Technical Meeting Document

(Compilation of information discussed in the working sessions)

January 1998

Environmental Practices in Offshore Oil and Gas Activities

International Expert Meeting
Noordwijk, The Netherlands
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TABLE OF CONTENTS

General introduction

Over the past five decades, the ever expanding exploration for, and exploitation of, offshore oil and gas resources have taken place in many parts of the world. The focus of these activities, which was originally concentrated on near-shore, shallow-water prospects, has expanded to include areas of deep water (e.g., in the Gulf of Mexico, and off Brazil, the United Kingdom, Norway, Nigeria, Angola and the Philippines) and severe environmental conditions (e.g., West of the Shetlands, Northern Russia and Canada). In parallel with this expansion, exploitation of petroleum resources continues to develop in environmentally vulnerable areas such as: enclosed (e.g., the Caspian) and semi-enclosed (e.g., Mediterranean Sea, Black Sea, Red Sea/Gulf of Suez and Persian Gulf) seas. These areas have historically been subjected to environmental pressures from land-based pollutant sources; and areas adjacent to coral reefs, mangrove stands and wetlands (e.g., the Indonesian Archipelago, Northwest Australia, the Seychelles, and The Netherlands).

Against this backdrop the need for environmental protection and sustainable development has been increasingly brought to the forefront. The fact that E&P activities have not always been without ecological side effects has led to the close examination of key operational practices, with the aim of improving environmental performance in offshore E&P activities.

In general, the benefits of adopting practices that protect the environment are widely recognised by regulators and operators alike. This recognition has contributed to the development of a variety of regional and national regulatory instruments, as well as to the development of self-regulation guidelines produced by the operators themselves and non-governmental organisations.

The world-wide scope of offshore E&P operations resulted in the need for an exchange of information and expertise on environmental practices in offshore oil and gas activities. This need has been addressed as part of the follow up to the 1992 United Nations *Conference on Environment and Sustainable Development* (UNCED). This conference resulted in, *inter alia*, the adoption of *Agenda 21*, which provides an international programme for achieving sustainable development in the 21st Century. In particular, Chapter 17 explicitly recognises that international law, as reflected in the provisions of the United Nations Convention on the Law of the Sea (UNCLOS), set forth rights and obligations of States and provides the legal basis upon which to pursue the protection and sustainable development of the marine and coastal environment and its resources. Specifically, Chapter 17.30 calls for measures to control the degradation of the marine environment by sea-based activities.

The *Commission on Sustainable Development's* meeting in 1996 encouraged:

> *"relevant and competent international and regional bodies to make available appropriate inputs to expert meetings to be held in The Netherlands on offshore oil and gas activities, in which national and regional experiences could be exchanged, and invites The Netherlands and Brazil, where a regional meeting recently took place on this subject, to make available to Commission members and other interested States the outcome of these expert meetings."*

As a consequence, The Netherlands and Brazil co-organised the International Expert Meeting on Environmental Practices in Offshore Oil and Gas Activities from November 17-20, 1997 in Noordwijk, The Netherlands.

The overall objectives of the Expert Meeting were:

- to provide a platform for the exchange information and experiences among relevant actors (e.g., governments, operators and public organisations) regarding offshore oil and gas activities in relation to the protection of the marine environment. This included information on the establishment of policies, strategies, environmental approaches, systems, etc.
- to identify and document sound environmental practices and, in turn, to contribute to the enhancement of the environmental performance of offshore E&P activities
- to maintain and improve the international co-operation, participation and exchange of information and experiences between governments, industry and relevant organisations

Scope

The purpose of this document is to provide a review of current developments regarding operational practices and to report on the discussions that took place in the nine working sessions of the Expert Meeting:

- Environmental Impact of Offshore Oil and Gas Activities
- Drilling Management
- Produced Water Management
- E&P Chemicals Management
- Waste Management
- Environmental Management Systems
- Environmental Impact Assessment
- Strategies and Policies
- Future Exchange of Information and Experience

Note: ***Calamities, accidental spills, climate change effects and platform decommissioning were not covered at the meeting, as these subjects are presently discussed in other international fora.***

The background information presented in this Technical Meeting Document, concerning regulatory issues, operational practices, technical aspects, environmental impacts and overall environmental management requirements or principles, is derived from a number of summary documents and international publications, the most relevant of which are listed in ***Appendix I*** and ***Appendix II***. The table included in Appendix I indicates which of the documents are relevant to each of the 8 workshop topics. The reader can use this table in order to easily identify sources for additional background information for specific workshops. The background information is complemented by facts, experiences and views articulated by participants at the Expert Meeting.

Structure

Each chapter addresses one working session of the Expert Meeting and covers:

- The **scope** of the working session, as defined by the Steering Committee of the Expert Meeting.
- **Background information** compiled from various sources including expert opinions collected by the Technical and Scientific Group prior to and during the meeting.
- A **Working Session Report** which provides a summary of the working session discussions and the conclusions of the working session's chairperson.

The conclusions of the Joint (Dutch and Brazilian) Chair, derived from the working session reports, has been included in this Technical Meeting Document in the following coloured pages.

CONCLUSIONS OF THE JOINT CHAIR
Background

Offshore oil and gas exploration and production takes place in all of the worlds five continents. In the beginning, the activities were concentrated in fields near-shore and in shallow waters, but, as a result of improved technology, have in recent years expanded into deep-water areas. The offshore industry has also extended its activities into more vulnerable areas such as enclosed and semi-enclosed areas, areas adjacent to coral reefs, mangrove stands and wetlands.

These developments call for increased attention to be placed on environmental awareness and protection and sustainable development. This was acknowledged at the fourth meeting of the Commission on Sustainable Development in 1996, which encouraged:

“Relevant and competent international and regional bodies to make available appropriate inputs to expert meeting to be held in The Netherlands on offshore oil and gas activities, in which national and regional experiences could be exchanged, and invited The Netherlands and Brazil, where a regional meeting recently took place on this subject, to make available to Commission members and other interested States the outcome of these expert meetings”

Consequently, The Netherlands and Brazil agreed in 1996 to organise this Expert Meeting in The Netherlands.

The Joint Chair of Brazil and The Netherlands acknowledged the interest and commitment shown by 59 Countries, 12 International Governmental Organisations and 13 Non-Governmental Organisations which attended the Expert Meeting on Environmental Practices in Offshore Oil and Gas Activities, held on 17-20 November 1997 in Noordwijk (The Netherlands). The Joint Chair expressed its appreciation for the work carried out during the Expert Meeting, and remain confident that the agreements as regards future exchange of information and experiences will ensure appropriate progress in the years to come.

Structure of the Expert Meeting

Eight parallel working sessions were established, namely: Environmental Impacts; Drilling; Produced Water Management; E&P Chemicals Management; Waste Management; Strategies and Policies; Environmental Management Systems and Environmental Impact Assessment. In addition, a plenary session was held to discuss future exchange of information and experiences.

Each workshop was introduced by a plenary keynote address followed by a few introductory presentations by invited speakers. The following discussions were based on a number of identified working session topics. The conclusions of these discussions were drafted by the working session chairmen. The Joint Brazilian- Netherlands co-chair drafted their conclusions of the meeting on the basis of the working session conclusions.

PRODUCTS OF THE EXPERT MEETING

There were two main products from the meeting, namely:

1. The Technical Meeting Document - consisting of an update of the Technical Background Document and the Working Session Reports.
2. The Conclusions of the Joint Chair - based on conclusions from each Working Session Report.

The conclusions of the Joint Chair will be forwarded to the United Nations Commission for Sustainable Development (UN-CSD) by the joint organisers (Brazil and The Netherlands). The Steering Committee will publish the Technical Meeting Document in December 1997.

CONCLUSIONS OF THE JOINT CHAIR

The offshore oil and gas industry operates in the context of a multitude of social, economic, physical and environmental factors, according to the principles of Sustainable Development and the Precautionary Approach, as articulated in Agenda 21 and the Rio Declaration on Environment and Development. The balance between these varies from region to region; companies and joint-ventures operate on a global-scale in strong world market competition, as well as in the context of global and regional conventions.

The main objective of Environmental Management Principles at company, national and regional level is to minimise environmental impacts and to identify negative impacts on the total environment including socio-economic issues.

A regulatory framework concerning offshore operations should not be based only on environmental regulations concerning critical requirements, but should encourage the industry to assume its responsibility to achieve agreed goals with respect to their environmental practices under local and regional conditions. Sharing of experience and expertise is important and effective in identifying sound Environmental Practices under these local conditions.

It has to be taken into account that development of state of the art technologies and better understanding of environmental sensitivities requires a flexible approach to the development of regulatory controls, allowing for a case-by-case determination of environmental standards and targets which accommodate a self-regulatory approach.

The concept of "Sustainable Development" can be made operational in the form of a joint development of environmental best practice guidelines in offshore oil and gas activities, obtained through open discussion between industries, governmental organisations and other interested parties within the framework of regional or local environmental and socio-economic conditions.

Although it is primarily the responsibility of governments to organise and maintain the discussion, it is a shared responsibility of governments, industry, and other interested partners to define the outcome and to review the implementation.

Companies should have, and behave according to, an integrated vision on production, safety, health and environment, regardless of where in the world they are active.

A Offshore E&P activities have local impacts on the marine environment, the extent and nature of which depend on the local environmental the operational practices.

- The degree of the potential impact of offshore oil and gas activities on the marine environment is considered to be largely local, but varies between ecosystems. The significance of the potential cumulative environmental impact of offshore activities can be related to the density of operations in perspective of the sensitivity of the local ecosystem.
- Prior assessment is important and baseline assessments/studies valuable to predict impacts.

- The verification of impacts by monitoring ,for which a number of methodologies are available, is important. In some areas, however, this is hampered by lack of monitoring or inadequate monitoring techniques.

B The industry has developed methods and technologies for the management of drilling and production activities, E&P chemicals and wastes, in order to minimise environmental impacts.

Drilling management

The objective of environmental management of drilling operations is to minimise potential environmental impacts.

- There are now drilling technologies that offer opportunities for minimising environmental impacts, but not all are applicable in every drilling operation.
- Opportunities to use these technologies are among the elements to consider in preparing the drilling plan.
- It is important to facilitate research and development to improve drilling technologies and achieve the overall objective as stated above.

Produced Water Management

The objective of environmental management of produced water is to reduce the quantity and to improve the quality of discharged produced water.

- There is to date no universal solution for the treatment of produced water. There is a need for further experience and information exchange on the use of different technologies associated with produced water.
- Integrated produced water management should be based on the following prioritised strategies:
  1) Prevent the production or inject produced water for reservoir pressure maintenance.
  2) Inject produced water for disposal, if energy requirements do not cause more environmental trade-offs.
  3) Minimise waste production.
  4) Treat and dispose remaining production water.
- Integrated produced water management would also require the minimisation of hazardous chemicals used in the treatment process.
- Integrated produced water management should take into account specific local conditions and engineering limitations.
- The industry should continuously seek to develop new technologies, but also implement the optimal utilisation of existing technology and resources including continuous training of personnel.

E&P Chemical Management

The objective of environmental management of E&P chemicals is to minimise or optimise the use of chemicals or substitute less toxic chemicals, taking into account the effect this may have on production capability, health and safety.

- E&P Chemical management is an integral part of the environmental management system as a whole.
- There is a need for expert judgement and the development of control systems based on both hazard and risk assessment. Methods for the environmental hazard and risk evaluation of E&P chemicals are presently available.
- A critical factor for assessment of chemicals, whichever management process is adopted, is the proper consideration of local and regional environmental conditions. Due account must be taken to lists of prohibited or approved chemicals (e.g., annexes to the London Convention). Further development of such lists need clear criteria for selection of substances. In this respect the persistence of substances, or of their metabolites, is identified as an important factor.
- Transparency and reporting of information is important in the communication with relevant stakeholders.

Other Waste Management

The objective of waste management for offshore activities is to minimise the environmental impact of discharges and disposal of trash, solid and hazardous waste.

- It is important to implement the following waste management hierarchy:
  1) Minimise
  2) Reduce, Recycle and Recover
  3) Treatment
  4) Disposal or Discharge
- A lack of adequate infrastructure is likely to present a challenge to the processing of wastes. Industry is responsible for E&P waste management. National authorities should have a regulatory role to facilitate the establishment of appropriate onshore infrastructure.

C Strategies and Policies aimed at integrating sound environmental practices into the total management of offshore operations depend on the implementation of Environmental Management Systems (EMS), at company level, in compliance with environmental management at national, regional and global level (legislation, conventions respectively sustainable development). Environmental Impact Assessment (EIA) is an adequate tool to ensure that protection of the marine environment is considered in the planning of offshore oil and gas activities.

Strategies and Policies

- 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 of E&P activities, agreement on environmental objectives for a specific area or region, and the establishment of plans as to 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.
- A consultative process involving governmental, petroleum and environmental agencies, the petroleum industry and other stakeholders, on a local and national level, would be an appropriate approach in establishing environmental objectives.
- It is the governmental responsibility to ensure that agreements at regional level should embody standards and environmental objectives in accordance with the consultative process at local or national level.
- Industry guidelines can play an important role in meeting the commitments under a goal-based regime. The guidelines should be developed in a consultative process with governments and other interested parties such as NGOs, when applicable.

- Areas vulnerable to the impacts of offshore oil and gas activities, and environmentally sensitive areas should be assessed and protected accordingly. Such areas need to be determined on a local, national or regional level, as appropriate.

Environmental Management Systems, EMS

- The overall aim of operators in managing the environmental impact of their offshore oil and gas activities should be three-fold:
  1) to meet the requirements imposed by the regulatory system(s) under which they operate
  2) to achieve control of all known environmental risks through the application of due diligence
  3) to continuously improve their environmental performance.
- EMS should be part of an integrated overall management system.
- Operators should aim to develop EMSs which can be accepted by the competent regulatory agencies (“the regulators”) as being well designed, properly resourced and organised and effectively implemented for the purpose of promoting good environmental performance. The emphasis on regulation can move from prescriptive measures towards setting the standards and leaving the choice of means to the operators.
- Transparency is required for the establishment of the standards which must be achieved, the levels of performance to which the operators are committed and the evaluation of whether those standards and performance levels have been achieved.
- The ISO 14000 series can offer a useful approach for an operator in developing an acceptable Environmental Management System. The Guidelines for the Development and Application of Health, Safety and Environmental Management Systems, produced by the E & P Forum in 1994, is a valuable guidance in further developing guidelines in consultation with stakeholders.
- The effectiveness of Environmental Management Systems will depend crucially on establishing a clear set of links between policies, objectives, targets and indicators, so that the translation of one into the other can be followed and checked.
- To reassure the public that the offshore oil and gas industry is applying sound environmental practices, it is essential that there is an evaluation of the implementation of Environmental Management Systems, in particular, performance against targets. While companies are reporting on their individual environmental performances, there is a need to develop means for reporting on the collective impact of companies in a region.

Environmental Impact Assessment, EIA

- The scope of EIA in the management of E&P activities, from seismic exploration to decommissioning, is:
  1. To apply EIA to all development steps;
  2. To aim at meaningfully protecting socio-economic structures and the environment;
  3. To consider cumulative effects on the receiving environment.

- When an EIA is applied, it should be considered in the implementation of the EMS.
- It is necessary to include an assessment of the socio-economic impacts of onshore developments related to offshore activities at all stages of exploration and production.

