco were hired in December 1997. By January 1999 the CRI equipment, based on designs originally developed by the Atlantic Richfield Corporation (ARCO), had been installed on all three platforms. Cormorant and Tern Alpha were operational more than a year before the UK Government deadline, using existing wells, while at Dunlin a dedicated well for slurrified drilling wastes will be drilled early in 2001, after tests showed no existing well was suitable for conversion to re-injection.

While the successful and rightly acclaimed Shell Expro CRI project in the North Sea was designed primarily to deal with drill cuttings contaminated with OBMs, it is clear that the technology can also be used to deal with WBM and/or SBM wastes contaminated with crude oil from production reservoirs.

There are other important conclusions from the project:

1. The equipment for CRI can be fitted onto normal-sized North Sea production platforms. While these are typically larger than those in Cook Inlet, Alaska, they are similar to offshore installations in Canada, and not much bigger than the Molikpaq platform on the Sakhalin Shelf. Finding enough space should not be an insoluble problem.
2. Methods to screen existing wells for use as waste disposal wells are now tried and tested.

¹⁵⁶ Secoy, B. 1999. Installing Cuttings Reinjection Systems on Shell/Esso Platforms. *Drilling Contractor*, Sept./Oct. 1999:40-41.

¹⁵⁷The process of grinding up drill cuttings into a slurry with other wastes has various names, depending on the manufacturer and type of the equipment used. In Alberta, Canada, Terralog Technologies Inc. (TTI) calls it Slurry Fracture Injection (SFI). In this paper, CRI is the preferred acronym.

3. Likewise, the techniques for splitting open geological strata, to receive slurrified waste and ensure it does not escape to the surface or adversely affect nearby producing strata, are now well known.
4. The geology of the northern North Sea appears almost ideal for CRI as a method of waste disposal. Strata are fairly level, faulting not too severe, cap rocks mostly good and seismic activity minor.

Shell Expro is the operator in the UK sector of the North Sea for Esso, an Exxon subsidiary involved in numerous joint ventures with Shell on the UKCS, where the Shell-Esso name appears on dozens of oil and gas leasing blocks. From its involvement with Shell in the North Sea, Exxon has therefore been fully aware of the practicability of offshore CRI since at least November 1997.

The corporation has other sources of information, notably its subsidiary, Exxon Production Research in Irving, Texas, which has been at the forefront of CRI research and development. In February this year, at the International Association of Drilling Contractors / Society of Petroleum Engineers' annual drilling conference in New Orleans, Ronald Steiger of Exxon Production Research and Zissis Moschovidis of PCM Technical, Tulsa, presented the final results and conclusions of an ingenious experiment¹⁵⁸ first planned in 1997, about the time the Shell-Esso project in the North Sea was getting under way. The Mounds Drill Cuttings Injection Field Experiment was carried out at an onshore well and designed to find out what happened to the underlying geology when cuttings were injected intermittently, to see if injection pressure was a reliable way of checking that the waste was confined to the target area, to "compile operational practices related to cuttings disposal", to show how seismic and tilt monitoring equipment could assess the size and shape of underground fracturing, and to test and improve theoretical models of waste injection.

The experiment "fulfilled most of its objectives" and, by the use of observation wells intercepting the strata where the injection well was fracturing the rocks and depositing wastes, gave a very clear picture of what actually happens while CRI is going on. The authors and their research team proved they could monitor 12 crucial variables in the process. They made a number of detailed recommendations on creating and controlling the extent of hydraulically-induced fractures in the rocks, using tracer chemicals, choosing suitable geological structures for waste disposal, preparing wells and mixing the slurries.

Although the Mounds experiment was on land, they recognised its relevance to offshore structures where space is at a premium:

Several cuttings slurrifying/injection operations have been carried out over the last few years. Many of the operators use skid-mounted slurrification units for grinding the drill cuttings into a very fine particle slurry. The skid-mounted units are typically about 20ft

¹⁵⁸ Moschovidis, Z. A. and Steiger, R. P. 2000. *The Mounds Drill-Cuttings Injection Field Experiment: Final Results and Conclusions*. IADC/SPE 59115. Washington, D.C.

(6m) long by 12ft (3.6m) high by 10ft (3m) wide and weigh about 10 to 15 tons.¹⁵⁹ They usually have two 50-bbl (8m³) slurrification tanks, centrifugal pump grinders and a shale-shaker for screening the slurry. The centrifugal pump grinders are pumps that have been modified with tungsten carbide coated impellers that function as grinders as well as transfer pumps. Cuttings are usually transported from the drilling fluid shale shakers to the grinding unit by screw conveyors.

In addition, a grinding mill may be required if hard or abrasive formations are expected to be encountered. A slurry storage tank that may range from 150 bbl to 500 bbl (24m³ to 80m³) is *typically used in offshore operations* for intermittent batch injections. A dedicated triplex pump is used to inject the slurry downhole with the cementing pump used as a backup. Some systems are skid mounted slurry units *built to fit platform space requirements. [emphasis added]*.

Steiger and his colleagues concluded:

Drill cuttings disposal by downhole injection is an economic and environmentally friendly solution for oil and gas operations under zero-discharge requirements. Disposal injections have been applied in several areas around the world and at significant depths where they will not interfere with surface and subsurface potable water sources. The critical issue associated with this technology is the assurance that the cuttings are permanently and safely isolated in a cost-effective manner.

This is further evidence that lack of space is unlikely to be a problem when installing CRI equipment aboard offshore production facilities on the Sakhalin Shelf.

If obstacles do exist, they could be geological. As the E&P Forum has noted, “It is important to ensure that the disposal is complete, with no chance of break-out of the waste to surface sediments and potable water sources, and that the integrity of the injection well is not compromised.”¹⁶⁰

In particular, badly faulted rocks are often suitable for CRI. There may also be difficulties if rocks overlying the intended waste disposal strata do not provide a reliable seal, or where severe seismic activity threatens the integrity of a waste deposit. The way to determine a rock formation’s suitability for CRI is to conduct and publish an independent, expert geological survey, and to apply the methodology developed and tested by Exxon Production Research and specialist contractors such as Terralog Technologies Inc. (TTI)¹⁶¹ of Calgary, Alberta.

¹⁵⁹ This is typically the size of the standard shipping containers that are commonplace on drilling platforms. JWGW.

¹⁶⁰ E&P Forum. 1993. Guidelines for the Planning of Downhole Injection Programmes for Oil Based Mud Wastes and Associated Cuttings from Offshore Wells. Report No. 2.56/187. E&P Forum, London.

¹⁶¹ Terralog Technologies Inc. 2000. *Slurry Fracture Injection Waste Management – Oilfield Applications*. Website <http://www.terralog.com/sfi.htm> Calgary, Alberta.

TTI was one of the expert contractors sponsored by the oil company ARCO (now part of BP Amoco) in a 1997 Drilling Engineering Association study¹⁶² on the current status of slurry fracture injection into unconsolidated sand deposits. In western Canada alone, TTI currently disposes of a million barrels of slurry a year by this method and says the technique is “expanding rapidly worldwide”.

Although offshore re-injection is certainly practicable, TTI admit that there can be difficulties. In a letter to the author on 28 April 2000, a company representative explained:

The concerns about the SFI equipment being used offshore are certainly valid. Depending on the amount of equipment you need, problems can arise with respect to space on an offshore platform. With respect to geological issues, large scale injection of waste material into shales is problematic and probably not technically viable in the long term. We generally recommend large scale injection into thick, unconsolidated formations, above or below a production reservoir. The geomechanical and flow response of the formation is such that any adverse effects on nearby wells and production activities can be mitigated. With proper formation management, large volume disposal of oil field wastes into deep wells is very effective.

The equipment that we employ can handle maximum grain sizes of 3/16" [4.76mm] and optimum grain sizes of 1/16" [1.58mm]. So in most cases we do not have to grind the material before slurrification and injection. Generally we do not use grinding equipment as part of our disposal operations. If the waste stream we are dealing with is fairly wet - large amounts of mix water for slurrification may not be required, which will further reduce the amount of equipment that is required for injection/disposal purposes. Our equipment can typically deal with a slurry stream of 20-35% by volume solids concentration. However, if required, a complete slurry disposal unit (our design) that can handle 'dry' material will take up an area of about 25m x 19m.