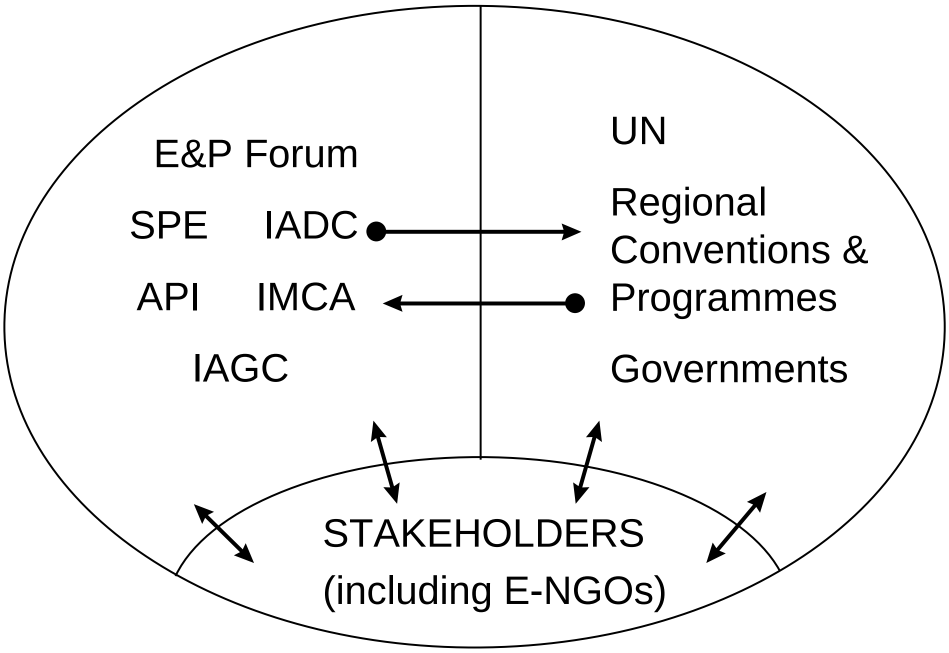
D Sharing of information (including experience and expertise) in a global network is a key factor in ensuring the development of good environmental practices within regional approaches to achieve "sustainable development", and in perspective of the global context of multinational operations, world market competition and enforcement of global conventions.

Future Exchange of information and experiences

- Regulatory agencies in many developing countries have limited economic resources to carry out sufficient control and enforcement. There is, therefore, a recognised need for instruments to improve the supervisory and regulatory role of such agencies. Companies operating in these areas should be proactive and operate in an environmental sound manner, even if national legislation proves to be inadequate.
- Information exchange and sharing of experience is a key point for further development of measures related to offshore industry. This work has to be built on experience and lessons learned in different countries. The information exchange between developed and developing countries is of particular importance.
- Offshore operators, non-governmental organisations and the general public share an interest in promoting good environmental practice. The development of such good environmental practice depends crucially on the availability of the relevant information, practical experience and scientific and technical expertise.
- This International Expert Meeting has brought together a wide range of people who between them possess a wealth of information, experience and expertise. The quality of the resulting discussion demonstrates the benefits of access to such a resource.
- Information, experience and expertise is needed to set environmental goals and develop environmental management systems. It is important that regulators, operators, non-governmental organisations and the interested sectors of the public have access to this.
- A large body of information already exists. This takes the form of, not only legislation, guidelines, reports and performance data, but also conference proceedings and workshops and research results. However, this is not organised in a manner which make it easy for those concerned to access the relevant information, or even to be aware of its existence.
- The development of good environmental practice in the offshore oil and gas industry will be facilitated by the creation of a voluntary arrangement from which all concerned parties can benefit and which will provide a prompt and effective way of making relevant new material generally available. In this context initiatives of the Expert Meeting are welcomed.
- It was proposed to establish a group consisting of representatives of The Netherlands, as organisers of this International Expert Meeting, the UN Environment Programme, as one of the main international agencies involved, the E & P Forum, on behalf of the offshore operators, and a relevant non-governmental organisation to develop an initiative in this field. It was welcomed that SPE is willing to share its experiences in technological information exchange. However, it is advisable to include a small number of additional representatives of other organisations and bodies which are ready to support the initiative. They should aim to develop a clear, simple plan for such an arrangement by the time of CSD VI, together with a solution to the question of how it can be resourced within existing constraints.

- Future exchange of information should be based on the “Sharing Experience Diagram” (see below) by making use of existing fora, rather than creating new ones. Information exchange can be facilitated through the use of tools such as a clearinghouse under the auspices of the United Nations.

Sharing Experience Diagram



- The success of the International Expert Meeting in creating a forum for the free exchange of information, experience and ideas between regulators, the offshore petroleum sector, inter-governmental and non-governmental organisations, suggests that efforts should be made to ensure that similar meetings take place on a periodic basis in the future. Exchange of information, experience and expertise can be promoted by face-to-face contact, which is not possible on paper or by electronic means. Discussion of differing points of view and examination of the justifications for them enable real progress to be made. It is advisable that regional meetings serve as a complement to the existing information structure on a global level to ensure regional participation.

SCOPE

Exchange of information and experiences related to observed or predicted environmental impacts due to seismic operation, drilling and production of offshore oil and gas reservoirs in relation to the protection of the marine environment. Evaluation of local environmental effects in perspective of recovery and restoration. Relation to economic development of the adjacent coastal zone. What are relevant environmental impacts?

1. Environmental Impacts of Offshore Oil and Gas Activities

Background information

Operational activities related to seismic surveys, drilling and production of offshore oil and gas may result in a variety of environmental impacts, especially at a local level. For example, standard operational practices such as the discharge of produced water, the discharge of drill-cuttings or the use of air-guns in seismic surveys may have an effect on ambient conditions. Similarly, the movement, installation and operation of a platform or pipeline cause localised, physical disturbance. The extent of the effects exhibit both spatial and temporal variations, depending on factors such as:

- the planning and implementation of activities
- the application of preventative measures and technologies
- the characteristics of the local environment

Proper planning, design and control of each phase in the operation, taking into account the environmental aspects of the activity as an integral part of the business, can help to avoid, minimise or mitigate the impacts.

The main categories of potential environmental impacts are related to:

- emissions: operational discharges and leakages
- ecosystem effects due to habitat: deterioration (especially pertinent in coastal wetlands, coral reefs and mangroves); disturbances by noise and extraneous light; interference with feeding or breeding areas and migration routes; and development of new artificial habitats at or around platform structures
- geomorphological effects: subsidence in coastal areas
- risks to human consumers of tainted seafood

In a broader perspective, operations related to exploration and production activities also include socio-economic impacts, such as changes in the social structure of human communities. These may especially relate to the in cultural differences between the companies involved and the local community (e.g., appreciation of the value of nature). Production activities and the resulting small-scale industrialisation, and urbanisation of the coastal region, may lead to changes in the landscape, structure and nature of the area. Moreover, ecological disturbances may affect the natural resources and thus the economy of local communities (e.g., fisheries). Communication between the operators local stakeholders is widely seen as an effective way of minimising the negative social- economic effects which result from E&P activities. The resulting mitigative measures may vary greatly from area to area and culture to culture. It is also important to consider the social, cultural and economic effects that seismic, drilling and production activities may have on local people.

Based on waste management guidelines published by a number of different non-governmental organisations (NGO's; see **Appendix I**), the key operational waste streams that occur as a result of offshore drilling and production activities include:

- drill-cuttings and muds
- production water
- storage displacement water
- cooling water
- deck drainage waters
- produced sand and scales
- well-treatment fluids

- desalination waste
- industrial wastes
- pipeline treatment fluids
- domestic and sanitary wastes
- anti-fouling paint and sacrificial electrodes on submerged structures

Components of these waste streams that are of particular environmental concern include:
- hydrocarbons
- chemical additives
- naturally occurring radioactive materials (NORM)
- heavy metals

The combined effects of these components may contribute to the individual waste stream's overall toxicity. In addition to those mentioned above, a number of the waste streams may occur as a result of discharges from associated shipping (e.g., ballast water discharges).

Environmental Impacts of Individual Waste Streams

The environmental impact of offshore oil and gas activities has been the subject of various studies. Emphasis has been particularly placed on the effects of hydrocarbons in drilling muds and production water, heavy metals in drilling wastes, surfactants, biocides and the possibility of shellfish tainting. Most studies have focused on the observable environmental impacts in close proximity to offshore installations. As with many human endeavours, more research is needed to understand in greater detail the potential environmental impacts of offshore E&P activities.

Drill-cuttings and muds

Besides the temporary effects of the physical burial of benthic fauna under low-energy seabed conditions, there have been no observed adverse environmental effects due to the deposition of cuttings (formation materials) themselves. However, cuttings are often contaminated with drilling muds which may have deleterious effects. A number of field studies in the North Sea and Gulf of Mexico have set out to assess the deterioration, in both abundance and diversity, of benthic life due to the discharge of drill-cuttings contaminated with mud residues**.**

The major components of drilling muds are clay, bentonite and barite all of which are chemically inert and non-toxic and a base fluid. Environmental impacts are primarily caused by direct ecotoxic effects and indirect effects due to smothering or extremely low redox potentials (and subsequent oxygen depletion and sulphide toxicity) of the base fluid of the mud.

Oil-Based Muds (OBM): Studies have demonstrated that OBM and cuttings may affect benthic organisms up to 500-800 metres in the residual current direction (and possibly farther) from the discharge point and may persist for many years. Studies have indicated that environmental effects associated with the presence of cuttings contaminated with oil-based muds include:

- inhibition of growth and reproductive development in scallops
- decreased feeding activity in deposit feeding bivalves
- reduced settlement of benthic organisms
- changes in immune responses in fish
- reduced spawning by fish
- reduced colonisation and burrowing by polychaetes and amphipods
- tainting of "reef"-fish

Monitoring studies also indicate that the recovery of benthic communities may begin soon after drilling operations have ceased. Recovery rates are strongly dependent on local environmental conditions (e.g., climatic and hydrologic), actual degradation of base oil and the characteristics of the ecosystem that has been affected.

Synthetics-Based Muds: Despite the initial environmental impetus for the development of alternatives to OBM, initial data concerning the environmental impact of SBM-contaminated cuttings on benthic life do not indicate any substanstial improvements over the impact of OBM-contaminated cuttings. However, a diverse new generation of mud fluids has been developed.

Water-Based Muds: Studies have demonstrated that the impact of WBM-contaminated cuttings is significantly lower than that of cuttings coated with other base materials.

Produced Water

Although laboratory studies have been performed to determine the acute toxicity of produced water, further research is needed to enable accurate predictions of the effects of produced water discharges in the actual field situation.

The composition of produced water varies widely depending on the stage of production and the characteristics of the field (e.g., reservoir rock geochemistry). Its impact on the environment, in turn, varies depending on its composition and dilution and the characteristics of the receiving environment.

Environmental concern over produced water has mainly focused on the residual hydrocarbons present. However, ecotoxicological risk analysis of complete produced water effluents, based on the combined toxicology of the main constituents, shows that hydrocarbons are only partly responsible for the observed toxicity of these effluents. In addition to the presence of residual concentrations of hydrocarbons, reactions between formation water and the local lithologies may result in significant concentrations of anions and cations (including low concentrations of radioactive isotopes) in produced water. Some of the metal salts present may add substantially to the produced water's overall ecotoxicity. Additional impacts may be caused by the relatively high temperature of, the total dissolved salt concentrations (i.e., salinity) of, and the presence of suspended solids in produced water.

Impacts may occur as far as 1 km from the production site. The actual environmental impact of discharged produced water is, however, mainly determined by its dilution in the ambient sea water. Generally, dilution to below the acute toxic threshold is observed in close proximity to the discharge point. The dilution rates are a function of water depth, current velocities and discharge regime. Other factors that determine the fate, and subsequent toxicity, of produced water are conversion of metals into precipitant insoluble salts, and evaporation and biodegradation of organic constituents. Bioaccumulation studies reveal that produced water components (e.g., metals, organic compounds, surfactants, PAHs and radium) are not bioaccumulated to harmful levels in the vicinity of the platform. In shallow waters, local impacts on the benthic fauna may occur if the produced water plume contacts the seabed. Such impacts can be avoided by re-designing the discharge configuration to prevent this.

E&P Chemicals

In addition to the compounds originating in the formation water, additives used as part of drilling and production processes (i.e., E&P Chemicals) may contribute to the toxicity of production water. Due to the uncertainty of the environmental fate of these chemicals and their relative low residual concentrations in discharged waters and cuttings, little is known about the actual environmental risks of releasing them into the marine environment. Some, such as most corrosion inhibitors and demulsifiers, tend to accumulate in the produced oil. Special consideration is given biocides and chemicals that are based on surfactants. Surfactants have a specific environmental behaviour and some can disrupt endocrine functions in vertebrates and may affect their sexual development.

Other Wastes

The waste associated with the presence of crew is, more or less, identical to domestic waste produced on land and includes domestic wastewater (i.e., sewage water), food wastes, debris from packages, etc. The release of sanitary waste may cause health problems by introducing pathogenic micro-organisms. In the offshore situation, however, pathogens are only observed in close proximity to the discharge point. With commonly used treatment methods (e.g., chlorination) some concern exists as to the potential formation of organochlorine compounds through reactions between discharged residual free chlorine and organic components in the waste stream, and the impact of these compounds on the environment.

Additional wastes associated with construction, maintenance and production include batteries, paint, sand- and grit-blasting materials, sacks, drums and residual chemicals. Of the assorted waste types that are currently released in the world's oceans, plastic debris is of particular concern, primarily on account of its resistance to biodegradation. Since regulations under MARPOL 73/78 prohibit the discharge of garbage from offshore platforms, for E&P operations in most jurisdictions it has become standard practice for waste to be returned to shore and disposed of in accordance with international regulatory requirements. This is also applicable to unused (hazardous) chemicals. When a waste disposal programme the impacts of onshore disposal and handling of such wastes needs to be considered.

Environmental Impacts Resulting from Physical Disturbances

Geophysical surveys cause localised, temporary disturbances to wildlife (especially breeding, spawning, feeding, brooding and migrating animals). Under certain conditions and in some areas of the world explosives are used during seismic surveys. The use of explosives has a localised lethal impact on fish and other marine life. The most commonly used successor of explosives are airguns, which are not lethal. The range and intensity of frequencies produced may, however, lead to behavioural changes in marine mammals, birds and fish (e.g., disturbance of cetacean communication and breaking up fish shoals).

The presence of platforms and the noise and light that they produce can also effect migration routes, breeding and feeding areas of mammals, birds and fish. These disturbances are of special concern in protected nature conservation areas. The heat produced by platforms can have some thermal effects on the surrounding ecosystem in temperate and cold regions. Activities such as dredging, filling, anchoring, laying pipelines and the actual presence of the well, lead to some seabed disturbances. However, the presence of a platform can also have a positive effect by supplying an artificial structure on and around which a variety of species can live.

Effects resulting from geophysical and drilling operations can be minimised by locating the activities at the least sensitive locations within the area and by planning the operations so that they do not coincide with the periods when the wildlife of the area are most vulnerable (“ecological window”).

A difficult point in the evaluation of environmental impacts are the indirect consequences of geological deformations due to either natural occurrences (i.e., earthquakes), or extraction of water, oil or gas from subsurface reservoirs in coastal zone areas (e.g., subsidence). With the exception of subsidence in some geologically well-mapped regions, there is not enough information available to predict potential consequences of such geological impairments. Only occasionally are these effects accounted for in monitoring surveys.

Synopsis of main ecological targets for impact assessment

The sources of pollutants and disturbances may eventually lead to effects on the biota present in the receiving environment. Although gaps in knowledge hinder ultimate conclusions, the most relevant sources of concern can be identified for different groups of biota. It should be noted that the ranking of effects strongly depends on the local environmental practices. Marine mammals are not expected to be significantly affected, but some concern for these species is focused on the effects on behaviour by seismic operations. For birds, the effects of air guns are not well known but are expected to be minor, as are the effects of toxicants. Fish are most likely to be affected by toxic substances, although effects may be restricted to eggs and larvae. Tainted fish, however, may become unmarketable for fisheries. Effects of toxic substances on pelagic (planktonic) organisms are not expected, due to the high dispersion and dilution. Benthic life is mainly vulnerable to toxic and physical effects caused by drilling waste that has entered the sediment. However, these effects are restricted to the direct vicinity of platforms.

Moreover, areas which are vulnerable to E&P activities can be identified on the basis of environmental conditions (e.g., shallow and enclosed systems) and vulnerable communities (e.g., mangroves).