For offshore applications, the easiest method is to bring the waste material back to shore where it is possible to dispose of the material through deep well injection/SFI with relative ease. Terralog is currently involved with such an offshore operation in Indonesia. If this approach is cost prohibitive, an injection-disposal system can be put together for an offshore installation. The amount of equipment/space required will depend on the grain size of the material and the amount of slurrification required prior to disposal. Any concerns with respect to geology can be managed effectively if suitable geology is present in the area.

Where the geology is suitable, there appear to be very considerable financial advantages in using CRI, particularly when very large volumes of water-based drilling mud are involved. Another recent study¹⁶³ published by the Society of Petroleum Engineers, shows how the treatment and disposal costs of WBM wastes at an onshore Indonesian oilfield may be halved by treating the waste on site and pumping it down the well in a

¹⁶² Drilling Engineering Association. 2000. *Disposal of Oilfield Waste in Unconsolidated Media by Slurry Fracture Injection*. DEA Project No. DI/74: 8/97. http://www.erch.org/~dea/projects/discussion_items.html

¹⁶³ Nugrohu, A. 2000. *Mud-Waste Handling: One Operator's Experience with On-Site Treatment*. PT Caltex Pacific Indonesia. IADC/SPE paper No. 39385.

“closed loop / zero discharge” system, rather than shipping it to a centralised mud treatment facility.

The official view of the UK Department of Trade and Industry is: “There are many examples, both in the UK and Norwegian sectors, of the successful slurrification and re-injection of drill cuttings.”¹⁶⁴

It appears that the UK Government does not keep a central register of cuttings re-injection activity but these installations in the North Sea are known to have carried out re-injection, mainly of OBM and SBM cuttings:

Table 13: Re-injection in the North Sea

<u>OPERATOR</u>	<u>PLATFORMS</u>
BP Amoco	Andrew; Harding; Magnus; Bruce; Marnock
Conoco	Murdoch
Shell/Esso	North Cormorant; Tern Alpha; Dunlin Alpha; Brent.
Total	North Alwyn; Dunbar

Courtesy of DTI, Aberdeen.

The Norwegian agency responsible for vetting and surveying offshore installations, Det Norske Veritas (DNV), published a report¹⁶⁵ in January 2000 on the best ways to deal with the accumulated piles of oil-contaminated drill cuttings on the seabed around most North Sea oil installations. The research was part of the Joint Industry Project set up by the OSPAR countries in 1998 and, while it deals with the problem of accumulations of cuttings and OBM wastes over more than 30 years, its conclusions are very relevant to the question of drill cuttings and waste disposal at new oilfields such as the Sakhalin Shelf, if long-term problems with drill cuttings piles are to be avoided.

DNV noted “re-injection of cuttings is currently the only established technique for offshore disposal” and, like Patin, complained of “a lack of information on the leaching of toxic contaminants and the toxic effects of the cuttings material as a whole and its components other than hydrocarbons”. There was also “still a lack of understanding of natural degradation processes and rates”.

A recent study for UKOOA¹⁶⁶ agreed:

Currently, the only acceptable offshore technique for dealing with oily drill cuttings is re-injection into a suitable formation. However, there are a number of emerging technologies as well as established onshore techniques for cleaning cuttings with potential for offshore application. Onshore solids treatment techniques considered were grinding; direct thermal desorption; and indirect thermal desorption. Emerging solids

¹⁶⁴ DTI spokesman, 2 May 2000, *pers. comm.*

¹⁶⁵ Det Norske Veritas. 2000. *Technical Report – Drill Cuttings Joint Industry Project. Phase I Summary Report. Revision 2: 20th January 2000.* DNV doc. order No. 29003500. Oslo.

¹⁶⁶ AMBIOS Environmental Consultants Ltd. 1999. *Impact of Offshore Disposal Solutions.* United Kingdom Offshore Operators’ Association, London.

treatment techniques considered were microemulsion; supercritical extraction using liquid natural gas; and supercritical extraction using liquid carbon dioxide.

Seven options were compared using sixteen criteria to address engineering feasibility, performance, cost and environmental issues.

Being the established technique for dealing with cuttings, re-injection scored reasonably against most criteria. However, where there is no suitable formation for re-injection, other options need to be considered.

Transport of solids to shore for treatment compared favourably especially in terms of solid and water treatment rates and the potential for re-use of recovered oil and cleaned cuttings...

Of the options for offshore solids treatment followed by discharge to sea, grinding and indirect thermal desorption systems scored well, both being able to clean cuttings to less than 0.5% residual oil content and having potential for good energy efficiency especially when the energy value of recovered oil is taken into account. However, both these techniques have high deckspace and deck weight requirements and are probably best suited to vessel rather than topside installation. In addition, the operating and capital costs are currently high in comparison to the other options but there is potential for reducing these through greater system integration and further discussions with suppliers.

The Norwegian state oil company, Statoil, describes shipping cuttings ashore for treatment as “a costly solution losing support from environmentally conscious countries like Norway, the UK, Canada and New Zealand”. A technique developed for Statoil offers “an effective solution that is both definitive and economical”.

In this new process, well cuttings are separated from drilling mud (which is generally recirculated) on the drilling platform and then crushed before adding seawater via a SMAAC¹⁶⁷ unit. The solution is then re-injected at a pressure of 3000 psi into a porous rock formation via a special riser. "If you consider that a North Sea well produces between 13,000 and 18,000 tons of cuttings, then it is easy to see the interest of our system" comments G. Guy Head of [Statoil's] DRAPS Department.

A similar system has reportedly been used at Exxon's new Balder and Jotun fields in the Norwegian sector, although both appear to discharge WBM cuttings on licence.¹⁶⁸ Jotun is 45% owned by the Exxon subsidiary Esso Norge¹⁶⁹ and Balder 100%.¹⁷⁰ Several firms, such as Coflexip-Stena, manufacture the special, high-pressure, flexible pipes necessary for re-injection from the FPSOs used at many smaller North Sea fields where a fixed platform is not economic.

¹⁶⁷ “Statoil Method for Autogenous Crushing & Classifications of Cuttings”

¹⁶⁸ STF source, April 2000. *pers. comm.*

¹⁶⁹ Exxon Mobil. 1999. *Archives 27 Oct. 1999*. Irving, Texas. Website: <http://www.businesswire.com/cgi-bin/xoms.cgi?story=/www/bw/webbox/bw.102799/193004002.htm&strip=1¬stmp=1&noctct=1&hdr=%2Fwww%2Fbw%2Fxom%2F1.htm&ftr=%2Fwww%2Fbw%2Fxom%2Fb.htm>

¹⁷⁰ Exxon Mobil. 1999. *Archives 6 Oct. 1999*. Irving, Texas. Website: <http://www.businesswire.com/cgi-bin/xoms.cgi?story=/www/bw/webbox/bw.100699/192794497.htm&strip=1¬stmp=1&noctct=1&hdr=%2Fwww%2Fbw%2Fxom%2F1.htm&ftr=%2Fwww%2Fbw%2Fxom%2Fb.htm>

In conclusion, cuttings re-injection has been established beyond doubt as a feasible and affordable method of waste disposal. Exxon and Shell have been leaders in the field. The only plausible reason for their joint ventures not using CRI on the Sakhalin Shelf would be geological. That can only be established by an independent survey.

Cleaning up Produced Water Streams

As more information has become available on the possible long-term effects of pouring such very large quantities of even mildly polluted water into the sea every day, governments, the industry and environmental campaigners have continued the search for ways to reduce the volume of produced water, to re-inject it into the rocks below the seabed, and to make it as clean as possible when there is no alternative to overboard discharge¹⁷¹.

In Norway, for example, the Jotun and Balder fields do not normally discharge any produced water. It is all re-injected from floating production, storage and offloading vessels (FPSOs)¹⁷².

In 1995 the American Petroleum Institute called a special two-day meeting, chaired by Joseph Smith of Exxon Production Research, to look at ways of cleaning up the wastewater stream from offshore installations.¹⁷³ Smith's work group responsible for producing the report of the meeting included representatives of Chevron, Conoco, Marathon, Phillips Petroleum, Shell and Texaco.

The report identified the following factors as contributing to the toxicity of produced water: very small particles, salinity (9% or greater), volatile compounds, extractable organics (acidic, basic, neutral), ammonia and hydrogen sulphide. Six water treatment technologies already proven onshore, were evaluated and costed - for offshore use. Although each method presented technical problems, none of them was insuperable. The report made it clear that, by using combinations of different technologies, it is possible to reduce the pollutants in produced water to almost undetectable levels. Further research was needed, however, before accurate cost estimates could be made. The accompanying table shows the technologies assessed by the API group.

In short, it is usually not necessary to discharge production water to the sea. It would not be done on land. It has been almost eliminated in some European countries' offshore oil

¹⁷¹ For an early discussion of the problems, see: Read, A.D. 1978. Treatment of oily water at North Sea installations - a progress report. In Johnstone, C.S. and Morris, R.J. (eds). *Oily Water Discharges. Regulatory, Technical and Scientific Considerations*. pp.127-136 Applied Science Publishers, Barking, England.

¹⁷² SFT spokesman, Oslo, May 2000. *pers. comm.*

¹⁷³ American Petroleum Institute. 1995. *op. cit.* See also: OSPAR. 1992b. *PARCOM Recommendation 92/6 on Best Available Technology for Produced Water Management on Offshore Gas and Oil Installations*. Brussels.

and gas fields. It continues elsewhere for economic rather than technical reasons.

Table 14: Technology to clean up Production Water

Technology	Processes	Advantages	Disadvantages	Costs
Carbon adsorption	Modular granular activated carbon systems.	Removes hydrocarbons and acid, base and neutral compounds; low energy requirements; higher throughput than other treatments (except biological); treats a broad range of contaminants; very efficient at removing high Mwt. Organics.	Fouling of carbon granules is a problem; produces waste stream of carbon and backwash; requires some pre-treatment of produced water stream.	“Middle range” of costs.
Air stripping	Packed tower with air bubbling through the produced water stream.	Can remove 95% of volatile compounds as well as benzene, toluene, naphthalene, phenanthrene, anthracene, pyrene and phenols; H ₂ S and ammonia can be stripped but pH must be adjusted; higher temperature improves removal of semi-volatiles; small size, low weight and low energy requirements; simple to operate; well-known technology.	Can be fouled by oil; risk of iron and calcium scales forming; generates an off-gas waste stream that may require treatment; requires some pre-treatment of produced water stream.	Low capital and operating costs; overall treatment cost US\$0.02 to \$0.10/1,000 gallons, plus \$0.50 to \$1.50/1,000 gal if off-gas control by activated carbon is required.
Filtration	Very fine membranes.	Effective removal of particles and dispersed and emulsified oil; small size, low weight and low energy requirements; high throughput rates.	Does not remove volatiles or dissolved compounds. Does not affect salinity; oil, sulfides or bacteria may foul membrane, which requires daily cleaning; waste streams may contain radioactive material; requires some pre-treatment of produced water stream.	Low capital and operating costs (similar to air stripping).
Ultra-violet light	Irradiation by UV lamps	Destroys dissolved organics and both volatile and non-volatile organic compounds, including organic biocides; does not generate additional waste stream; handles upset or high-loading conditions.	Will not treat ammonia, dispersed oil droplets, heavy metals or salinity; relatively high energy requirements; UV lamps may become fouled; residues may be toxic if peroxide used; requires some pre-treatment of produced water stream.	Similar capital costs to chemical oxidation with ozone but operating costs lower because no waste stream.
Chemical oxidation	Ozone and/or hydrogen peroxide oxidation	Removes H ₂ S and particulates; treats hydrocarbons, acid, base and neutral organics, volatiles and non-volatiles; low energy requirements if peroxide system used; straightforward to operate.	High energy inputs for ozone system; oil may foul catalyst; may produce sludge and toxic residues; requires some pre-treatment of produced water stream.	“Middle range” of costs.
Biological treatment	Aerobic system with fixed film biotower or suspended growth (e.g. deep shaft)	Treats biodegradable hydrocarbons and organic compounds, H ₂ S, some metals and, in some conditions, ammonia; “fairly low” energy requirements; handles variable loadings, if acclimated.	Large, heavy plant required for long residence times; build-up of oil and/or iron may hinder biological activity; aeration may cause calcium scale to form; may produce gas and sludge requiring treatment; requires some pre-treatment of produced water stream.	“No costs estimated”

(After API, 1995)

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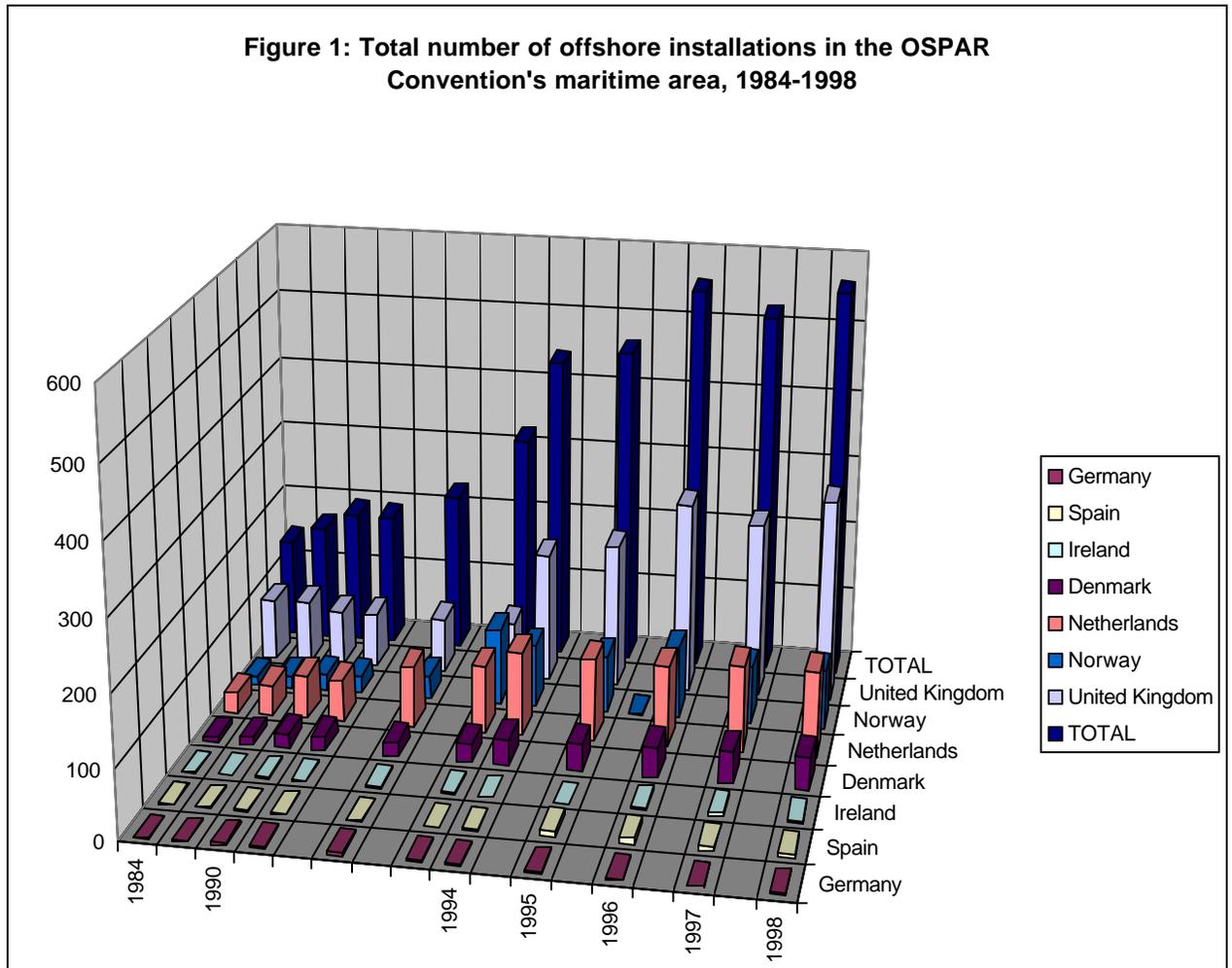
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Appendix 1