Assessment and Monitoring of Potential Environmental Impacts

No standard techniques are available for the quantitative assessment of potential environmental impacts of E&P operations in various marine environmental conditions and ecological community types (ecotopes). The impact assessment is generally based on local expertise and expert opinion regarding the local biological communities and their sensitivity to disturbances in general. The impacts of pollutants are generally assessed on the basis of a comparison of Predicted Environmental Concentrations (PEC, which is based on emission characteristics and modelling of the distribution/dilution of waste streams in the environment) with the Predicted No-Effect Concentrations (PNEC, which is based on ecotoxicological data). This technique is rapidly evolving for the risk assessment of produced water and drill cutting discharges in the North Sea. Some concern exists for overlooking sublethal effects of particular substances that may occur at low concentrations.

In many countries, environmental monitoring surveys have been carried out in the vicinity of offshore E&P operations in order to assess the response of the environment to E&P activities. For example, changes over time in local biological communities in relation to their exposure to chemicals (e.g., hydrocarbons, barium and metal-salts). A review of observed environmental effects of offshore E&P activities on the basis of monitoring data has been compiled by GESAMP. More since environmental monitoring surveys have been executed and reported (a.o. GOOMEX in Gulf of Mexico; various programmes in Australia and Brazil etc.)

Working Session Report

Chaired by Dr. Siân Pullen (WWF)

Key Note Presentation

Dr Alistair D. McIntyre (GESAMP)
Environmental Effects of Offshore Oil and Gas Activities

Introductory Papers

Mr Edward J. Pinceratto (APPEA, BHP, Australia)
Review of Environmental Implications of Offshore Oil and Gas Development in Australia

Dr David Santillo (Greenpeace, UK)
Environmental Impacts of Operational Discharges from the Offshore Industry: The Need for Improved Assessment and Control

Dr Pasquale F. Roscigno (MMS, Gulf of Mexico OCS region, USA)
Assessing Sublethal Responses to Environmental Contamination: The Gulf of Mexico Offshore Operations Monitoring Experiment (GOOMEX)

Mr Leonardo Souza (Petrobras, Brazil)
Campos Basin and Cabiúnas Environmental Monitoring Programme

Dr Liz Rogers (Azerbijan International Operating Company, Azerbaijan)
Operating in an Environmentally Sensitive Area -The Caspian Sea

Discussions

The following summarises many of the points raised in discussions, but it is not intended to reflect all the points made during discussions.

What are the key environmental issues (pollution, disturbance, geomorphic, and socio-economic) associated with seismic, drilling and production activities?

Socio-economic
1. the socio-economic situation varies from one country to an other and need to be considered locally, nationally or regionally, as appropriate;
2. it is necessary to consider culture, gender and tradition, in particular in developing countries;
3. the solution to environmental problems should not be generalised as to be applied to all parts of the world, but should be found locally, nationally or regionally, as appropriate, together with local stakeholders;
4. the existence of, and impact on, archaeological or historic marine sites should be considered;

Pollution and Disturbance
1. it is necessary to combine laboratory experiments with field observations in order to make a good assessment of the effects of contaminated cuttings on the marine environment;
2. a locally, nationally or regionally approach, as appropriate, to the impacts is necessary;
3. there is clear evidence of localised environmental effects of offshore oil and gas in some areas, for example in the North Sea (see the North Sea Quality Status Report 1993), the Gulf of Mexico and the Caspian Sea;
4. interference, such as debris, historical well-heads and pipelines, is perceived by fishermen as a greater socio-economic impact on fisheries than the pollution resulting from offshore activities;
5. the concerns associated with the presence of persistent contaminants in operational discharges are of importance;
6. determining cause and effect relationships is difficult;
7. some impacts, such as sub-lethal impacts, may go undetected;

Geomorphic

1. subsidence due to oil and gas extraction might have adverse effects on the ecosystem, and should be considered within an Environmental Impact Assessment (EIA);

Seismic

1. many countries use alternative techniques to explosives, but there is continued use in some countries and concern about its impact on the fish stocks and fish farming;
2. noise from vessels, rather than the seismic signals, are suspected of having an impact on fish (breaking up shoals).

What are the best strategies/methods of monitoring these potential environmental impacts and their mitigation, and how can these be effectively implemented?

During discussions it was pointed out that:

1. baseline studies are a necessity, prior to new E&P activities;
2. a precautionary approach should be adopted;
3. well-managed regulatory programmes are necessary;
4. regulation does not imply enforcement;
5. it is necessary to consider the potential environmental impact of all mitigation options.
6. EIA processes should take account of cumulative effects;
7. some countries have issued guidelines that cover precautionary practices such as interruption of seismic survey and gradual start-up of air gas arrays to allow whales to move away from seismic noise. It is common practice to determine windows when seismic and drilling operations will have a minimal impact on the marine environment;
8. recognition of regional variation is important.

Should offshore operations be permitted in vulnerable areas and, if so, how should they be approached?

During discussions it was pointed out that:

1. EIAs should provide the answer to the vulnerability of defined areas;
2. there are countries, such as Australia and the U.S, which have defined areas where E&P will not take place, and other areas where E&P will not take place in the interim;

3. it is necessary:
   - to determine 'vulnerable areas' according to agreed criteria, involving all stakeholders;
   - to take account of cumulative effects in areas under consideration, in addition to EIA activities.
4. local knowledge is critical.

Furthermore, during discussions, it was pointed out that:

- the standards and practices applied by some oil companies vary according to the country/continent they work in.
- it would be possible to apply 'planning gain' schemes whereby oil companies use some of their benefit to set up social community schemes

Conclusions

After further discussion, the Chairman concluded that:

1. the degree of the impact of offshore oil and gas activities on the marine environment is considered to be largely local, but it differs in different ecosystems and increases in those areas where there are a number of installations and developments. There are linkages between the socio-economic and environmental effects of offshore oil and gas development. However, there was no consensus on the significance of the environmental impact of offshore activities.
2. modifications of nearshore habitat could lead to loss of livelihood and social disruption. Moreover, when development is not considered and performed in the context of an open and participatory environment, it could result in resentment and social division.
3. prior assessment is important and baseline assessments/studies valuable to predict impacts. Some parties do not consider Environmental Impact Assessments (EIA) to be sufficient to determine impacts and believe that strategic environmental assessment is necessary to accommodate cumulative impacts. The importance of a precautionary approach to the development of offshore oil and gas activities was recognised.
4. monitoring is important and a number of methodologies are available. Details of monitoring methods were not evaluated, due to time constraints. Further sharing of experience at international level would be beneficial.
5. the verification of impacts is hampered by lack of monitoring or inadequate monitoring techniques in some areas. The rigor and scale of impact studies and monitoring programmes are important and an integrated approach to scientific studies and monitoring should be taken, including peer review. Clear cause-effect relationships are difficult to establish but, as techniques improve, the impacts will be better understood. The importance of minimising the area of impact was recognised.
6. in some cases, the lack of an open process could result in some corporations becoming reluctant to operate. This in turn could increase the chances of damage to the environment and fewer resources and capacity for response to damage.
7. areas vulnerable to the impacts of offshore oil and gas, and environmentally sensitive areas should be adequately protected. Such areas need to be determined on a local, national or regional level, as appropriate.

2. Drilling management

SCOPE

The exchange of information, methods and experiences related to the occurrence, prevention and reduction of seabed pollution with drilling muds and cuttings contaminated with mud residuals. What is needed and what is feasible in drilling mud selection and management? What are the efficiency and cost effectiveness and overall performance of environmental technologies, alternative mud systems and novel drilling or production techniques?

BACKGROUND INFORMATION

Considerable environmental concern exists with regard to the potential impact of discharged drilling wastes on benthic life, in the proximity of offshore drilling installations. In particular, this concern is related to the discharge of oil-contaminated drill-cuttings. In order to understand the potential environmental impacts of drilling muds and cuttings, their physical/chemical properties must first be understood. To this end a brief description of drilling muds and cuttings is given below.

Drilling Muds

Drilling muds are liquids used in drilling operations to cool and lubricate the bit, carry away drill-cuttings and balance underground hydrostatic pressure. They are pumped down the drill string, through the bit and then carry the drill-cuttings through the drill pipe back up to the surface.

Drilling muds contain a base liquid (oil, water, or a synthetic material), barite and a variety of chemicals which are added to give the mud the desired properties. These chemicals may include: viscosifiers, emulsifiers, biocides, lubricants, wetting agents, corrosion inhibitors, surfactants, detergents, caustic soda (NaOH), salts (NaCl, $CaCl_2$, KCl), and organic polymers. There are three broad categories of drilling muds, as follows:

- *Oil-Based Muds* (OBM): Although diesel oil was originally used as the base material, the observed toxicological effects led to its replacement in the early 1980’s in the North Sea and Gulf of Mexico by aliphatic and naphthenic mineral oils
- *Synthetic-Based Muds* (SBM): Increasingly stringent regulations on the seabed disposal of OBM-contaminated cuttings initiated the development of substitute base material and SBM were developed. SBM may contain, *inter alia,* esters, poly-alpha-olefins, linear-alpha-benzene’s, acetyl, linear-alpha-olefins, linear paraffins and internal olefins as a base. The use of this kind of alternative has become commonplace in drilling operations in the North Sea and Gulf of Mexico.
- *Water-Based Muds* (WBM): Water-based muds are considered an environmentally better alternative for OBM, and where possible their use is favoured over OBM use.

The physical/chemical characteristics, and thus the applicability in drilling operations, of WBM are different than those of OBM and SBM. Although WBM are the environmentally more favourable option, for both technical and safety reasons OBM or SBM may still be required in situations where drilling operations are more complex (e.g., in the lower sections, in specific formations, in High Pressure/High Temperature wells, and in non-vertical drilling operations). It is, therefor, common practice for WBM to be used for drilling the upper section of the well and OBM or SBM for the more complex sections.

Currently emphasis is being placed on the development of High Performance Water-Based Muds (HPWBM) containing dissolved sodium silicates in the water fraction. Recent evaluations indicate that such muds are thermally stable at temperatures of up to approximately 300°C, with a lubricity that approaches that of OBM. These muds can replace OBM and SBM in more situations than WBM.

Drill-cuttings

Drill-cuttings are typically comprised of a heterogeneous mixture of lithologies dependent upon the local stratigraphy. When the mixture of drill-cuttings and muds reaches the surface, the cuttings are removed using shale shakers, sand traps, desanders, desilters, centrifuges, and mud cleaners and are ultimately disposed of or, in some case, recycled. The environmental impact of these cuttings, which themselves generally pose no threat to the environment, is determined by the extent and nature of their contamination with drilling muds.

Regulatory Framework

The discharge of contaminated drilling wastes is dealt with through regional agreements in certain marine areas (e.g., the Mediterranean, Baltic and North Seas) and, more commonly, through national legislation. For example, implementing regulations, developed under the framework of the *Paris Convention 1974,* impose a maximum discharge standard for oil-contaminated drill-cuttings of 10g oil per kg dry cuttings. As a result of current waste treatment limitations, this corresponds to a *de facto* discharge prohibition. Indeed, due to observed detrimental environmental effects, several countries have prohibited the discharge of oil-contaminated cuttings to the marine environment. Contaminated cuttings must, therefore, be taken onshore for treatment and disposal. In response to increasing environmental concerns and legislative developments, a number of operational guidelines have been developed regarding the management of drilling wastes.

Note: The US Environmental Protection Agency has not yet issued separate regulations for the discharge of drill-cuttings coated with residual SBM. The USEPA considers SBM as a separate class of drilling fluid technology, which may be less harmful to the environment in comparison with OBM, the discharge of which is prohibited. The USEPA is in the process of determining the appropriate limitations for future disposal of SBM-contaminated cuttings. For the OSPAR region no consensus has been reached on how to regulate the use of SBM.

Treatment and Disposal Strategies

Drilling wastes are typically comprised of a complex mixture of drilling muds, chemicals and formation material. The overall composition of formation materials may be highly variable and, as such, the chemical reactions that take place and resultant products are unpredictable. For this reason, proper disposal methods can only be chosen after a thorough chemical analysis of the waste has been carried out.

Studies have shown that the maximum area affected following the direct disposal of drill-cuttings to the marine environment is a complex function of oil concentration, water depth and turbulence (i.e., tides and currents). Indeed, the same studies suggest that the overall impact from the discharge of oil-contaminated cuttings is limited, provided that the original oil content is less than 1%.

Field surveys and bioassays have demonstrated the toxicity of both OBM and SBM on benthic biota. Consequently, there is a tendency towards reduction, treatment or confined disposal of oil-contaminated drilling wastes, primarily by means of process and procedure modifications.

Possible methods of reducing the environmental impacts of drilling wastes include:

- Reducing waste volumes by:
  - increased recycling of muds and chemicals
  - using reduced casing, slim-hole, coiled tubing drilling techniques, or multilateral (multiple drain hole) wells
- Reducing the toxicity of drill-cuttings by:
  - using WBM and HPWBM instead of OBM and SBM
  - using the best available solids recovery equipment in order to remove OBM and SBM (which can then be recycled)
  - reducing the hydrocarbon content of cuttings by mechanical (centrifuge, wash), chemical (solvent extraction) or thermal clean-up treatment (TORBED incineration) prior to discharge. Indeed, monitoring studies indicate that the adverse impacts of cuttings with OBM residuals that are discharged after thermal treatment are minor and comparable with those of WBM-contaminated cuttings. However, as noted above, in a number of countries operators are required to bring cuttings contaminated with OBM and SBM residuals onshore for treatment and disposal.
- Reducing the toxicity of drilling muds by:
  - developing and using chemicals with lower toxicity and lower levels of biologically available heavy metals
  - reducing the use of biocides
  - replacing OBM and SBM by WBM, where technically possible
- Effective management of drilling wastes including:
  - confined disposal (onshore or by re-injection)
  - processing/recycling of drilling waste (e.g., use of cuttings for making bricks or road fill)

- Avoiding drilling in sensitive areas by using directional drilling (horizontal drilling and extended reach) techniques to access the reservoir from a less sensitive area
- Cluster drilling to minimise the "footprint" of the platform

In relation to these options, re-injection of drilling wastes into sub-surface rock strata can be considered as an alternative disposal option. This approach has been successfully tested and applied in Alaska, the Gulf of Mexico and the North Sea. Although re-injection can be an attractive option, it is by no means universally applicable and the amount of energy required should be taken into account. When properly engineered, however, evidence suggest that it does ensure long term containment.

Although there are a number of environmental benefits associated with the alternative drilling methods and strategies summarised above, there are also a number of performance limitations associated with each option. For example:

- Although directional drilling is an effective method of moving drilling activities out of environmentally sensitive areas, it often requires the use of OBM and SBM, more energy and more drilling fluids than vertical drilling.
- Slim-hole drilling and coiled tubing drilling techniques may pose well control problems, particularly in high pressure wells. In the case of slim-hole drilling, well evaluation is also compromised, to some extent, by the technological constraints on the logging tools that are currently available for narrow bore wells.
- Re-use of drilling muds has both technical and economic limits.
- Thermal treatment of drill-cuttings requires large energy inputs.
- Shipping of drilling waste for onshore disposal can bring additional safety hazards and operational limits with regard to the handling of wastes.
- Recent developments in the use of highly salted muds (i.e., HPWBM) require the development of new disposal criteria.

For all the options mentioned, an evaluation of cost-effectiveness, in terms of the cost of implementation of a certain technology versus the expected overall environmental risk reduction is required. This may help to avoid implementation of costly technologies in situations where only very limited environmental improvements may be expected.

WORKING SESSIONS REPORT

Chaired by Ms. Cynthia Quarterman (MMS, USA)

Key Note Presentation

Dr. Aston A. Hinds (Dresser Industries, USA)
Minimizing the environmental impacts of offshore drilling operations: challenges for the 21st Century.

Introductory Presentations

Dr. Scott McKelvie (Rudall Blanchard Associates, UK)
The physical and biological effects of processed oily drill cuttings.

Dr. Joe P. Smith (Exxon, USA)
Considerations for the development of acceptability criteria for the discharge of cuttings from drilling with synthetic based drilling fluids.