Figure 1: Total number of offshore installations in the OSPAR Convention's maritime area, 1984-1998



Appendix 2

Use of water-based and alternative drilling fluids in 1998 (OSPAR countries)

Country	Discharged (tonnes)			Injected (tonnes)			Brought onshore (tonnes)		
	OBM	WBM	Alt. muds	OBM	WBM	Alt. muds	OBM	WBM	Alt. muds
Germany	0	0	0	0	0	0	1,450	3,312	0
Spain	0	0	0	0	0	0	0	0	0
Ireland	0	410	14.5	0	0	0	0	0	0
Denmark	0	0	0	1,031	0	0	2,867	746	0
Netherlands	0	0	0	0	0	0	16,206	12,816	0
Norway	0	159,695	34,654	88,725	NI	5,213	28,902	NI	1,046
United Kingdom	n/a	NI	5,005	197	NI	136	250	NI	1,357

* Discharges with cuttings as synthetic mud (linear alkene base fluid)

Appendix 3

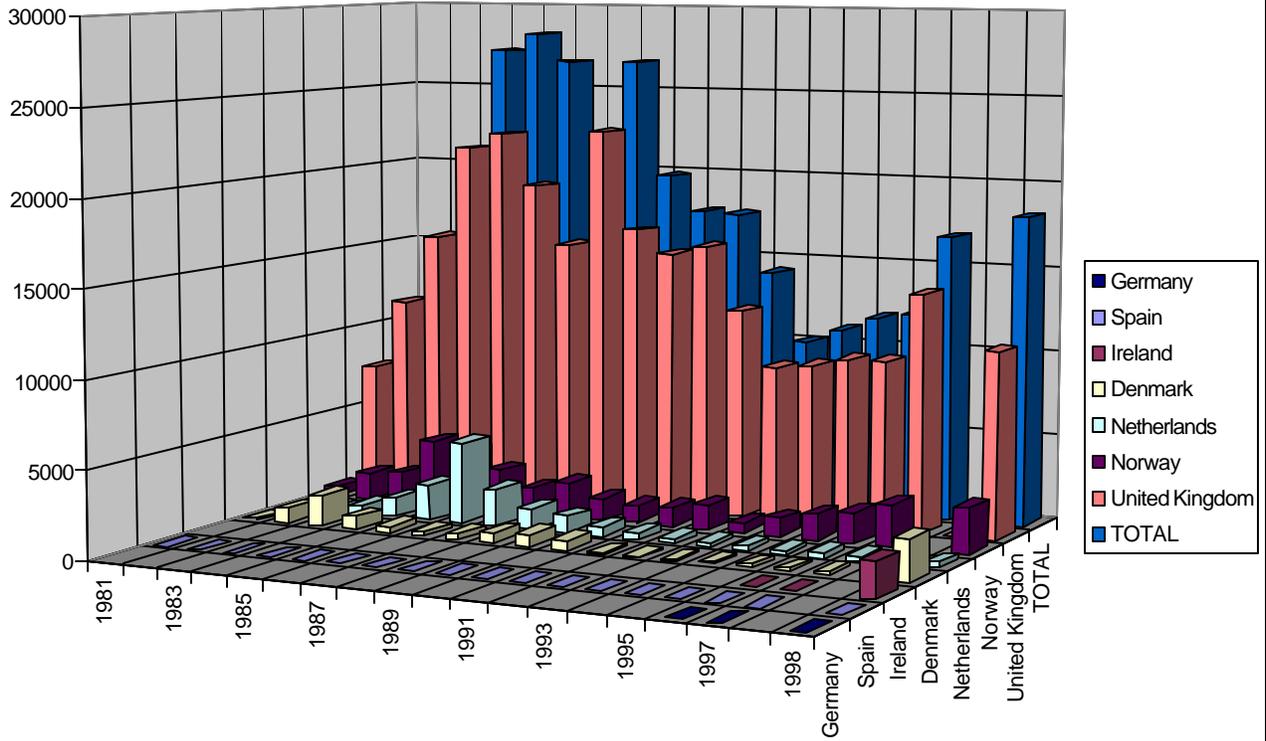
Total number of wells drilled, number of wells drilled with oil-based muds (OBM) and number of wells drilled with water-based muds (WBM), 1993 / 1996 / 1998
after OSPAR, 2000.

Country	1993			1996			1998		
	Tot	OBM	WBM	Tot	OBM	WBM	Tot	OBM	WBM
Germany	0	0	0	1	0	1	3	3	3
Spain				0	0	0	0	0	0
Ireland				2	0	2	1	0	1
Denmark	32	0	32	19	0	16	28	8	20
Netherlands	37	12	24	35	21	14	38	36	2
Norway	116	36	96	178	50	88	155	76	NI
United Kingdom	336	150	186	374	90	284	318	172	146
TOTAL	521	198	338	609	161	405	543	295	172

NI = No Information

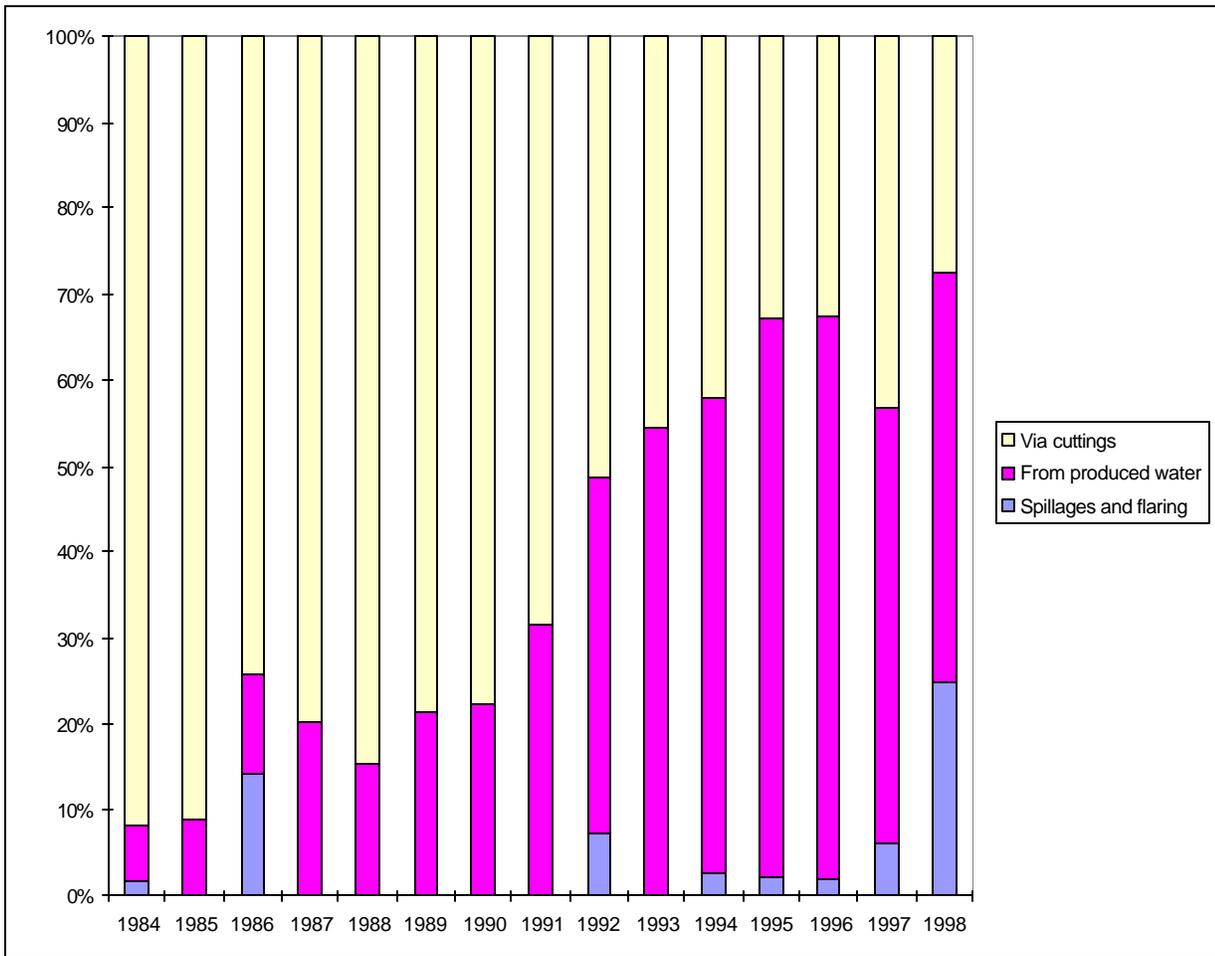
Appendix 4

Figure 2: Total discharges of oil from offshore installations to the OSPAR Convention's maritime area, 1981-1998 (tonnes)