Dr. Ahmed S. Abou-Sayed (BP, USA)
Deep well injection of oil field wastes for final disposal: opportunities and challenges.

Mr. Michael Payne (Enterprise Oil, UK) and Mr. Eddie Belle (SNOC, Seychelles)
Environmental care whilst drilling off the Seychelles

Dr. Avinash Chandra (Directorate General Hydrocarbons, India)
Environmental safeguards in offshore drilling operations in India.

Discussions

The five speakers identified above were introduced by the chair and made their respective presentations. A lively discussion on the Technical presentations ensued. One point that was specifically requested to be included in the report from the session was that some participants believed that all drilling fluids and cuttings have negative environmental impacts when discharged. There were also statements made that scientific evidence supports the environmental acceptability of discharging water based drilling fluids and cuttings.

What are the most environmentally promising novel drilling techniques? How have they performed? What are their environmental benefits in relation to the extra costs?

What are the most environmentally promising new drilling fluids? How have they performed? What are their environmental benefits in relation to the extra costs?

What is feasible in the disposal or treatment of drilling cuttings and what are the benefits for the environment?

During the discussion the participants drafted the attached table that identifies the range of drilling techniques available, the performance limitations of each technique and the economic cost-benefit as well as the environmental cost-benefit of using each technique. (This cost-benefit analysis ranked three elements (high, medium and low): the degree to which the production of drilling waste could be minimised by using each technique; the degree to which the technique is sensitive to the environment; and the economic viability of using each technique.)

The table also identifies the range of drilling fluids available, the performance limitations of each fluid and the economic cost-benefit as well as the environmental cost-benefit of using each fluid assuming discharge into the ocean. (This cost-benefit analysis considered the same three elements as identified above relating to drilling fluids.)

Finally, the table identifies the options available for disposing of or treating oily or synthetic drilling fluids and cuttings, the performance limitations of each option the economic cost-benefit as well as the environmental cost-benefit of using each option. (This cost-benefit analysis considered the same three elements as identified above relating to the disposal and treatment options.)

The table fully represents the opinion of the participants regarding the technical limitations and the cost benefit analysis and addresses the first three questions posed in the working session.

How do we incorporate development and the use of novel drilling techniques, now drilling fluids and disposal or treatment technologies into integral environmental management?

The participants then discussed how to incorporate the options set forth in the chart into an integrated environmental management system for drilling. However, it was recognised that any such system must be integrated into an overall management system as determined by each nation. The following objective and guiding principles to be considered in such a system were set forth:

Integrated Environmental Management System (drilling only)

Objective: Attempt to minimise the potential environmental impacts resulting from drilling operations.

Principles to be considered (consistent with Agenda 21 agreed to at the United Nations Conference on Environment and Economic Development in Rio, 1992):

- geographic sensitivity (i.e., recognise that practices differ according to location);
- safety/Health (a primary responsibility of any drilling program);
- economics (i.e., project cost benefit analysis);
- socio-economics (i.e., effects on local populations);
- facilitation of research and development.

It was mentioned that the elements associated with the five stages of the waste hierarchy contained in the E&P Forum's 1995 guidelines can be also considered.

Conclusions

After further discussion, the working session chair concluded that:

- there are now drilling technologies that offer opportunities for minimising environmental impacts, but not all are applicable to every drilling application;
- opportunities to use these technologies are among the parameters to consider in preparing the drilling plan (e.g., see attached table);
- it is important to facilitate research and development to improve drilling technologies and achieve the overall objective as stated above.

The working session chair further concluded that:

- 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 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. However, it is important to promote improvements of drilling techniques, which minimise waste production; of drilling fluids, which improve drilling performance and lower toxicity; and of drilling fluids and cuttings treatment and disposal methodologies.

DRILLING TECHNOLOGY	**Performance Limits**	**Cost / Benefits Rankings (according to factors below) waste minimization / site sensitivity / economic viability**
Slim Hole	applicable only to few reservoirs lack of logging tools inability for future intervention high flow deep reservoirs	High/Low/Medium
Coiled Tubing	not applicable for corrosive wells offshore logistics similar to slim hole	High/Medium/High
Multilaterals	low reliability/longevity	High/High/High
Horizontal Well	lack of reservoir control	Medium/High/High
Conventional Well	higher waste volume[1]	Low/Low/High
DRILLING FLUIDS **Oil Based Muds**	spill treatment need for disposal health and safety hazard	Medium/Low/High
Synthetic Based Muds	hole instability high temperature	Medium/Medium/Low
Water Based Muds	not good for sensitive shales low lubricity high friction losses	Medium/High/High
Hi-Performance water-based Muds	Future development	Future Development
DRILLING CUTTINGS [2] **Recycling/processing**	volume availability toxicity	High/Low/Low
Pollutants Removal (chem, mech, therm)	new waste stream generation disposal needed health impact size/weight	Low/Low/Medium
On-shore Disposal	long-term liability site availability transportation hazards	Low/Low/Medium
Re-Injection	availability of suitable formation hazards if transportation is needed pressure requirements	High/High/Medium
OTHER ISSUES [3] **Small Foot print/Clustering** **Liability** **Training** **Sharing Information**		

[1] discharge to oceans assumed
[2] applicable to OBM and SBM only
[3] sent to other working sessions

The cost-benefit analysis ranked the techniques according to:
1) the degree to which the production of drilling waste could be minimized by using the technique;
2) the degree to which the technique is sensitive to the environment;
3) the economic viability of using each technique.

3. Produced Water Management

Scope

Exchange of information, methods and experiences related to the occurrence, prevention and reduction of the emissions of hydrocarbons, process chemicals and formation substances/elements (including naturally occurring radioactive substances) with produced water discharges. What is feasible in produced water management? What are the performance, efficiency and cost effectiveness of environmental technologies and the environmental aspects of new production techniques and process innovation?

Background information

Produced water is the water brought to the surface along with oil during oil and gas production operations. Although water is always present in oil producing formations, during the early stages of production water may only be a minor component of the fluids produced. However, as the reservoirs become oil-depleted, the volume of water produced increases, while typically the pressure within the reservoir decreases. In order to maintain pressure and sustain existing production rates, water may be injected into the reservoir. This injected water may be subsequently recovered as produced water.

In the later stages of production, the volume of produced water is generally several times greater than that of the oil, making produced water, volumetrically, the largest waste stream from offshore oil production platforms. In the UK sector of the North Sea, for example, the current oil to produced water ratio is approximately 1:1.5. The average oil:water ratio over the entire lifespan of all wells is 1:6. Gas platforms produce much lower volumes of water. For example, in the North Sea, produced water volumes from gas platforms range from 2-30 m^3/day in comparison with 2400-40000 m^3/day for those producing oil. When it becomes economically unfeasible to treat the produced water, the operation is stopped and the oil remaining in the formation is abandoned. Governments often consider this fact when formulating treatment standards.

Produced water is a complex mixture, which may typically contain hydrocarbons, naturally occurring radioactive material (NORM), production chemicals, inorganic salts, solids and metal salts. Although other disposal options exist, for offshore operations it is standard operational practice for produced water to be treated (i.e., oil/water separation) before being discharged into the marine environment.

Regulatory Framework

Discharge restrictions for produced water are commonly implemented through regional and national regulations. In practice, a wide range of standards has been prescribed at national level (ranging from 10-50 $mg.l^{-1}$ total petroleum hydrocarbons, with exceptions of up to 100 $mg.l^{-1}$). To date, emphasis has been placed on regulating the concentration of oil in produced water. In some jurisdictions, however, constraints are also imposed on:

- total dissolved solid concentration (TDS)
- copper, arsenic and zinc concentrations
- aromatic fraction
- concentration of specific radioisotopes
- chronic toxicity of the whole effluent

It should be noted that, regional and national standards are sometimes expressed as a monthly average, sometimes as a maximum level and sometimes as both. Furthermore, the value determined for the concentration of oil in water is dependent on the analytical method used. For example, the use of the gravimetric method is considered relatively imprecise in comparison with solvent extraction of the hydrocarbon fraction. Different extraction solvents, and analytical methods (GC and IR) give different results, making data incomparable. This obviously has implications for achieving compliance with the standards prescribed.

Produced water management

Produced water, as one of the waste streams from to oil and gas production, needs to be managed carefully in order to minimise its environmental impact. As previously discussed, several options are available for reducing the environmental impact caused by the discharge of produced water. Since the environmental impact of produced water is a result of the environmental impact of the individual components, the goal of integrated produced water management is to reduce the concentrations of contaminants in the discharged water (e.g., produced water treatment, E&P chemical management) and to reduce the volumes of produced water discharged into the environment. Maximum impact reduction requires the optimal utilisation of existing technology and resources; this requires specific knowledge of the entire production process, from the reservoir to final discharge, and thus also requires the continual training of personnel.

Integrated produced water management generally follows a series of steps, as follows:

- Selection the least hazardous chemicals in order to minimise produced water toxicity (see section 6)
- Reduction in the volume of water produced
- Re-use of produced water, if water quality allows (e.g., re-injection for pressure maintenance)
- Reduction in the volume of produced water discharged into the ambient environment
- Reduction in pollutant concentrations of discharged produced water

Reduction in the volume of water produced

Reduction in the volume of water produced may be achieved by:

- shutting down water producing wells
- isolating water producing zones in the reservoir by setting plugs and using cement and chemical treatments
- utilising polymer gels and relative permeability modifiers

Another possible option for the reduction of produced water volumes which is still in the development stage is downhole seperation. This technique is based on hydrocyclone separation which is followed by the pumping of oil to the surface using a submersible pumping system and the re-injection of the water. The advantages include not only a reduction in the volume of water produced and discharged, but also a reduction in operational expenses and improved recoverability. The methodology was developed in the early 1990’s and is already in use for up to 40 onshore installations. Technical and economical feasibility for offshore application was investigated from 1994 – 1996. In 1997 and 1998 the applicability of the technology for offshore application will be studied in a practical situation. However, at present, the feasibility of this technique offshore is limited by:

- the capacity of transfer tubes
- problems of re-injection of water in fields with heavy oil
- the fact that it is only applicable under conditions of low flowrates and high water-cuts (60-95%)

Reduction in the volume of produced water discharged

After reducing the amount of water produced as much as possible, the amount of produced water which is release into the ambient environment can also by reduced. One possible method which can be used in order to do this the disposal of the produced water by re-injection into an underground formation.

Produced water re-injection in the offshore situation, which has become everyday practice in more mature fields, still presents some technical problems. The higher organic matter content of the produced water leads to increased potential for plugging. Due to the fact that produced water is often much warmer than sea water, its re-injected causes less fracturing of the formation than the re-injection of sea water; this may lead to a decrease in the injection rate. Furthermore, there are potential problems with scaling, corrosion and bacterial growth. These limitations, however, may be overcome with the development of new technologies. It must also be noted that re-injection might lead to increased energy requirements and increased CO_2 emission from the platform.

Reduction of pollutant concentrations in discharged produced water

End of pipe treatment technologies, which are, or could be, used for the reduction of hydrocarbons in produced water, can be divided into three different categories:

- Primary treatment equipment (e.g. skimmers) to protect the downstream facilities from surges and upset conditions
- Secondary treatment equipment (e.g. coalescers, flotation units) which are used for bulk oil removal, and are able to remove small oil droplets
- Polishing treatment equipment (e.g. filters, hydrocyclones, stripping, filtration) to remove the very fine oil particles

Several other technologies have been developed for use onshore. The potential application of some of these techniques in offshore operations is still in doubt. Specific limitations such as the space constraints, highly variable water flow rates, corrosive and scaling properties of the waste streams, extended retention times, tendency to block, and high energy requirements, impose severe restraints on their utilisation. These techniques include:

- biofilm airlift reactor
- membrane pertraction (ion exchange)/ultrasonic descaling
- activated carbon filtration
- electric flocculation
- solvent extraction
- wet oxidation
- ozonation

Each technique needs to be tailored to the problem, meeting the specific conditions with regard to dispersion droplet sizes, solids, quantity, energy consumption and size and weight of equipment.

To attain maximum benefit, with regard to environmental risk reduction, from investment in treatment technologies, it is crucial to first define which components of the produced water should be focused on (i.e., those elements and compounds which have the most significant impact on the ambient conditions of the receiving medium). This can vary with the field and with the stage of the production. In some cases instead of investing in new end of pipe technologies, it may be sufficient to adjust and optimise the use of the equipment that is already installed on the platform. The choice of the technology should be based on an integrated evaluation.

In addition to the presence of residuals of dissolved and dispersed hydrocarbons, equilibration of formation waters with the host lithologies may result in the presence of significant concentrations of anions and cations in produced water. The reduction in the concentrations of these components can be technically achieved prior to discharge. This, however, would require major investment in water treatment technologies by platform operators. As such, the relative environmental benefits of investments in new and complex water treatment technologies need to be assessed.
For all of the above mentioned options, an evaluation of cost-effectiveness, in terms of the cost of implementation of a certain technology versus the expected overall environmental risk reduction, is advised. This may help to avoid implementation of costly technologies in situations where little or no environmental improvement can be expected.

Working session report

Chaired by Mr. Gertjan Lankhorst (Ministry of Economic Affairs, The Netherlands)

Key Note Presentation

Jan Hartog (E&P-Forum, Shell)
Produced Water: Overview of Composition, Environmental Aspects, Treatment and Management

Introductory Papers

Dr. Mohammed Essam Kandil (GUPCO, Egypt)
Comparative Evaluation of Oil Water Separation Techniques

Mr. Jose Francisco Tebaldi de Castro (Petrobas, Brazil)
Treatment of Produced Water in Brazil

Mr. John Shaw (Statoil, Norway)
Downhole Separation of Produced Water: The Challenges Facing the Offshore Industry

Dr. James P. Ray (API, USA)
Bioaccumulation of Principle Components of Discharged Produced Water

Discussions

Technologies, experiences and perspectives

During discussion it was pointed out that:

- downhole separation technologies have potential, but need to be developed further;
- hydrocyclones have proven to be the most successful treatment technology in northern areas (i.e. North Sea), basically due to their effectiveness in relation to costs (for other regions this is not necessarily the case);
- novel water treatment technologies (e.g. microfiltration, membranes) have so far not been successful in offshore operations;
- for gas production, other treatment technologies are sometimes required. The use of certain end of pipe techniques, such as stripping techniques, has been successful to a certain extent, but such techniques often create additional waste streams.
- technology development should be carried out in accordance with risk assessment studies;
- treatment of produced water, aiming at a reduction of other contaminants in addition to hydrocarbons, requires many different technologies for which further research and development is necessary in order to make them suitable for offshore application;
- the choice of the technology should be based on an integrated evaluation. There is a need to develop new techniques in the field of produced water management, but also to modify existing installations in order to improve their efficiency in a cost effective way;

- in many cases, it is far more difficult and costly to introduce new strategies to reduce discharges of produced water (such as re-injection technology) on existing installations; and
- re-injection of produced water may be more complicated and costly in deep water reservoirs and in high pressure wells.

Integrated produced water management, planning and reservoir management

During discussion it was pointed out that:

1. when developing a new field there is a need for good planning regarding the challenges associated with produced water;
2. some expressed the view that there is a need to examine the impact of existing discharges before introducing new techniques, whilst other delegations stated that introducing new techniques is primarily guided by the development of BAT;
3. surveys and studies (impact assessments) should be carried out, where possible, on a regional basis and not undertaken on a "installation by installation" basis;
4. some stated that environmental standards should be based upon proven environmental impacts of E&P activities in the specific areas and not take into account different states' economic situation, whilst other delegations argued that such standards should take into account the economic situation of the countries;
5. integrated produced water management in order to minimise its possible negative effects on the environment would be based on the following prioritised listed strategies;
   - to eliminate discharges of produced water to the marine environment by e.g. preventing the production of water to surface;
   - to re-use water where possible, e.g. re-injection for pressure maintenance;
   - to minimise water production by e.g. subsurface disposal in non-usable zones;
   - to treat remaining production water;
6. integrated produced water management should take into account specific local conditions, safety in operations and engineering limitations. Integrated produced water management should also be based on the principles of Best Available Technology and the Precautionary Approach.