Appendix 5

Oil discharges as proportions from each source, OSPAR area, 1981-1998



Appendix 6

Discharges per "source" and per country (expressed as a percentage of each country's total discharges), 1998

Country	Production and Displacement water	Cuttings	Spills and flaring
Germany	0	0	0
Spain	0	0	0
Ireland	<1	0	>99
Denmark	7.3	0	92.7
Netherlands	99.6	0	0.4
Norway	94.1	0	5.9
United Kingdom	52.5	46.2	1.3

Appendix 7 Quantities of oil discharged via cuttings (in tonnes), 1984-1998*

Country	1984		1985		1986	1987	1988	1989	1990
	Others	Diesel	Others	Diesel	Oil	Oil	Oil	Oil	Oil
Spain	0	0	0	0	0	0	0	0	0
Denmark	676	0	264	0	178	279	545	651	507
Netherlands	969	48	1,977	0	4,553	1,838	825	593	284
Norway	2,819	647	3,331	0	2,030	1,256	1,705	943	636
United Kingdom	18,400	1,400	20,230	0	13,000	12,400	19,480	13,400 ¹	12,312
TOTAL	22,864	2,095	25,802	0	19,761	15,773	22,555	15,587	13,739

Country	1991	1992	1993	1994	1995	1996	1997	1998
	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil
Germany	0	0	0	0	0	0	0	0
Spain	0	0	0	0	NI	0	0	0
Ireland						0	0	0
Denmark	0	0	0	0	0	0	31 ⁶	0
Netherlands	142 ²	41 ³	0	0	0	0	0	0
Norway	683 ⁴	83 ⁵	0	0	0	0	0	0
United Kingdom	11,225	7,169	4,588	4,582	3,865	3,965	7,203 ⁷	5,005 ⁷
TOTAL	12,050	7,293	4,588	4,582	3,865	3,965	7,234	5,005

* Germany: No oil discharged via cuttings from 1984-1990 (Notes continue on next page)

1 10 325 tonnes from drilling rigs; 3 075 tonnes discharged from offshore installations producing oil, gas and condensates.

2 Low toxic oil discharged from 6 wells

3 Discharged from one well out of 9 wells drilled with OBM

4 Oil discharged from 22 wells in 7 oil and gas production fields

5 Oil discharged with cuttings from 11 wells in 3 oil and gas production fields

6 Discharged with cuttings as synthetic mud (linear alkene base fluid)

7 Synthetic mud only

Appendix 8

Oil discharged in displacement and production water (in tonnes), 1982-1998
(after OSPAR)

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990
Spain		1			1	0.02	0.025	NI	0.065
Denmark	10	32.5	57	87	43	47	35	29	36
Netherlands	3.7	6.8	76	116	209	327	470	405	262
Norway	239	203	154	151	217	291	357	380	460
United Kingdom	927	1,628	1,430	2,152	2,622	3,330	3,234	3,423	3,187
TOTAL	1,180	1,870	1,717	2,506	3,091	3,995	4,096	4,237	3,945

Country	1991	1992	1993	1994	1995	1996	1997	1998
Germany	0	0	0	0	0	0	0	0
Spain	NI	NI	NI	0	NI	0	0	0
Ireland						0	0.005	0.02
Denmark	43	72	106	138	129	164	127	174
Netherlands	247	239	241	265	231	249	265	298
Norway	486	613	585	1,009	1,402	1,750	2,332	2,492
United Kingdom	4,796	4,940	4,553	4,615	5,886	5,784	5,789	5,692
TOTAL	5,572	5,864	5,485	6,027	7,648	7,947	8,513	8,656

Appendix 9

Number of installations with discharges exceeding the 40 mg oil/l target standard, 1981-1998

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No. of installations exceeding 40 mg/l	10	13	8	12	21	41	49	43	48	70	68	65	64	59	46	45	32	39
Quantity of hydrocarbons discharged by these installations (tonnes)	131	325	940	601	895	975	1,266	836	1,265	2,701	2,027	4,299	1,017	1,724	2,429	840	607	420
Total no. of installations with discharges in the Convention area	NA	NA	127	143	149	167	156	181	187	192	190	228	285	356	385	388	344	560

Appendix 10

Number of installations exceeding the 40 mg oil/l target standard - by Contracting Party, 1995-1998

Country	1995		1996		1997		1998	
	Number of platforms	Amount discharged						
Germany	0	0	0	0	0	0	0	0
Spain	NI	NI	0	0	0	0	0	0
Ireland	NI	NI	0	0	0	0	0	0
Denmark	0	0	2	101	1	4	2	27
Netherlands	20	31	16	5	10	5	10	5
Norway	4	40	3	32	2	46	3	26
United Kingdom	22	2,359	24	702	19	551	24	362

NI = No Information.

Source: OSPAR, 1998.

Appendix 11
OSPAR List of Substances/Compounds Liable to Cause Taint

(revised at SEBA 2000)

CAS number(s)	Name	CAS number(s)	Name
75-07-0	Acetaldehyde	502-56-7	Di-n-butyl ketone
107-02-8	Acrolein	95-50-1	o-Dichlorobenzene
	Alkyl (C8-C9) phenylamine, in aromatic solvent (LOA)	111-44-4	sym-Dichlorodiethyl ether
538-68-1	Amylbenzene	120-83-2	2,4-Dichlorophenol
110-66-7	Amylthiol	87-65-0	2,6-Dichlorophenol
100-66-3	Anisole	25167-81-1	Dichlorophenols mixed
100-52-7	Benzaldehyde	94-75-7	2,4-Dichlorophenoxyacetic acid
109-79-5	1-butane thiol	5742-19-8	2,4-Dichlorophenoxyacetic acid, diethanolamine salt, solution
109-79-5 513-53-1	Butanethiols	2008-39-1	2,4-Dichlorophenoxyacetic acid, dimethylamine salt, 70% or less solution
820-29-1	Butyl n-amyl ketone		2,4-Dichlorophenoxyacetic acid, triisopropanolamine salt soln
104-51-8	Butyl benzene	105-57-7	1,1-Diethoxyethane
	Butyl benzene, (all isomers)	25340-17-4	Diethyl benzene (mixed isomers)
135-98-8	Sec-butyl benzene	462-18-0	Di-n-hexyl ketone
98-06-6	Tert-butyl benzene	99-62-7	1,3-Diisopropylbenzene
109-21-7	Butyl butyrate	100-18-5	1,4-Diisopropylbenzene
1638-22-8 3180-09-4 4074-43-5 28805-86-9	Butyl phenols (liquid or solid)	624-92-0	Di methyl disulphide
590-01-2	Butyl propionate	431-03-8	Dimethyl glyoxal
98-51-1	p-tert-Butyl toluene	75-18-3	Dimethyl sulphide
123-72-8	Butyraldehyde	534-52-1	4,6-Dinitro-o-cresol
61789-36-4	Calcium naphthenate	138-86-3	Dipentene
	Calcium naphthenate in mineral oil (LOA)	28984-87-4	Diphenyl/Diphenyl ether (mixtures)
8008-51-3	Camphor oil, white	101-84-8	Diphenyl ether
84650-03-3	Carbolic oil		Diphenyl ether/Biphenyl phenyl ether mixtures
95-49-8	o-chlorotoluene	123-19-3	Di-n-propyl ketone
8007-45-2	Coal tar	759-94-4	EPTC (ISO) :- (S-ethyl di-N,N-propylthiocarbamate)
65996-79-4	Coal tar naphtha	75-08-1	Ethane thiol
	Cobalt naphthenate in solvent naphtha	140-88-5	Ethyl acrylate
8001-58-9	Creosote (Coal Tar)	106-68-3	Ethyl amyl ketone
8021-39-4	Creosote (wood tar)	106-35-4	Ethyl butyl ketone
1319-77-3	Cresols (mixed isomers)	97-96-1	2-Ethylbutyraldehyde
Same as cre.sols	Cresylic acids		Ethylchlorothioformate
?	Cresylic acids, dephenolised	928-80-3	Ethyl n-heptyl ketone
	Cresylic acids, sodium salt solution	123-05-7	2-Ethyl hexaldehyde
77-73-6	1,3-Cyclopentadiene dimer (molten)	925-78-0	Ethyl n-hexyl ketone
112-31-2	Decaldehyde	611-14-3	1-Ethyl-2-methyl-benzene