Conclusions

After further discussion, the Chairman concluded that:

1. there is, to date, no universal solution for the treatment of produced water. There is a need for further experience and information exchange on the use of different technologies associated with produced water;
2. integrated produced water management in order to minimise its possible negative effects on the environment would be based on the following prioritised listed strategies:
   - to eliminate discharges of produced water to the marine environment by e.g. to prevent the production of water to surface;
   - re-use water where possible e.g. re-injection for pressure maintenance;
   - minimise water production by e.g. subsurface disposal in non usable zones;
   - treat remaining production water;

3. Integrated produced water management would also require the minimisation of the use of hazardous chemical in the treatment process;
4. integrated produced water management should take into account specific local conditions, safety in operations and engineering limitations. Integrated produced water management should also be based on the principles of Best Available Technology and the Precautionary Approach.
5. integrated produced water management would also imply an optimal use of existing technology and resources which, i.a., require continuous training of personnel. Improvement of knowledge of the entire production process (from the reservoir characteristics on the one hand to the final discharge on the other) is an essential element in this respect;
6. as regards the use of different technologies, experience has shown that currently, there are basically two main options, namely re-injection and treatment. Re-injection is considered to be the most promising solution and is already applied in several areas with E&P activities. Re-injection is considered to be the best option for the protection of the environment. Re-injection should be considered especially at sites in areas of shallow waters or near ecological sensitive sites;
7. the industry should continuously seek to develop new technologies. One option is the use of down-hole separation methods. These methods require re-injection of water;
8. water shut-off technologies should also be considered to reduce the volumes of produced water to the surface;
9. novel technologies, such as microfiltration and membrane, have so far proven to be unsuitable in offshore operations; and
10. further improvement of environmental performance in E&P activities requires more knowledge about such activities' impact on the environment. There is therefore a need for environmental impact studies preferably on a regional basis. The outcome of such studies should be used as a basis for the planning and designing of new installations and the improvement of existing installations.

It was agreed that it was beyond the terms of reference of the expert meeting to discuss discharges standards.

4. E&P Chemicals Management

Scope

Exchange of methods and experiences with regard to the use of chemicals and the evaluation of the environmental impacts thereof. What are the principles for notification, selection and registration of E&P chemicals (e.g. CHARM, Chemical Use Plan requirements)? What are the factors to be assessed and what are the criteria?

Background information

The use of a wide range of different chemicals and additives is integral to drilling operations and the production of oil and gas. Chemicals are used in a wide range of applications including: as drilling mud additives, for pipework cementing and in completion and workover operations. The chemicals involved are jointly referred to as offshore E&P chemicals, and include corrosion inhibitors, scale inhibitors, biocides, oxygen scavengers, emulsifiers, anti-foamers, viscosifiers, cleaners and emulsion-breakers.

All these chemicals may be introduced into the environment after discharge of mud, mud contaminated cuttings, produced water or other process or activity related discharges. Marine biota may subsequently be adversely affected by exposure to these chemicals. The use of E&P chemicals should therefore be regarded as one of the activities in the offshore production of oil and gas that may lead to environmental impact.

The impacts of E&P chemicals may be reduced by choosing the least hazardous chemicals for a specific operation, as well as by implementing new operational practices which requires the use of fewer chemicals. For example, the use of corrosion inhibitors can be avoided by using stainless steel production tubing and flowlines. Similarly; the use of biocides and oxygen scavengers can be avoided by using a closed circulation produced water re-injection system. However, these options for “greener chemical management” should be carefully considered in the context of the actual environmental effects and the risk reduction that the management option provides in relation to actual applicability and cost-effectiveness.

It is also important to realise that the relative environmental benefits associated with the use a specific chemical are dependent upon the situation in which it is used.

Regulatory Framework

Increasing concern over the potential environmental impacts of E&P chemicals in the marine environment has led to the development of regulatory requirements in some jurisdictions and a number of different methodologies for the management of E&P chemicals. The use and discharge of E&P chemicals is regulated under the legislative framework of a number of regional agreements (e.g., Paris Convention 1974, Kuwait Convention 1978 and Barcelona Convention 1976) for contracting parties to develop chemical management strategies for offshore E&P activities (i.e., Chemical Use Plans). Furthermore, in some cases regional agreements (e.g., the Paris Convention 1974 and OSPAR 1992) call for the establishment of a framework for the identification of chemicals which, because of their potential environmental impacts, should be subject to strong regulatory control.

In some jurisdictions, Chemical Use Plans have become a legislative requirement and in response, a number of guidelines for the use and disposal of production chemicals have been published by governmental and non-governmental organisations.

Methodologies for the Management of E&P Chemicals

In the evaluation of the environmental impact of offshore E&P chemicals, use, release and toxicity predominantly determine the environmental impact as a function of the chemical intrinsic properties. The amount of chemical released is a function of the use, dosage and behaviour of a chemical in the process (‘process fate’). The environmental fate (e.g., biodegradation and partitioning into the sediment) of this released fraction determines the degree to which the biota in the ambient environment of the platform are exposured. So, the toxicity of the chemical, and the sensitivity of the ecosystem, ultimately determine the environmental impact of chemical use and discharge.

The above indicates that intrinsic chemical properties play a major role in determining the environmental impact of chemicals utilised as part of offshore E&P activities. The properties that have to be considered, therefore, usually include:

- biodegradation rates
- ecotoxicity
- partitioning parameters (e.g., P_{ow}, is used to indicate the extent to which compounds accumulate in biota and sediment)

Besides these intrinsic chemical parameters, it is important to consider the dosage required of the chemical under consideration. Relatively toxic chemical used in low volumes might be less hazardous than using high volume of a less toxic chemical.

Before going into an evaluation of the chemical product, it is important to screen the product and its individual constituents for the occurrence on a list of undesirable substances, sometimes referred to as a *black* or *grey list*. These lists have been drawn up to ban the use of chemicals that are considered extremely hazardous for the environment.

The screening and chemical selection process must take place against a backdrop of other issues, such as, the availability of alternative chemicals and the impact that these may have on both technical performance and operational safety. As such, these factors should also be considered when regulating the use of specific chemicals used in offshore E&P operations.

Recently, there has been increasing emphasis on the use of harmonised assessment methodologies for the management of E&P chemicals. In the OSPAR and ROPME regions this has lead to the subsequent development of the CHARM Model and ROPME Chemical Use Plan respectively. In the United States, however, legislation is not based upon evaluation of the individual chemicals, but instead considers total effluent toxicity (implemented in the NPDES Permit Program). These three approaches are discussed in the following paragraphs.

The CHARM Model

In order to assist in the selection of environmentally acceptable chemicals for use in the North Sea Region and in the development of appropriate legislation, an evaluation framework, “CHARM” (Chemical Hazard Assessment and Risk Management), has been developed. The development has taken place as a co-operative action between governments, operators and chemical suppliers within the North Sea countries. In accordance with European Union policy, CHARM is to be utilised, both by governments and operators, in the notification procedures for E&P chemicals.

The CHARM model is a tool, which is used to support the environmental evaluation of the use and discharge of E&P chemicals, on the basis of available data on these chemicals, and platform related conditions. The CHARM model performs standard calculations on the basis of the OSPAR Harmonised Offshore Chemical Notification Format (HOCNF). Since CHARM is a decision supporting model it generates information according to criteria which are defined by the user.

The CHARM model enables a step-by-step environmental evaluation of E&P chemicals by means of a successive pre-screening - hazard assessment - risk analysis - risk management process:

- The pre-screening step assesses a chemical’s hazardous properties that are not accounted for accurately in a PEC: PNEC analysis (i.e., long-term persistence and/or accumulation potential).
- The hazard assessment step is used to identify the potential of a substance (a chemical itself or a product thereof) to cause harm to the target groups exposed to it, on the basis of intrinsic properties of that chemical. The hazard, expressed in a general quotient of PEC:PNEC, is related to the "realistic worst case" (not including exceptional circumstances or accidents) conditions at a reference drilling oil or gas production platform. The hazard assessment is primarily meant for the ranking or classifying classification of chemicals.
- The risk analysis step is used to estimate the probability of the actual occurrence of harmful effects. This requires a more specific evaluation of the environmental impact from the discharge of a chemical or a combination of chemicals under actual conditions. Such a specific analysis enables risk management on the basis of various scenarios for environmental care options, in order to evaluate the cost-effectiveness of a measure.

One important limitation of the CHARM-model is that it can not adequately be used in the evaluation of surfactants, a group of chemicals that is well-represented in production chemicals. This limitation is due to the fact that the environmental fate of these substances does not follow the standard lipophilic chemical partitioning (P_{ow}), the parameter which plays the most important role in estimating the environmental partitioning of a chemical in standard environmental risk assessment methods.

The use of a suitable hazard assessment model for offshore E&P chemicals is mentioned in the OSPAR Harmonised Mandatory Control System (HMCS). The only such model which currently exists is the CHARM model. The implementation of CHARM is still hampered by the lack of practical users manuals for both the CHARM-model and the software in which the model is implemented; the CHARM-Wizard.

ROPME's Chemical Use Plan

The Regional Organisation for the Protection of the Marine Environment (ROPME), was established in 1979 to implement the Kuwait Action Plan (KAP), and the Kuwait Regional Convention and its protocols. In 1990, a protocol concerning offshore marine pollution from exploration and exploitation entered into force. One of the elements of this protocol is that each operator of an offshore installation draws up a “Chemical Use Plan”, in which an operator defines:

- the chemicals intended to be used in offshore operations
- the purpose(s) of the use of the chemical
- the maximum concentrations of the chemicals intended to be used in combination with any other substances, and maximum amounts intended to be used in any specific period
- the area within which the chemical may be released into the marine environment.

The Chemical Use Plan includes a comprehensive data sheet in which the above mentioned information is documented, along with intrinsic chemical properties such as biodegradation and toxicity.

The Competent State Authority has the power to prohibit, limit or regulate the use of a chemical or product, and to impose conditions on its use and storage. The authorities refer to the Guidelines on the Use and Storage of Chemicals in Offshore Operations, adopted by ROPME council in 1990. Some chemicals are exempt from notification and need not be included in the Chemical Use Plan. Approval for the use of other chemicals can be granted, provided that the Competent State Authority is notified at least 21 days before use of the chemical. The use of some listed chemical constituents are only approved under special circumstances.

This procedure has relieved ROPME Contracting States from the strict licensing of E&P chemicals. The lack of appropriate legislation, enforcement capacities, as well as economic considerations have, however, hindered proper implementation of the Guidelines regarding use and storage of E&P Chemicals. To overcome this, ROPME is preparing a list of “approved” chemicals to assist operators in their selection of chemicals for submission of the “Chemical Use Plan”.

The current program also includes the development of a centralised database with the environmental characteristics of E&P chemicals; and the adoption of a common procedure for the approval of Chemical Use Plans.

NPDES permit program

In the United States the NPDES (National Pollutant Discharge Elimination System) permit program is one of the centrepieces of the US Clean Water Act's (CWA) water pollution control programs. The permit program is focused on controlling pollutants determined to be harmful to receiving water, and on the sources of such pollutants.

The discharge limits imposed in a permit are arrived at by consideration of:

- *Technology based limits* - The effluent guidelines are intended to represent the greatest pollutant reductions that are economically achievable for an industry sector or portion of the industry. In the evaluation, the EPA considers many factors such as the age of equipment, processes employed, potential process changes, engineering aspects, the cost of achieving effluent reductions, cross-media impacts and any other factors relevant to decision making.
- *Water quality based limits* - The above mentioned technology based regulations are developed without consideration of site or regional specific environmental effects of discharges, and controls

may, therefore, not be sufficiently protective for the environment at that location. The procedures for setting water quality based limits take into account the designated use of the water body, existing pollution controls, the variability of the pollutant in the effluent, species sensitivity and dilution in the receiving water.

The permits require each facility to monitor chemical releases, and define the frequency for collecting waste water samples, the location for sample collection, the pollutants to be analysed and the laboratory procedures to be used in conducting the analysis.

The Coastal Subcategory (or ‘Offshore Subcategory’) of the CWA essentially includes all oil and gas facilities located off the U.S. coast. In general, the EPA regulates offshore oil and gas activities through multi-facility, regional NPDES permits (termed “general permits”).

Public reporting of chemical information

Chemical Release Inventories were developed in the 1990’s as a policy tool to control the discharge of chemicals to the environment. The importance of public accountability was highlighted at the United Nations Conference on Environment and Development in Rio in 1992. It was stressed that citizens in general have the “right to know” about potential releases of chemicals.

Besides the public in general, the reporting of data also has benefits for industry and governments. It is generally regarded as a means of ensuring information exchange concerning the use and discharge of E&P chemicals.

Currently in many countries chemical data are made available through discharge permit requirements, in which operators must supply the government and the public (through NGO’s) with information about the chemical properties, as well as information on the use and discharge characteristics.

WORKING SESSION REPORT

Chaired by Mr John A. Campbell (E&P Forum)

Key Note Presentation

Mr Henk Schobben (Ministry of Transport, Public Works and Water Management, North Sea Directorate, The Netherlands).
E&P Chemicals Management: Exchange of Methods and Experiences

Introductory Presentations

Dr. Henry Craddock (EOSCA, UK)
CHARM – A supply side view.

Dr. Hassan Mohammadi and Dr. Mahmood Y. Abdulraheem (ROPME, Kuwait).
Enforcement of the Chemical Use Plan in the ROPME region.

Mr Ronald Jordan (USA-EPA)
US Regulations relevant to E&P Chemical use on offshore oil and gas platforms.

Mr Mike Robson (Maersk, Denmark)
Operators selection of green chemicals.

Dr. Laurent K. Granier (University of Reading, UK).
Public reporting of the chemicals used in the offshore oil and gas industry in the UK.

Discussions

A discussion on the technical presentations took place, during which a number of issues relating to various aspects of E&P Chemicals Management were identified and discussed.

Although the topics planned for the working session. were not discussed in the order they appear below, in effect, the three topics were all tackled during the session.

- *What are the challenges and impediments of CHARM (OSPAR), Chemical Used Plan (ROPME) and the US Effluent toxicity assessment, in supporting the best environmental practice in E&P chemicals management? Do they lead to development and use of green chemicals?*
- *Is there a need for common provision of environmental data on E&P chemicals? If so, how should this be effected?*
- *Are chemicals always needed? Can the use of chemicals be avoided by using different techniques*?

Conclusions

The chairman concluded that E&P chemicals management is an integral part of the environmental management system as a whole.

It is clear that the technical aspects relating to the management of E&P chemicals are overlain by policy considerations, most notably the global acknowledgement of the precautionary approach. Furthermore, it was noted that the use of chemicals in E&P activities was unavoidable. Nevertheless, it made good sense, both from an environmental and from an economic perspective, to minimise or optimise the use of chemicals against production capability and safety. In this context, the development of 'greener' chemicals is a positive development.

The working session reviewed two approaches to management. These are based on:
- a chemical management approach (CHARM and ROPME);
- an effluent quality approach (US EPA).

On the former, there is a clear need for transparency and realism. Validation was seen as important and the working session was informed of difficulties in this area with the CHARM model.

The working session noted that biological testing of chemicals is expensive and discussed whether it was advisable to apply toxicological data on E&P chemicals from one geographical region in another region. It was recognised that biological responses would be broadly similar, but that it is essential to consider regional and local conditions (e.g. temperature, habitats and community structures) in making final decisions on chemicals' suitability.

Secondly, controlling the quality of effluents is another strategy to manage E&P chemicals; that strategy is less proactive than the chemical controls approach. Such an approach necessitates more detailed discharge monitoring strategies, the results of which can be fed back into the control process. Notably, concentrations, acute toxicity and, even more importantly, chronic toxicity, are crucial factors in this approach.

Common to both approaches are the recognition of the need for expert judgement and the development of control systems based on both hazard and risk assessments.

A critical factor for assessment of chemicals, whichever management process is adopted, is proper consideration of local and regional environmental conditions. It was also noted that lists of proscribed or approved chemicals cannot be ignored.

However, it was stated that further development of such lists needed clear criteria for the selection of substances. In this respect, the persistence of substances, or of their metabolites, was identified as an important factor.

Reporting and openness

It was recognised that environmental data should be made publicly available. For this reason, the published information should be understandable, and might even generate a positive feedback on the part of the public.

Transparency was considered to be one of the main criteria of the reporting systems, whether the information originates from companies or government departments, and whether the reports are for regulatory authorities, the general public or the NGO's, and that they could be consulted by them.

With regard to product composition, the question of confidentiality is a problem for some organisations, but is critical for the protection of chemical supply businesses. It was stated that in the exchange of information between manufacturers or suppliers and regulators, this question remains sensitive and prominent, especially if full disclosure of information is to be required.

Specific requests

The question was raised as to whether a workshop on the wider applicability of ecotoxicological data generated in a particular region might be useful.

5. Waste Management

Scope

Exchange of information, methods and experiences related to the collection, translocation and processing of waste (plastics and other debris, garbage, scale etc., excluding produced water and drilling wastes). What is feasible in prevention and reuse? What are the possibilities for onshore waste processing?

Background information

Offshore oil and gas exploration and production (E&P) activities result in the generation of a range of different waste types. Drilling waste (e.g., cuttings and drilling mud residuals) and production waste (e.g., produced water) have been discussed in Sections 3 and 4 and therefore will not be discussed here. This section focuses on the management of a wide variety of other waste streams including:

- **wastes associated with supplied materials:** packaging wastes including drums, wooden pallets, plastic containers, plastic foils
- **industrial waste:** leftovers of E&P chemicals and materials, scrap metal, sludges, scales, batteries, spent acids, spent lubricants, filters, etc.
- **domestic waste:** sanitary waste and rubbish
- **construction and maintenance wastes:** cement, grit, blasting and painting wastes
- **drainage water:** rainwater runoff, rig wash, process water

For a more detailed list of waste streams associated with E&P operations and potential waste management options see Appendix III.

Regulatory Framework

An international regulatory framework for the management of domestic wastes generated as part of offshore E&P activities is provided by Annex V of *MARPOL 73/78*, which prohibits the discharge of garbage close to land, and prohibits the discharge of plastics altogether. Food wastes, however, may be discharged, provided that the platform is located more than 12 nautical miles (n.m.) from the nearest land. In general, regional instruments (e.g., the *Kuwait Protocol 1989*) tend to be in accordance with these provisions. A global framework for the discharge of sewage is provided by Annex IV to *MARPOL 73/78*, although this is not yet in force. Amongst other provisions, the discharge of treated and untreated sewage are prohibited within 4 n.m. and 12 n.m. of the nearest land, respectively. In general, regional instruments (e.g., the *Kuwait Protocol 1989*) tend to be in accordance with these provisions.

Where regional agreements deal with the issue of sewage discharge from offshore installations (e.g., *Helsinki Convention 1974*; *Barcelona Protocol 1994*), the operational provisions prescribed tend to be in accordance with Annex IV of *MARPOL*. At national level in some jurisdictions, the chlorine concentration in discharged sanitary wastes is limited.

Waste Management and Disposal Strategies

The underlying principle of waste management is the need to prevent pollution. Waste management is most effective when incorporated into each operational stage and when a detailed, clear and responsible waste management plan is in place. This plan should be designed to take into account the characteristics of the receiving environment and the availability of facilities. In addition to the waste management guidelines mentioned in Appendix 1, the IMO is currently developing a Manual on Waste Management which is scheduled to be finalised at the 42nd session of IMO's Marine Environmental Protection Committee in November 1998.

Most waste management plans employ a hierarchical system of options which provide for waste minimisation (by reducing, re-using and recycling as much as possible) before treatment and disposal. Effective waste management is an ongoing process within which the waste management plan can be revised as new waste management practices, or technological options for reduction, reuse, recycling, recovery, treatment or responsible disposal are identified. Appendix III contains a table indicating which methods are applicable for specific waste streams.

Minimising Waste Volumes
The best approach to waste management is to firstly take appropriate measures to minimise the volume produced. Potential methods of doing this include:
- purchasing in bulk to reduce packaging wastes
- monitoring waste streams in order to avoid over-use of chemicals
- using good inventory management (e.g., to reduce the over-stocking of production chemicals)
- using efficient equipment and maintaining it in good working order
- training workers to take waste reductive measures
- re-use of chemical containers (possibly by returning them to suppliers) and other wastes
- using waste oil for energy production
- recycling of scrap metal
- installing effective waste separation and storage facilities

Treatment
After the waste volume has been minimised, the produced waste can often be treated in order to both further reduce its volume and minimise environmental impacts associated with its disposal. Several methods can be employed including:
- incineration
- filtration
- evaporation
- neutralisation
- composting
- chlorination
- biodegradation
- land-farming
- detoxification

The types of wastes that may be incinerated are limited under Annex V of *MARPOL 73/78*. Furthermore, when put into effect, the newly-adopted Annex VI of *MARPOL 73/78* will include provisions concerning the incineration of garbage using shipboard facilities.

The environmental effects of sewage can be reduced by treatment prior to discharge. Although there are several possible sewage treatment methods, the general trend is towards the use of chlorination. As an alternative, natural microbiological breakdown processes may be utilised. The volume of the organic material and the number of pathogens are reduced by up to 90% via this method.

Disposal
When the waste volumes have been reduced as much as is possible, methods of disposal suitable for the receiving environment should be identified. This should be done on the basis of waste categorisation, taking into account engineering limitations, regulatory restrictions, operating feasibility (including safety and health aspects), economics and long-term liabilities. Bearing in mind the limitations prescribed under *MARPOL 73/78* on the marine discharge of the waste streams listed above, disposal options are restricted to: shipping ashore for treatment and disposal or injection into the subsurface. Factors that must be considered in developing appropriate waste management plans include: the distance to shore and the availability of onshore facilities equipped to handle the specific waste streams, as well as technical and economic constraints on injection.

Several measures can be taken in order to avoid the discharge of sanitary wastewater into the environment. The effectiveness of these measures should be evaluated against the disadvantages with respect to the safety and health of the platform personnel and the potential side effects on the environment. For example, transport of sewage to land may be considered, but would involve storage at the platform and its removal from the platform by ships. Storage may give rise to health problems, while removal may cause unacceptable safety risks. Indeed, these risks may be greater than those associated with treatment and disposal on site.

Special care must be taken with respect to the safe handling of low activity scale (LAS) and sludges contaminated with naturally occurring radioactive material (NORM). Scale and sludge removal should be carried out under authorisation of a skilled radiation specialist, using protective clothing and radioactivity monitoring equipment. NORM contaminated waste should be disposed off according to standard procedures for radioactive waste treatment. Re-injection may be considered as a possible method of disposal. Indeed, the re-injection of NORM-contaminated waste has become standard practice in certain oil and gas producing regions of the US.

WORKING SESSION REPORT

Chaired by Mr. John Karau (London Convention)

Key Note Presentation

Mr. John A. Veil (Argonne National Laboratory, USA)
Management of Offshore Wastes in the United States

Introductory Presentations

Mr. Jørgen Magner (DEPA, Denmark)
Waste Processing on Offshore Platforms in Denmark

Mr. Chris Berry (Berry Marine Consultants, UK)
Environmental Best Practice and Waste Management in the Offshore Oil and Gas Sector – An Environmentalist Perspective

Ms. Alma L. Cedeno G. (Petroleos de Venezuela)
Waste Management at Offshore Oil Exploration and Production Activities in Venezuela

Mr. Wei Wen Pu (China Offshore Oil Company)
Waste Management at Offshore Oil Platforms in China

Discussions

What is feasible in the reduction, re-use, separation and recovery of waste materials produced by offshore installations?

During discussions, it was pointed out that:

1. some of the terms used in this question, e.g., re-use, can be interpreted differently and that common terminology would be beneficial;
2. a holistic assessment of waste management options that evaluates the positive and negative environmental effects of offshore and onshore disposal is desired;
3. the following waste management hierarchy should guide waste management:
   - minimise
   - reduce, recycle, and recover,
   - treat, and
   - dispose;
4. the goal of zero discharge to the marine environment has been accepted and promoted by some countries in the North Sea area. Nonetheless, the goal of zero discharge is not universally supported as being applicable on a universal basis;
5. in reviewing specific waste as shown in Appendix 3 of the Technical Background Document, it was noted that the waste streams found in column K of Appendix 3 may be considered for discharge at sea on a case-by-case basis using the waste management hierarchy for decision making. Those wastes not found in column K could be considered as more appropriately disposed of onshore.

What conditions and infrastructure are needed for the proper disposal and onshore processing of offshore wastes? What are the critical limitations of this option?

During discussions, it was pointed out that:

1. The second working session topic (see section 7.1.2) should be rephrased as "what are the critical challenges to establishing the required conditions and infrastructure to dispose and process offshore wastes on land". The term "challenges" was used since limitation may imply insurmountable barriers. Challenges identified include:
   - inadequate processing and recycling infrastructure on shore;
   - remote location; and
   - local communities not wishing to have waste processing or storage nearby;
2. in the consideration of transportation of waste from offshore to onshore facilities, the role of supply ships should be considered;
3. environmental impact assessment should consider the provision of waste management systems in evaluating a project.

How can special wastes (e.g., NORM, spent acids and hazardous chemical waste) be processed?

During discussions, it was pointed out that based on the available information and time, specific recommendations on special wastes are not possible. Nonetheless it was considered an extremely important topic for future information exchange.

Furthermore, there was a preliminary exchange of views related to NORM, particularly as it relates to the interpretation of the 1972 London Convention and the application of the waste management hierarchy to NORM. This served as an important example of the need for greater exchange of information and views on the appropriate waste management approaches and options.

What are the critical factors in the implementation of a waste management plan ("good house-keeping practices") for offshore E&P activities?

During discussions, it was pointed out that:

1. developing and implementing a waste management plan are two complementary activities;
2. a first step is an inventory (or audit or characterisation) of waste produced for which guidance is currently available;
3. secondly, it was suggested to establish waste targets;
4. waste management targets and the waste management hierarchy are viewed as important waste management tools;
5. in addition, the importance and value of monitoring compliance with targets and with national goals should be acknowledged;
6. the relationship between waste management and EMS should be considered. In addition, a number of participants desired the consideration of international guidelines. However, no consensus was reached.

What are the critical factors in the implementation of a waste management plan ("good house-keeping practices") for offshore E&P activities? What is the relationship between waste management and EMS?

The waste management hierarchy should be linked to EMS and to other waste streams (e.g., production wastes and drilling wastes). With respect to guidance, the waste management hierarchy should be incorporated within the EMS.

Is there a role for general international guidelines for waste management within the E&P Industry?

During discussions, it was pointed out that:

1. international guidelines do not have to be prescriptive, but can rather provide general guidance regarding the role of the waste management hierarchy;
2. guidelines developed by a number of governments and by industry associations currently exist;
3. guidelines were also viewed by some as inhibitors of innovation since they can foster a compliance attitude;
4. opportunities for harmonisation are probably best achieved at the regional level.

Conclusions

After further discussion, the Chairman concluded that:

1. to minimise environmental impact and take into account the precautionary principle, it is important to implement the following hierarchy of waste management which implies an order of increasing environmental impact:
   - reduction
   - re-use
   - recovery
   - disposal
2. Waste minimisation includes, but is not limited to, zero discharge.
3. a lack of adequate infrastructure is likely to present a challenge to the processing of wastes. There is industry responsibility for appropriate waste management as well as the associated regulatory role to facilitate the establishment of appropriate onshore infrastructure.
4. waste management implementation should be based on a comprehensive waste inventory, the establishment of targets, and a schedule for implementation. The waste hierarchy can be used to plan how to achieve targets.
5. an assessment on the applicability and us of existing international guidance should be thoroughly investigated as part of the future consideration of information exchange and review of guidance for waste management.

6. Environmental Management Systems

Scope

Exchange of information, methods and experiences in the development and application of Environmental Management Systems (EMS) in offshore oil and gas industries. The implementation of "management system standards" (e.g., ISO 14000 etc.) in practice. What are the priorities and impediments? What are the responsibilities of industries and governmental authorities? Should environmental management be integrated with safety and health management?

Background information

Traditionally governmental authorities have attempted to regulate E&P activities through prescriptive measures. However, recent years have witnessed an increased emphasis on self-regulation and non-regulatory, voluntary environmental policy instruments to achieve stated environmental objectives. These voluntary instruments have been designed as a means of complementing or replacing traditional command and control legislative approaches. In this context, growing attention is being given to environmental protection systems *within* companies, principally through the development of Environmental Management Systems (EMS) and, more recently, through the development of integrated health, safety and environment management systems (HSE-MS).

The evolution of the EMS concept has been rapid and has its origins in the Quality System principles of ISO 9000-standard series. The concept was given a boost by the report from the Cullen Inquiry into the 1988 Piper Alpha disaster, published in 1990, which recommended the application of the Safety Management System (SMS) concept. Since then EMS, SMS and, increasingly, integrated HSE-MS have been promoted by a number of industry organisations and trade associations. Most of the major oil and gas companies have started to adopt detailed EMS and/or HSE-MS and internal environmental operating guidelines. An important driving force for the implementation of an EMS is the recognition that good environmental practices and economic progress go hand in hand.

Purpose and Scope

An EMS is a voluntary, self-regulatory instrument used by companies in order to ensure that their environmental objectives are reached by integrating them into the overall management system. This integration ensures that environmental concerns are taken into account when business decisions are made. An EMS also provides a structured process for the continual improvement in environmental performance, the rate and extent of which is determined by the company in light of economic, regulatory and other considerations. In this way an EMS can lead to a practical and feasible environmental protection strategy.

An EMS not only sets out procedural rules for internal use by the company concerned; it can also be used as a means of communication with stakeholders and as a performance indicator. More specifically, EMSs are used by industry to steer and optimise their environmental management and monitor the results, while allowing government and other stakeholders (including employees, shareholders, financial institutions, business partners, customers, regulators, environmental groups and the general public) to evaluate and/or control the environmental performance of companies.

Elements of an EMS

The essential premise of an EMS/HSE-MS is that leadership and commitment is needed both from the top down and from the bottom up. This means that environmental protection is based on the involvement, motivation, competence and education of all employees within a company.

While there are many approaches to management that a company can choose to follow, there are a number of common elements in these systems. The most important of these include the following:

- Leadership and commitment
- Policy and strategic objectives
- Evaluation and risk management
- Organisation, resources and documentation
- Planning
- Implementation and monitoring
- Auditing

- Review and management assessment

EMSs are intended to be part of Total Quality Management as an integral part of the business. The aim is to integrate environment with safety and health aspects in the whole management life cycle, as described by Deming (plan-do-check-act), on the same scale as financial, personnel and other management aspects. The critical elements needed to ensure the maximum effectiveness and benefit of such management systems are:

- Implementation
- Effective communication internally and externally
- Integration into the overall business management systems
- Linkage with contractors.

Overall, an EMS should include the objectives of the operator regarding, for example, emission reduction, energy savings, noise, odour, dust, and physical impacts, as well as information on how those objectives are to be met. Likewise, they should include performance standards to be met, and plans for monitoring these. The emphasis, in other words, is on performance.

Guidelines

In recent years there has been a trend towards combining health, safety and environmental protection into one management system, because of similarity in objectives and measures. There have also been a number of guidelines written to assist in the development of a EMS/HSE-MS. Two of these guidelines which are of direct relevance to offshore E&P operations, and which are described in further detail below, include the Minerals Management Service (MMS)/American Petroleum Institute (API) *Safety and Environmental Management Program (SEMP)* of 1993, the E&P Forum *Guidelines for the Development and Application of Health, Safety and Environmental Management Systems* of 1994.

The IMO's International Safety Management Code, which is applicable to vessel operations, also addresses health and safety management and environmental protection in a single management structure.