CAS number(s)	Name	CAS number(s)	Name
112-30-1	Decanol (<i>1-decanol</i>)	90-00-6	o-Ethyl phenol
645-62-5	2-Ethyl-3-propyl acrolein	111-87-5	1-Octanol
927-49-1	Di-n-amyl ketone	143-08-8	1-Nonanol
142-83-6	2,4-Hexadiene aldehyde	124-13-0	Octaldehyde
66-25-1	Hexyl aldehyde	1560-06-1	1-Phenyl-2-butene
538-93-2	Isobutyl benzene	768-56-9	4-Phenyl-1-butene
539-90-2	Isobutyl butyrate	622-76-4	1-Phenyl-1-butyne
97-85-8	Isobutyl isobutyrate		1-Phenyl-1-hexyne
540-42-1	Iso butyl propionate	4250-81-1	1-Phenyl-1-pentyne
78-84-2	Isobutylaldehyde	673-32-5	1-Phenyl-1-propyne
3085-26-5	Isodecaldehyde		3-Phenyl-1-propyne
25339-17-7	Isodecanol	80-56-8	alpha-Pinene
27458-94-2	Isononanol	107-03-9	1-Propanethiol
52738-99-5	Isooctaldehyde	75-33-2	2-Propanethiol
26952-21-6	Isooctanol		Propane thiols
98-82-8	Isopropyl benzene	123-38-6	Propionaldehyde
25155-15-1 527-84-4 535-77-3 99-87-6	Isopropyl toluenes	4485-09-0	Propyl n-amyl ketone
590-86-3	Isovaleraldehyde	103-65-1	Propyl benzene
	Laktane (light naphtha solvent, aromatics less than 25%)	589-63-9	Propyl n-butyl ketone
74-93-1	Methane thiol	624-16-8	Propyl n-hexyl ketone
110-43-0	Methyl amyl ketone	100-42-5	Styrene (monomer)
96-17-3	2-Methyl butyraldehyde	488-23-3	1,2,3,4-Tetramethylbenzene
6175-49-1	Methyl n-decyl ketone	527-53-7	1,2,3,5-Tetramethylbenzene
2345-27-9	Methyl n-dodecyl ketone	95-93-2	1,2,4,5-Tetramethylbenzene
1758-88-9	1,4-Methyl ethyl benzene	102-25-0	1,3,5-Triethylbenzene
104-90-5	2-Methyl-5-ethylpyridine	526-73-8	1,2,3-Trimethylbenzene
821-55-6	Methyl heptyl ketone	95-63-6	1,2,4-Trimethylbenzene
111-13-7	Methyl hexyl ketone	108-67-8	1,3,5-Trimethylbenzene
?	Methyl mercaptopropionaldehyde	9005-90-7	Turpentine (wood)
90-12-0	1-Methyl naphthalene	112-42-5	1-Undecanol
91-57-6	2-Methyl naphthalene	110-62-3	Valeraldehyde
1321-94-4	Methyl naphthalenes	25013-15-4	Vinyl toluenes
112-12-9	Methyl n-nonyl ketone	526-75-0	2,3-Xylenol
693-54-9	Methyl n-octyl ketone	105-67-9	2,4-Xylenol
119-36-8	Methyl salicylate	95-87-4	2,5-Xylenol
98-83-9	alpha-Methylstyrene	576-26-1	2,6-Xylenol
593-08-8	Methyl n-undecyl ketone	95-65-8	3,4-Xylenol
98-95-3	Mononitrobenzene	108-68-9	3,5-Xylenol
91-20-3	Naphthalene	1300-71-6	Xylenols (mixtures)
1338-24-5	Naphthenic acids		
12167-20-3	Nitrocresols		
99-08-1	m-Nitrotoluene		
88-72-2	o-Nitrotoluene		
99-99-0	p-Nitrotoluene		
25168-04-1	Nitroxylenes		
124-19-6	1-Nonanal		

Appendix 12

OSPAR List of Substances / Preparations Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR)

As proposed by SEBA, 2000.

CAS Number	Substance/Preparation
64-19-7	Acetic acid
1335-30-4	Aluminium silicate
10043-01-3	Aluminium sulphate
7783-28-0	Ammonium acid phosphate
10192-30-0	Ammonium bisulphite
12125-02-9	Ammonium chloride
1336-21-6	Ammonium hydroxide
10196-04-0	Ammonium sulphite
9000-92-4	Amylase
50-81-7	Ascorbic acid
12174-11-7	Attapulgit clay
13462-86-7	Barite with lowest levels of trace metal impurities
7727-43-7	Barium sulphate
1302-78-9	Bentonite
78-92-2	Butanol (Butan-2-ol)
7789-41-5	Calcium bromide
471-34-1	Calcium carbonate
10043-52-4	Calcium chloride
1305-62-0	Calcium hydroxide
8061-52-7	Calcium lignosulphate
10124-37-5	Calcium nitrate
1305-78-8	Calcium oxide
7758-79-4	Calcium phosphate
7778-18-9	Calcium sulphate
9004-30-2	Carboxy methyl hydroxy ethyl cellulose
125494-51-1	Causticized lignite
9012-54-8	Cellulase
-	Cement Grade G
77-92-9	Citric acid
65996-61-4	Cellulose fibre
-	Cornstarch, hydroxy ethyl cellulose, calcium carbonate
-	Cotton seed hulls
61790-53-2	Diatomaceous earth
10034-77-2	Dicalcium silicate
16389-88-1	Dolomite
64-17-5	Ethanol
-	Ethanol (denatured)
9004-57-3	Ethyl cellulose
10028-22-5	Ferric sulphate
563-71-3	Ferrous carbonate

CAS Number	Substance/Preparation
1332-37-2	Finely divided iron oxide
64-18-6	Formic acid (HCOOH) ¹⁷⁴
-	Glass beads
56-81-5	Glycerine
7782-42-5	Graphite
9000-30-0	Guar gum
7778-18-9	Gypsum
	Hydroxyethyl cellulose
9004-62-0	2-Hydroxyethyl ether cellulose
39421-75-5	Hydroxypropyl guar gum
12168-52-4	Ilmenite
10290-71-8	Iron carbonate
	Iron lignosulphate
1332-37-2	Iron oxides
67-63-0	Isopropanol
1332-58-7	Kaolin
63-42-3	Lactose
8002-43-5	Lecithin
9005-53-2	Lignin
8002-53-7	Lignite
1305-78-8	Lime
1317-65-3	Limestone
7786-30-3	Magnesium chloride
1309-48-4	Magnesium oxide
	Lightly calcinated magnesium hydroxide
1309-42-8	Magnesium hydroxide
1317-35-7	Manganese tetraoxide
67-56-1	Methanol
	Mica
107-21-1	Monoethylenglycol
-	Nutshells
-	Olive pitts
-	Polysaccharide containing glucose, mannose and glucuronic acid units
584-08-7	Potash
298-14-6	Potassium bicarbonate
584-08-7	Potassium carbonate
7447-40-7	Potassium chloride
7757-79-1	Potassium nitrate
16068-46-5	Potassium phosphate
-	Pregelatinized potato starch
71-23-8	Propanol
7758-16-9	Pyrophosphate (sodium acid pyrophosphate; SAPP)
63231-67-4	Silica gel
14808-60-7	Silica sand
7631-86-9	Silicon dioxide
497-19-8	Soda ash
127-09-3	Sodium acetate
532-32-1	Sodium benzoate
144-55-8	Sodium bicarbonate

¹⁷⁴

Reservation from Denmark and the Netherlands on the inclusion of formic acid (HCOOH).