SEMP

The MMS/API SEMP initiative resulted in the publication in 1993 of API RP 75 – *Recommended Practice for Development of a Safety and Environmental Management Program for Outer Continental Shelf (OCS) Operation and Facilities*. It is important to emphasise that SEMP is not a regulatory regime. Rather it is a management programme designed to promote a mentality which recognises safety and environmental issues, instead of a compliance mentality. Its intent is to assist in the development of a management programme designed to promote safety and environmental protection during oil, gas and sulphur operations on the outer continental shelf. As such it addresses the identification and management of safety and environmental hazards in design, construction, start-up, operation, inspection and maintenance of new, existing, or modified drilling and production facilities.

E&P Forum Guidelines

At international level, the E&P Forum's HSE-MS (Health, Safety and Environmental-Management System) guidelines, published in 1994, deserve special attention. They represent an attempt to provide a template for companies and contractors and to set out the HSE-MS as a management cycle (see figure below). The key elements of this model and the issues it addresses are as follows:

- ***Leadership and commitment***: top-down commitment and company culture.
- ***Policy and strategic objectives***: corporate intentions, principles of actions and aspirations, compliance with legislation (including goal-setting with authorities).
- ***Organisation, resources and documentation***: organisation of people, resources and sound documentation.
- ***Evaluation and risk management***: identification of HSE risks for activities, products and services, and development of risk reduction measures. EIA (see chapter 5) is an adequate tool.
- ***Planning***: planning of environmental practices; changes in processes, activities, products or services; and emergency response.
- ***Implementation and monitoring***: monitoring of the performance and evaluation whether corrective actions were effective.

- ***Auditing and reviewing***: periodic assessment of the EMS performance and effectiveness by external and internal audits, including senior management review of fundamental suitability (policy and strategy) and governmental inspection.

In addition to the 1994 HSE-MS guidelines, E&P Forum has recently published a review of EMS with UNEP. The E&P Forum/UNEP guidelines aim to assist companies in fully integrating environmental protection in the regulatory and business processes that control the exploration and production of oil and gas. To this end, the document provides an overview of the environmental issues and the technical and management approaches to achieving high environmental protection performance in E&P activities.

Implementation

Organisations of all kinds are increasingly becoming concerned with the impact of their activities, products or services on the environment and are, therefore, implementing environmental policies in order to achieve and demonstrate sound environmental performance. They do so in the context of increasingly stringent legislation, the development of economic incentives and other measures to foster environmental protection, and a general increase in the concern of interested parties for environmental and sustainable development matters.

Many organisations have undertaken environmental reviews or audits to assess their environmental performance. On their own, however, these reviews and audits may not be sufficient to provide an organisation with the assurance that its performance meets, and will continue to meet, its legal and policy requirements. To be effective, audits need to be conducted within a structured management system and integrated into the overall management. To this end, a number of standards have been adopted in recent years that specify the minimum requirements of such an EMS. These standards have been written for all types and sizes of organisations and to accommodate diverse geographical, cultural and social conditions. The two schemes which are most relevant to international E&P operations are the European Union's Environmental Management and Audit Scheme (EMAS) at regional level and the International Standard Organisation's (ISO) 14000 Series of Management Standards at international level. The ISO 14001 EMS, in particular, provides the framework and requirements for companies to be ISO certified.

Note: The ISO 14000 series of Management Standards include Auditing Guidelines (ISO 14010-12), Environmental Performance Evaluation Guidelines (ISO 140031), Environment System Standards (ISO 14004), Life Cycle Assessment (ISO 14040-42), Labelling (ISO 14020, 14021, 14025).

With the entry into force of the EU's EMAS Regulation in April 1995 and the adoption in September 1996 of the ISO 14001 EMS Standard, interest in EMS certification is set to grow considerably around the world. According to a recent survey, the current number of certifications is only the tip of the iceberg, showing perhaps fewer than 10% of all companies currently actively working towards certification. The recent surge in ISO 9000 certification is indicative of a global interest in internationally recognised "badges of approval", with EMAS and potentially ISO 14001 benefiting from this development. At the time of writing, some 2300 ISO 14001 EMS certificates had been issued world-wide, with Germany, Japan, The Netherlands and the United Kingdom accounting for more than half of the total.

EMS certification is becoming an accepted requirement in most business sectors. A growing number of European, Asian and Latin American companies and countries are, in fact, taking the lead with regard to ISO 14000 certification. In the Far East, countries such as Indonesia, Japan, Korea, Malaysia, Singapore and Taiwan are implementing national EMSs based on ISO 14001. Similarly, China regards the new ISO standards as an opportunity to improve environmental performance of its companies. In Latin America, interest in EMS standards is increasing, the most active countries being Mexico, Brazil, Argentina, Chile, Colombia and Venezuela all of which have national delegations participating in ISO's Technical Committee (TC) 207. The most important factor driving ISO 14000 in Asia and Latin America is the fact that companies are coming under increasing pressure to comply with strict international environmental standards in order to sell their goods and services abroad. A key driving force in the Far East is a fear that the lack of EMSs may become a barrier to trade in the European market.

WORKING SESSION REPORT

Chaired by Mr. Alan Simcock (OSPAR)

Key Note Presentation

Mr. Geraldo Koeler (Petrobas, Brazil)
Environment and Business: An Integrated Vision

Introductory Presentations

Dr. Fritz Balkau (UNEP-IE)
EMS in Offshore Exploration and Production, a UNEP View

Terry L. Thoem (E&P Forum, Conoco, USA)
Development and Implementation of HSE Management Systems

Mr. Leopoldo R. Henriquez (State Supervision of Mines, The Netherlands)
The Evaluation of Environmental Management Systems Implemented by the Dutch E&P Industry

Mr. Edison D.R. Carvalho (GAIA, Brazil)
Environmental Education Program – A Support to Health, Safety and Environmental Management System

Discussions

The discussion considered the following topics from the Technical Background Document. The following points were made:

Should ISO 14001 be seen as a threat or as an opportunity?

ISO 14000 was considered to be not a threat, but an opportunity to be used as a tool. It is certainly not the only solution, but it is a good example of a modern, comprehensive approach. Further, it was felt that the implementation of ISO 14000 could be improved. The emphasis should be placed on establishing an effective management system within which environment is addressed.

How can EMS effectively be combined with Health and Safety Management Systems?

EMS can be combined or addressed separately depending on the company in question, operating conditions, and regulatory requirements.

What is the experience to date with EMSs? Are they as effective as expected? How can they be improved?

It is premature to determine whether EMSs have been as effective as expected. Nonetheless, preliminary results in the E&P industry are positive. In addition, EMS is considered to hold much promise, especially since it has been successful in other industrial sectors. Further, Safety MSs in the offshore oil and gas industry have produced very positive results. There is, therefore, optimism that similar results can be achieved for EMSs. EMS has had positive benefits, including:

- allows for clearer accountability;
- reduces compliance culture;
- increases internal ownership;
- improves profits;
- permits regulators to address non-compliance at all levels within a company;
- is a source of pride for company and its workers;
- provides some level of assurance to regulators through external audit; and

- raises the profile of environmental management within companies using HSE.

To date, no clear proof of substantial improvement in environmental performance has been observed as a result of the new generation of EMS. There are, as well, instances where EMS has been developed within a company, but not transferred to the shop floor. Implementation is still being developed. A key shortfall in implementation is the development of agreed ways of measuring certain performance indicators.

A regulatory framework can be cumbersome, requiring companies to follow unnecessary or irrelevant bureaucratic procedures. Because EMS is internal to a company, such bureaucratic procedures can be avoided while achieving similar objectives.

EMS and regulations can be useful at different points in the evolution of an industry. Regulations may be more appropriate as an industry emerges but, as it matures, EMS can play an increasingly important role.

It was also pointed out that there are many similarities between EMS and traditional command and control approaches: both have the goal of minimising adverse environmental impact. A difference is that traditional approaches have included equipment specifications while EMS permits companies to achieve results using technology and approaches determined by the company itself. A second difference under EMS is that hardware inspection is partially replaced by the companies themselves providing evidence to regulators that they are meeting objectives and achieving compliance.

EMS should be developed in light of hazards and then plans should be developed to address these hazards. Hazards are often identified during the environmental assessment (EA) process and EA can, therefore, be an important input into EMS at the project level. The use of EA to develop EMS can play a valuable role in integrating public and local issues.

Targets should be set in light of past performance of a company. This can be done easily within companies. However, due to limited information on environmental conditions and a lack of agreed upon performance targets, it is currently difficult to set targets across the industry.

Does the implementation of an EMS contribute to the reassurance of the public and NGOs that the E&P industry is applying environmentally responsible practices?

EMS may contribute to the reassurance of the public and NGOs but further progress on reporting of concrete positive gains is required.
What is the government experience with companies that have implemented EMSs? How do governments respond to companies that have implemented an EMS (are there any effects on licensing or monitoring activities)?

The development of an EMS by a company may be a positive factor in obtaining licenses and may simplify governmental monitoring and auditing activities. Nonetheless, it was pointed out that not all EMSs are equal and that, while certification aims as a minimum at compliance with existing legal requirements, it does not guarantee such compliance. Regulatory bodies must remain vigilant.

Further questions

The discussion also included the following questions as a basis for moving towards conclusions:

- How should EMS relate to the regulatory framework?
- What is the role of ISO 14000?
- How should EMS and SHMS relate?
- How should EMS be developed for the company, regulators, the broader community?
- What EMS targets should be set?
- How should EMS target-setting relate to the company, regulators, and the broader community?
- How to check EMS performance for the company, regulators, and the broader community?

Conclusions

Relation between Environmental Management Systems and the rest of management

- The overall aim of operators in managing offshore oil and gas activities that can have an environmental impact should be threefold:

– to meet the requirements imposed by the regulatory system(s) under which they operate;
– to achieve control of all known environmental risk through the application of due diligence; and
– to improve continuously their environmental performance.

- The way in which the operators manage their environmental performance will inevitably be part of their overall management system. It will be a matter of local convenience, practice and regulatory requirement how far it is necessary or desirable to provide a separate description of an environmental management system, a description of a combined health, safety and environmental management system, or a description of some other combination of the environmental and other aspects of the management system. The important point is that the management of environmental impact should be acknowledged as an important element of overall management. References in what follows to an "Environmental Management System" are references to this element when organised systematically and properly integrated with other management systems. This must include the Deming cycle of Plan-Do-Check-Improve in a way that meets best available modern management practice. Separate statements on Environmental Management Systems should not result in the divorce of this element from the rest by demands for separate management systems.

Relation between Environmental Management Systems and regulation

- Operators should aim to develop their own Environmental Management Systems which can be recognised by the competent regulatory agencies ("the regulators") as being well designed, properly organised and financially-supported, and effectively implemented for the purpose of promoting good environmental performance. When the regulators can accept such Environmental Management Systems, beneficial developments in regulatory practices are possible. The emphasis in regulation can move from prescriptive measures towards setting the standards and leaving the choice of means to the operators. In addition, the emphasis on enforcement can move from inspecting regulatory compliance towards evaluating the operators' proofs that they have performed to the standards to which they have committed themselves. These proofs are an essential part of the "contract" between operators and the public, represented by the regulators, under which the operators' concessions are worked. The Environmental Management Systems can thus complement the essential core of regulatory work.
- However, transparency continues to be required on the questions of the standards which must be delivered, the levels of performance to which the operators are committed and the evaluation of whether those standards and performance levels have been achieved. Without this, there will not be public confidence in the effectiveness of the regulatory system or the performance of the companies

The role of ISO 14000

- Deciding whether an operator's Environmental Management System reaches such a level of acceptability is an important question for regulators. The ISO 14000 series can offer a useful approach for an operator in developing an acceptable Environmental Management System, but regulators cannot, at least for the time being, regard certification as being sufficient proof that such a level of acceptability has been achieved. This International Expert Meeting could usefully encourage the International Standards Organisation to explore ways of assuring trust in ISO 14000 certificates.
- Other similar schemes, such as EMAS and ISO 9000, can play a similar role.

The development of an Environmental Management System

- An operator's overall Environment Management System will be made up of many components: these will range from what is relevant to day-to-day operations on the deck of offshore installations to those relating to the highest level of management within the company. For companies operating in a number of locations, there will need to be a common framework, within which components will be tailored to meet local requirements and outlook. The overall Environment Management System will therefore need to be developed in relation to a large number of different audiences. Within the company, the corporate level, the operating unit and the site/activity level will all need their own, but linked, EMSs. Within these systems, the different levels of management and the operatives will all have their own distinct environmental responsibilities. The involvement of all sections and all levels of the company will be an important step towards making the management of environmental impacts a part of everyone's task and not a function confined to the "Environment Department". Outside the company, it will be necessary to consider the company's suppliers and contractors, its regulators, its other stakeholders and the various sectors of the general public with which it interacts.

- Companies should develop their own EMS themselves since this will generate a much higher degree of involvement and consistency with the rest of their management system. The development process, and the subsequent regular reviews, bring important dividends themselves.

- Operators should be prepared to accept responsibility for the environmental performance of their suppliers and contractors. Regulators are entitled to look to an operator to organise all aspects of managing the environmental impact of the activities, and cannot be expected to deal separately with those brought in by operators for their convenience. At the same time, operators need to be prepared to help small and medium-sized enterprises establish their own adequate Environmental Management Systems in order to contribute efficiently to the overall management of environmental impact.
- The Guidelines for the Development and Application of Health, Safety and Environmental Management Systems, produced by the E & P Forum in 1994, are a valuable tool in this field. The E & P Forum should undertake a campaign to promote their use and the understanding that regulators have of these guidelines. Such a campaign should have a focus at the regional level. The Guidelines could usefully be extended to include material on the appropriate extent to which, and effective ways in which, to involve sectors of the general public in this work.

The role of target-setting

- The effectiveness of Environmental Management Systems will depend crucially on establishing a clear set of links between policies, objective, targets and indicators, so that the translation of the one into the other can be followed and checked. In this chain, targets for improving environmental performance over and above the minimum regulatory standards are the most important. These targets can be set in a number of ways: in terms of the ambient environment (very difficult in view of the other significant influences on the ambient environment), of environmental performance, of emissions, discharges, losses and wastes, of the effort expended, the inputs made or the activities undertaken, or of the levels of compliance achieved. The targets at the site/activity level will largely flow from Environmental Impact Assessment - which should not be regarded as a one-time activity undertaken before the start of a project, but as an iterative process forming an essential part of the Environmental Management System.
- As with the Environment Management System itself, the setting of targets needs to involve all sections and all levels within the company, the regulators, and relevant stakeholders and sectors of the general public. Again, the E & P Forum's Guidelines could usefully give guidance on this. Different timeframes should be considered as appropriate since, for example, what is a sensible target for the medium term (5 - 10 years) is unlikely to be feasible for the short term.

Assessing performance against targets

- To reassure the public that the offshore oil and gas industry is applying environmentally responsible practices, it is essential that there is an evaluation of the implementation of Environmental Management Systems - in particular, performance against targets. In the first instance, this is a task for the industry itself as part of its work of proving that it is delivering its part of the "contract".
- While companies are increasingly reporting on their individual environmental performances, there is a need to develop a mechanism for reporting on the collective impact of companies in a region. The E & P Forum should be invited to develop an initiative for this purpose. However, assessing the combined effect of all sources of environmental impact on the quality status of the ambient marine environment of a region remains the responsibility of governments and regional seas programmes and conventions.

- Four tasks are involved in assessing performance against targets, both for individual operators and collectively for all the operators active in a region:
  - identifying the indicators which can be used for this purpose, and establishing mechanisms for data collection on a consistent basis (the existing work of the E & P Forum in collecting data on safety indicators could be a useful model for this process); these indicators could also include information on factors (such as levels of training, response speed following environmental audit comments, and number of compliance failures) where poor performance is likely to lead to unacceptable environmental performance ("leading indicators");
  - developing regional reporting formats for companies; this should be done as far as possible in consultation with the existing regional seas organisations;
  - the assessment of the information collected on targets and the corresponding indicators and their publication; and
  - setting targets which go beyond the minimum standards required; such targets must be set in relation to the performance measured by the indicators at (a), thus completing the cycle.
- The sequence in which these four tasks are tackled may vary from case to case. Governments and operators need to determine how the tasks are to be carried out, how responsibility for them should be divided (task (c), for example, would appropriately be done by the regulator), and how other stakeholders should be involved.