CAS Number	Substance/Preparation
7631-90-5	Sodium bisulphite
1333-73-9	Sodium borate
7647-15-6	Sodium bromide
497-19-8	Sodium carbonate
9004-32-4	Sodium carboxymethylcellulose
7647-14-5	Sodium chloride
8061-51-6	Sodium lignosulphonate
7631-99-4	Sodium nitrate
7632-00-0	Sodium nitrite (NaNO ₂)
7632-05-5	Sodium phosphate
1344-09-8	Sodium silicate
7757-83-7	Sodium sulphite
14986-84-6	Sodium tetraphosphate
10102-17-7	Sodium thiosulphate pentahydrate
50-70-4	Sorbitol
9005-25-8	Starch (without additives)
68476-78-8	Sugarcane molasses
12168-85-3	Tricalcium silicate
57-13-6	Urea
-	Vegetable fibre
1318-00-9	Vermiculite
	Wood fibres
11138-66-2	Xanthan gum
-	10% aqueous polyaluminium chloride
-	25% amylase/75% amylopectin polymer (only as a preservative for pregelatinised starch with a maximum concentration of 5%)
-	100% high MW hydroxy ethyl cellulose polymer
-	100% hydroxypropylated cross-linked corn starch
-	98% hydroxypropyl guar gum, 2% fumaric acid
-	99,9% sodium chloride and 0,1% sodium ferrocyanide

Appendix 13

OSPAR Guidelines for Completing the Harmonised Offshore Chemical Notification Format (HOCNF), as proposed by SEBA, 2000.

Introduction

1. The Harmonised Offshore Chemical Notification Format (HOCNF)¹⁷⁵ applies to all chemicals used in connection with offshore exploration & production activities in the OSPAR maritime area. Exact chemical composition of preparations will be held in commercial confidence in the relevant governmental bodies, and will not be published or transmitted to third parties.

Data Requirements

2. For the purpose of these OSPAR guidelines, the following data requirements apply:
- "mandatory data" must always be provided;
 - "conditional data" become mandatory when the defined conditions mentioned in Appendix 1 of the OSPAR Recommendation 2000/? on a Harmonised Offshore Chemical Notification Format (HOCNF) or in these guidelines are met;
 - "optional data" should be provided by the supplier if available and relevant.
3. The following text of these OSPAR guidelines relates to the provisions and requirements stipulated in Appendix 1 of the OSPAR Recommendation 2000/? on a Harmonised Offshore Chemical Notification Format (HOCNF) and the 'parts' and 'paragraph numbers' mentioned in the headings and subheadings refer to that Appendix of that OSPAR Recommendation.

PART 1: General information on substances and preparations

§ 1.3 Use

4. Information on quantities used and discharged and on application categories is required. The function is defined as the process for which the substance/preparation is normally or primarily used, e.g. drilling fluid, biocide, scale-inhibitor, demulsifier.
5. Application details describe the process(es)/system(s) to which the substance/preparation is applied e.g. upstream of the production separator, batch treatment to a water injection system, drilling fluid system.
6. Dosage and frequency details describe the concentration, stating weight or volume units of the substance/preparation, either as continuously injected or as a

¹⁷⁵ cf. Appendix 1 of OSPAR Recommendation 2000/? on a Harmonised Offshore Chemical Notification Format (HOCNF)

batch/slug at a given frequency. Production dosage should be stated as a concentration based upon total fluids, production water and produced oil.

§ 1.4 Discharge

7. A substance/preparation should be assigned to the category "closed system" only if it remains within a reactor or is transferred from vessel to vessel through closed pipework and therefore accidental spillage is the only likely cause for human exposure or environmental contamination. Substances/preparations that are used in closed systems, but might be released into the environment after use or where significant discharges into the environment cannot be excluded during use, should be assigned to the "open system".

§ 1.5 Fate

8. A description of the likely fate of the substance/preparation can be explained in general terms by the producer/supplier. This should include whether the substance/preparation is likely to end up in the sediment, the water column, the air or biota.

§ 1.6 Composition

9. In all applications concerning chemicals used offshore, the names of all deliberately added substances within a preparation shall be reported to the competent national authorities. Sufficient information must be available to operators to allow them to properly assess the chemicals they use.

10. When providing this form to non-governmental organisations, information regarding composition as normally given on a Safety Data Sheet (SDS) should be provided.

11. The full chemical composition must be given when submitting the form to government bodies. The complete and precise composition of the substance or preparation should be reported, including each "active" substance, "inert" substance, solvent and additive substance and their proportions, using recognised chemical formulae or recognised chemical names for all substances.

12. Constituent substances should be named and concentration ranges given in accordance with the allowed variation ¹⁷⁶. The concentrations of each substance should

¹⁷⁶ **Concentration ranges:**

Initial concentration range of the constituent	Permitted variation in initial concentration of the constituent
≤ 2,5%	± 15%
> 2,5 ≤ 10%	± 10%
> 10 ≤ 25%	± 6%
> 25 ≤ 50%	± 5%
> 50 ≤ 100%	± 2,5%

be specific, but if these concentrations are variable then the range should be quoted. If the toxicity tests are carried out on a preparation, the concentrations of each substance in the formulation used in the toxicity tests should be quoted to enable authority to assign correct relevance to these test values.

13. All substances, known to be deliberately added, including those present at less than 1% by weight of an entire preparation, should be declared. Substances (except those stated in paragraph 1.7 of the OSPAR Recommendation 2000/? on a Harmonised Offshore Chemical Notification Format (HOCNF)), which are not deliberately added and are present at less than 1% by weight should not be declared.

14. Give CAS numbers or EINECS/ELINCS numbers (where applicable) and molecular weight for all substances and state whether any substance is on the OSPAR List of Substances / Preparations Used and Discharged Offshore Which are Considered to Pose Little or no Risk to the Environment (PLONOR).

15. Where only generic descriptions can be given (e.g. tall oil soaps, polyoxyalkylated glycols, phenol/formaldehyde resins, reaction-products, copolymer series) the source materials should be given, together with the best description of the range of major substances/preparations present.

16. Where solvents or other additives are refinery or petrochemical products consisting mainly or entirely of hydrocarbons, the generic description (e.g. straight-chain alkenes, 3-5 ring aromatics) should be given together with the concentrations of any aromatics, and the method used for determination should be stated.

17. Please note that **trade names will not be accepted as compositional information.**

§ 1.7 Contents

18. For substances/preparations where knowledge of the raw materials and manufacturing processes involved indicate that the substances will not be present, select the 'NO' box for all categories. Supportive evidence for the above should be provided where available in the 'Comments' box.

6. PART 2 ECOTOXICOLOGICAL INFORMATION

19. Ecotoxicological information can be mandatory, conditional or optional. If the offshore chemical is on the PLONOR List or all the relevant ecotoxicological information has already been submitted to the authority, Part 2 of Appendix 1 to OSPAR Recommendation 2000/? on a Harmonised Offshore Chemical Notification Format (HOCNF) need not be completed.

20. Ecotoxicological data will only be accepted from tests performed according to international standard protocols or guidelines (as e.g. the OSPAR guidelines and ISO test guidelines) and prepared by laboratories working in compliance with the OECD Good Laboratory Practice or laboratories approved by national authorities. Test laboratories should follow the OSPAR Guidelines for Toxicity Testing of Substances and Preparations Used and Discharged Offshore whenever samples are received for testing. The testing laboratories should confirm to the supplier, in every case, that the validity criteria for the reference test have been met.

§ 2.1 Partitioning and bioaccumulation potential

21. N-octanol water partitioning data are required for all organic substances with the exception of those with surface active properties. For preparations, individual information on all deliberately added substances is required. This can be estimated by measuring or calculating the partitioning of the substances between water and n-octanol (Pow).

22. A standard method (shake flask) for the determination of Pow is: OECD Guidelines for Testing of Chemicals, 1981-107 (shake flask method not applicable for preparations and complex substances).

23. A standard method for the calculation of the Pow is: OECD Guidelines for Testing of Chemicals, 1989 - 117. HPLC method; applicable for preparations and complex substances. For HPLC calculations for complex substances the Pow range needs to be stated. Ionisable substances should be measured in their unionised form under appropriate pH conditions.

24. Reliable methods are now available for calculation of Pow for many types of organic substances and often laboratory testing can be avoided. Examples of reliable methods are CLOGP, LOGKOW and AUTOLOGP (cf. European Commission (1996). Technical guidance documents in support of the Commission Directive 93/67/EEC on risk assessment for new notified substances and the Commission Regulation (EC) No. 1488/94 on risk assessment for existing substances. Part III.

25. If the calculated or measured log Pow ≥ 3 , bioaccumulation will be assumed unless experimental bioconcentration factor (BCF) tests indicate the opposite. While high molecular weight compounds are less likely to bioaccumulate a precise threshold is not recognised. BCF data are relevant for all deliberately added substances whose log Pow > 3 . The BCF is determined from the ratio of animal tissue concentration and water concentration of the test substance at equilibrium, or from the ratio of the uptake and depuration rate constants. The authority should be consulted beforehand to ensure that the test method proposed is suitable. In general, for fully water miscible substances/preparations, either a fish or a bivalve mollusc bioaccumulation test would usually be appropriate (e.g. OECD 305 or ASTM E1022), whereas a substance/preparation that gives rise to suspended particles may be more suitably tested with a filter feeding organism such as a bivalve mollusc.

26. The presence of surface active substances may increase the bioavailability of other substances in preparations. Therefore a bioconcentration test may be required for such preparations. In such a test, exposure to the preparation should be followed by analysis of the test animals conducted on a substance by substances basis. The relevant bioconcentration test should be agreed following consultation with the authority. Where an inappropriate test for a particular preparation/substance has been used, the authority will reserve the right to classify the preparation/substance as bioaccumulative. The *Mytilus* or a fish species would be suitable as test organisms, but other test species may also be appropriate.

§ 2.2 Biodegradability

27. Data on biodegradability in the marine environment are relevant for all organic substances.

28. If the substance is found not to be readily biodegradable or if a ready aerobic biodegradation test has not been performed, it will be assumed to be persistent in aerobic conditions unless an inherent test is performed to indicate the opposite. The relevance of an inherent biodegradation test should be agreed in consultation with the authority.

29. All new chemicals shall be tested according to the standard test methods for biodegradability: OECD Guidelines for Testing of Chemicals, 1992 306, or any of the four protocols published in the report "Biodegradability of chemicals in sea water". Results of the ring tests undertaken by OSPARCOM, Elf Akvamiljö, September 1996." For already tested chemicals OECD Guidelines for Testing of Chemicals, 1992 301 A-F can be accepted by national authorities.

30. The standard test methods for inherent biodegradability: OECD Guidelines for testing of chemicals, 1981 302 A-C.

31. Tests on substances known to be toxic to microbes (e.g. biocides) should follow the recommendations in Annex II of OECD 1992 301.

32. Tests on poorly soluble materials should follow the recommendations set out in ECETOC Technical Report No. 20 (1986) Annex III of OECD 1992 301 and ISO Guidance document ISO 10634.

33. For substances or substances in preparations which qualify for a sediment reworker toxicity test, an anaerobic biodegradation test may be conducted in addition to aerobic tests. If one is not conducted, the substance will be assumed to be non-biodegradable in anaerobic conditions.

34. Anaerobic biodegradability testing should be carried out following the recommendations set out in the ECETOC Technical reports No. 28 (1988) and No. 54 (1993) or the ISO protocol for the "Evaluation of the "Ultimate" Anaerobic Biodegradability of Organic Compounds in Digestive Sludge", ISO/TC 147/SC5, N103,

1992. Anaerobic biodegradability data are not relevant for water soluble materials which do not adsorb to surfaces.

35. Contracting Parties may require additional biodegradation data, e.g. seawater simulation studies, seabed survey.

§ 2.3 Taint

36. Preparations/substances known or expected to cause taint if lost or discharged, and which are non-biodegradable or discharged daily, will receive a taint warning. A list of compounds liable to cause taint is included in the OSPAR List of Substances/Compounds Liable to Cause Taint.

§ 2.4 Aquatic toxicity

37. Marine toxicity data must be provided for all preparations or their constituent substances, unless they appear on the PLONOR List. The relevance of marine toxicity test data other than that specified in this notification format should be agreed in consultation with the relevant authority. However, for non-OSPAR marine data, safety factors may need to be applied. For certain substances additional seawater toxicity may be required at any time if evidence supports doubt on the relevance of existing test data. This is relevant for Contracting Parties before a full OSPAR data set becomes available.

38. For new substances and preparations and, where relevant, for re-notification of existing substances/preparations (e.g. preparations containing surface active substances or pseudo oil-based drilling fluids), a full OSPAR data sets on:

- a. *Skeletonema costatum*;
- b. *Acartia tonsa*;
- c. *Scophthalmus maximus*;

should be provided in accordance with the Protocols on Methods for the Testing of Chemicals Used in the Offshore Industry, published by OSPAR in 1995.

39. Substances and preparations which:

- a. are "sinkers"; or
- b. have a $K_{OC} > 1000$ (see 2.5); or
- c. are in any other way known to adsorb to particles or end up in the sediment (e.g. contains surface active substances of the type which enhance adsorption to particles);

require in addition a sediment reworker test with *Acartia tonsa*.

40. If available, long-term toxicity test data should be filled in.

2.5 Adsorbability

41. The organic carbon adsorption coefficient (K_{OC}) is only applicable for individual substances. The K_{OC} can generally be calculated from the octanol/water partition coefficient ($\log P_{OW}$) and the organic carbon content of the sediment and suspended solids. Where this cannot be done, Shake-Flask measurements of K_{OC} using marine sediments and seawater may be provided. Suitable methods of calculation and measurement are described in Karickhoff, S.W., Brown, D.S., and Scott, T.A. (1979), Water Research 13:241-248.

42. For surface active substances, measured K_{oc} data are mandatory and the methodology used should be stated. SEBA 2000 recognised that at present there are no standard test methods available which would provide reliable and robust K_{oc} data for surface active substances. SEBA 2000 therefore agreed to initiate the collection of information and literature references to evaluate existing methodology.

2.6 Mammalian toxicity

43. Data from mammalian toxicity test for food chain risks should be stated if available.

Part 3 Confirmation Statement

44. The confirmation statement is a written declaration renewable every three years to confirm that:

- a. the information in the form still applies precisely to the substance/preparation being manufactured or supplied under that specific trade name. Any change in formulation, by the addition of any new substance, or the removal of any existing substance, other than by trace quantities (<100 ppm or <0,01%), necessitates the immediate action to consider whether new data are required. Any change in composition, i.e., in the concentrations of a substance, unless within the previously accepted range of variability, similarly necessitates the immediate evaluation of the new composition. Any change of name, coding or number requires an immediate declaration that the existing format now applies to this new named preparation;
- b. all tests referred to in Appendix 1 to OSPAR Recommendation 2000/? on a Harmonised Offshore Chemical Notification Format (HOCNF) were carried out in accordance with the OECD principles of Good Laboratory Practice (cf. also § 20 above).

45. Suppliers may be asked at any time to submit samples of substances/preparations to governmental bodies for analysis or testing. Offshore users may also be asked at any time to submit to governmental bodies a sample of the preparation currently in use.

46. Before the renewal date the notifier should consult the national authorities. More relevant or missing data on substances/preparations which had been previously accepted for use may be required.