7. Environmental Impact Assessment

Scope

Exchange of information methods and experiences in the scoping of Environmental Impact Assessment (EIA) reports concerning exploration and production in perspective of specific, ecological values (i.e., erosion of coastal ecosystems, such as mangroves, sea grass fields and coral reefs). How to assess the impacts of activities and effluents? How to address risks due to potential incidents and subsidence?
How to include social impact assessment concerning coastline urbanisation? What are the criteria for reviewing EIAs?

Background information

The ultimate objective of an EIA is to identify and predict for the public stakeholders any potential environmental, socio-economic, or human health effects which may result from the planned activity before they occur, and to identify or develop suitable preventative or mitigative measures to eliminate or reduce the undesirable effects. In many jurisdictions, EIA or similar studies have become an important tool for integrating environmental and social considerations into the planning and authorisation of new development projects. Minimising environmental impacts is an iterative process considering various project design and operation alternatives.

It has become widely accepted that an EIA is to:

- help ensure that all environmental and social concerns are addressed early on in the planning process, decreasing, in a cost effective way, the chance that expensive plan modifications will be needed at a later stage;
- improve decision making and planning
- improve future assessments and practises
- improve the public acceptance of the operation by developing confidence and partnership among the various stakeholders and interested parties
- improve company credibility
- help align expectations and reduce conflict

In addition, environmental protection is increasingly becoming an essential criterion for decisions concerning funding of international development projects (e.g., World Bank and Asian Development Bank funded projects). To this end, EIA provides a means of systematically addressing environmental and socio-economic concerns.

In the context of offshore E&P operations, EIA is increasingly used by the competent authorities to help ensure that operations comply with national environmental policies and standards. Operators use the EIA in an iterative process of designing planned activities, while taking into account the necessary environmental requirements.

Although the process of EIA can be applied at many levels of the development of an offshore field, it is usually only applied when considering individual projects. This means that the actions and decisions made at earlier stages of the development process fall outside the scope of the EIA. In order to address these limitations, some countries (e.g., USA, The Netherlands and Norway) and the Worldbank now require that the EIA process be applied at the policy, plan, or programme levels, in the form of a Strategic Environmental Assessment (SEA). In contrast to EIA applied only at the project level, it is possible for SEA to:

- encourage the consideration of environmental protection objectives during policy, plan and programme-making activities
- facilitate consultation between authorities on, and enhance public involvement in, the evaluation of environmental aspects of policy, plan and programme formulation
- allow formulation of standard or generic mitigation measures for later projects
- encourage consideration of alternatives to the development
- direct the development away from environmentally sensitive areas
- consider the cumulative effects of several projects

It is important that an EIA contain an integral environmental and socio-economic review of various E&P activities (seismic, exploratory drilling, production drilling, construction, production, maintenance and decommissioning). This helps to define the environmental production optimum of oil and gas from a certain field under acceptable circumstances for other stakeholders. The EIA should be an integrated part of the Environmental Management System(EMS).

Regulatory Framework

At international level, a regulatory framework for EIAs and environmental monitoring is provided by the United Nations Convention on the Law of the Sea (UNCLOS). Specifically, Article 206 requires that when States have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial changes to the marine environment, they shall asses the potential effects of such activities on the marine environment. Article 204 calls for States to monitor the risks or effects of pollution of the marine environment.

At regional level, more specific provisions are contained within, firstly, the Espoo Convention 1991, although this instrument is not, as yet, in force. In certain areas of the world (e.g., the Mediterranean and the Persian Gulf) regional conventions and their implementing protocols (e.g., *the Mediterranean Seabed "Barcelona" Protocol 1994* and the *Kuwait Protocol 1989*) call for contracting parties to implement EIA requirements pertaining to offshore production activities. In addition, the EC has recently issued a new directive 97/11/EC (an amendment of 85/337/EC) concerning the requirements of an EIA for proposed projects including production of oil and gas.

At national level, provisions concerning EIAs are typically an integral component of framework environmental legislation and it is not uncommon for an EIA to be mandatory prior to commencing production activities. In some jurisdictions, an EIA may also be required prior to commencing exploration drilling with baseline environmental surveys being conducted prior to prospecting activities (e.g., seismic surveys). Commonly, the competent authorities publish EIA guidelines. In some countries, specific guidelines have been developed for the assessment of the impact of E&P operations.

Even in countries where EIAs are not statutory requirements, operators commonly carry out such studies prior to commencing E&P activities. In the absence of national EIA guidelines, reference can be made to guidelines published by non-governmental organisations (e.g., E&P Forum, IUCN, ARPEL) and funding organisations (e.g., World Bank).

Scope of an EIA

In order for an EIA to be comprehensive and effective it must:

- be made early on in the planning process
- provide a description of the operation
- make use of all available relevant data
- identify and assess the potential harmful effects to the environment and socio-economic impacts for each step of the operation
- describe likely effects and provide alternatives, in an iterative manner
- provide opportunities for public consultation and encourage communication between the public and operator

A comparative review of EIA guidelines indicates that, typically, an EIA is comprised of the following basic components:

- information relating to baseline environmental conditions (environmental profile)
- a definition of the project
- estimation of the type and quantity of expected residues and emission
- identification of the hazards and their potential impacts, by means of risk assessment
- the description of methods used to asses effects
- identification of the biota and area of impact
- justification for the work plan proposed with direct consideration of alternatives
- specification of preventative/mitigation measures and contingency planning, along with justification for their selection, in an iterative manner
- environmental monitoring plans

An EIA should also lead to the development of an overall environmental management system plan (actually EIA is an essential part of an EMS). Increasingly, social impacts (e.g., impacts on population, economic conditions, employment, cultural values, quality of life, social structures and resources) are being assessed in such studies. This requires consultation in order to identify interested parties and their issues, concerns, needs, ideas and values as well as mutual interests in and potential conflicts with the objectives of the company. This could also lead to an additional social management plan.

The geographical area considered in an EIA may vary according to the nature of the proposed project. For example, a distinction may be made between a project specific EIA (e.g., well operation) as opposed to a regional EIA (e.g., offshore oil and gas field development activities, regional assessment of a marine area, etc.). For the most part, the global impact of a proposed project (e.g., contribution to global warming) is not considered explicitly within the scope of an EIA. A point for discussion is, to what extent wider local or regional impacts (such as those listed below) should be considered for inclusion in the EIA:

- E&P activities relating to the development of a new oil and/or gas field may lead to changes in the local coastal zone areas. These changes may lead to coastline urbanisation which often replaces traditional economic activities (e.g., fisheries)
- The establishment of production infrastructure (e.g., terminals, installations, pipelines and access ports) may have an impact on the adjacent onshore area. Associated impacts, for example, might include localised deforestation and the ingress of local people into previously uninhabited/inaccessible areas via communication links established as part of the proposed project.
- Offshore activities can, in this respect, also compete with and/or contribute to tourist resort development along the coastlines.
- Another social issue to consider for inclusion in an EIA is the inevitable decline in economic activities when adjacent oil or gas fields are depleted and the effect this decline will have on the local community.

WORKING SESSION REPORT

Chaired by Mr Geraldo Koeler (Petrobras, Brazil)

Key Note Presentation

Dr. Siân Pullen (WWF, UK)
The Role of Strategic Environmental Assessment And Environmental Impact Assessments in the Licensing of Offshore Oil & Gas Exploration.

Introductory Talks

Mr. Thomas L. Laughlin (NOAA, USA)
Arctic Offshore Oil & Gas Guidelines: Environmental Impact Assessment Provisions Background

Ms Jean Bruney (E&P Forum, Exxon, USA)
Industry Recognition of the Importance of Social Issues in Impact Assessment.

Mr. Mike W. Covil (IAGC, UK)
The Impact of Environmental Aspects on the Planning of Marine Seismic Operations

Dr. Martin Abraham (ERM, Malaysia)
Some Critical Issues and Initiatives of Concern to the Application of EIAs in the Asian Region

Ms. Svetlana G. Goloubeva (Russian Federation State Committee on Environmental Protection)
Environmental Impact Assessment Procedure in the Russian Federation: National and International Aspects

Discussions

General
It was felt that it was necessary to have a definition of Environmental Impact Assessment (EIA). After discussion, the Chairman concluded that the following definition could be used:

EIA is defined as “ a systematic process that examines the environmental and socio-economic consequences of development actions in advance of development”.

What should be the scope and role of EIA (or similar studies) in the management of the entire E&P lifecycle (from seismic exploration to abandonment)?

In discussion of the scope of EIA the following issues were, *inter alia*, mentioned:

1. EIA is a 'living tool' which addresses all steps, including impact assessment, mitigation, monitoring and implementation;
2. EIA is not only a procedural tool, but aims at meaningfully protecting socio-economic and environmental consequences;
3. EIA is applicable to all development stages, but its size and scope will depend on elements such as the receiving environment, anticipated impacts, experience and familiarity with operations in the environment;
4. the scope of EIA should include considerations of cumulative effects upon the receiving environment;
5. an EIA should be focused on integrated approach instead of separate phases of activities;
6. the EIA should be one of the tools leading to the development of Environmental Management Systems, and should be part of the decision making process;
7. EIA should include an assessment of the impact of emergency actions;
8. compliance monitoring forms an essential part of an EIA.

What should be the scope of impact assessment in an EIA regarding offshore activities: Should regional considerations be taken into account? What degree of detail is needed in the baseline survey?

During discussions it was pointed out that:

1. baseline data should be appropriate for the purpose of determining whether predicted impacts occur and whether there are unforeseen impacts, associated with the proposed project;
2. the quantity and quality of data should be "fit for purpose" as regards the determination of the baseline;
3. regional considerations represent an important part of EIAs regarding offshore activities;
4. it is within the scope of EIAs to consider the impact of offshore activities on the environment and vice versa.

When is it necessary to include an assessment of the socio-economic impacts of onshore developments, related to offshore activities, in an EIA?

During discussions it was pointed out that:

1. socio-economic assessment (as well as an environmental assessment) should cover at all stages of exploration and development;
2. the extent of the assessment should reflect the extent of the potential impacts

How can local expertise be used, and stakeholders be consulted in the process of developing an EIA?

During discussions it was pointed out that:

1. much of the relevant information for developing an EIA could be made available from local sources;
2. in facilitating information exchange, training and capacity building for all interested parties, the establishment of a "Clearing House" could play an important role;
3. in keeping with Principle 10 of the Rio Declaration, local knowledge and experience should be considered;
4. working within the social and cultural context would enhance the transparency of this process;
5. dialogues, public hearings and education for all interested parties, were pointed out as valuable tools in the consultation process.

Conclusions

What should be the scope and role of EIA (or similar studies) in the management of the entire E&P lifecycle (from seismic exploration to abandonment)?

After discussion, the Chairman concluded that the scope of EIA in the management of the entire E&P lifecycle is:

- to apply EIA to all development stages, but its size and scope depend on elements such as the receiving environment, anticipated impacts, experience and familiarity with operations in the environment;
- to aim at meaningfully protecting socio-economic and environmental consequences;
- to consider cumulative effects upon the receiving environment.

What should be the scope of impact assessment in an EIA regarding offshore activities: Should regional considerations be taken into account? What degree of detail is needed in the baseline survey?

After discussion, the Chairman concluded that:

- baseline data should be appropriate both as regards quantity and quality in order to facilitate the required decision making process;
- local, national and/or regional considerations, as appropriate, should be taken into account in an EIA regarding offshore activities.

When is it necessary to include an assessment of the socio-economic impacts of onshore developments, related to offshore activities, in an EIA?

After discussion, the Chairman concluded that it is necessary to include an assessment of the socio-economic impacts of onshore developments related to offshore activities at all stages of exploration and development.

How can local expertise be used, and stakeholders be consulted in the process of developing an EIA?

After discussion, the Chairman concluded there are various ways to involve local expertise and stakeholders to share their experience, and working within the social and cultural context will enhance the transparency of this process.

How can operators benefit from an EIA?

After discussion, the Chairman concluded that the benefits of integrated social and environmental assessment included, *inter alia,* to:

1. protect environment and communities;
2. identify and enhance potential project benefits;
3. improve decision making and planning;
4. identify design options over remedial solutions;
5. help align expectations and avoid conflict;
6. facilitate balancing of environmental and social expectations
7. establish baseline and document impacts;
8. improve future assessments and practice;
9. contribute to building or strengthening local capability.

8. Strategies and Policies

Scope

Exchange of experiences in environmental approaches aimed at the protection of the marine environment. What are the instruments (regulations, convenants, codes of conduct, management standards, action plans), and their effectiveness? What are the perspectives and scope for goal setting versus prescriptive approaches and for self-regulation.

Background information

Offshore oil and gas exploration and production (E&P) activities are associated with a variety of environmental impacts, especially at a local level. Many host governments are increasingly concerned about the environmental viability of E&P activities, onshore and offshore, and have adopted more stringent regulatory controls. This proliferation of prescriptive environmental policies is not limited to countries with long existing offshore oil and gas activities. From a synoptic review, compiled by Petroconsultants (U.K.) Ltd, it is evident that a wide variety of policy tools and strategies are applied in various countries, in order to protect the marine environment from unacceptable pollution derived from offshore oil and gas E&P activities. Angola, for example, has drafted new environmental regulations for offshore activities. Elsewhere, countries such as Cambodia and Vietnam are in the process of adopting offshore environmental legislation. A similar trend can be observed in Latin America and other parts of the world.

This proliferation of regulatory controls has given rise to a debate over the efficacy of environmental law as a tool for achieving environmental policy objectives. Central in this debate is the question of effectiveness of the policies, implementation, enforceability, and cost effectiveness. In response, over last two decades there has been a trend towards a goal-setting approach in which the operators are more responsible for self-regulation and implementation.

The growing proliferation of environmental regulations and standards around the world has also given rise to concerns regarding the impact and plausibility of transferring standards and regulatory approaches from developed countries to the developing world, where, frequently, legal and administrative structures to accommodate accelerating oil and gas investment are still developing.

More widely, questions regarding the nature of environmental quality objectives and the extent to which these should be harmonised internationally have been raised. Calls for regional or ecosystem-based environmental quality standards and related environmental standards have also been articulated, though it is as yet unclear how much support there is for such an approach.

Regulatory Approach

Broadly speaking there are two approaches to regulating the environmental performance of oil and gas companies: the prescriptive approach and the performance-based approach.

Prescriptive approach

The prescriptive ("command and control") approach to regulating an operator's environmental and safety performance is one which is well rooted in many countries. In this approach a set of specific regulatory requirements are made by governments, which must be met by operators. These regulations are written in great technical detail, making it clear to operators exactly what is required of them and giving the regulations legal certainty. This makes it relatively easy to determine whether an operator is meeting requirements and leads to relatively simple inspection procedures.

However, in many countries the offshore oil and gas production industry is developing faster than governments can produce prescriptive regulations to regulate them. Furthermore, this approach requires strict and frequent government inspection by technical inspectors. In addition to being costly for governments, the fast rate of industry development often leads to a shortage of inspectors. It has also been argued that prescriptive regulations focus to much attention on paperwork and that by requiring specific compliance, they tend to foster a "compliance mentality", promoting the status quo rather than encouraging the development of new technologies and creative practical solutions.

Performance-based approach

"Self-regulation" is based on agreements made between government and operators in which environmental goals/standards to be met are specified. It is then the responsibility of the operators to define strategies and plans in order to achieve the overall objectives and criteria set by the regulator. In this approach the operators themselves are responsible for providing evidence assuring that they are complying with the agreements. The focus in self-regulation is, therefore, on self-inspection (internal audits) by company experts, in consultations with skilled external auditors, in order to check compliance and report to the regulator. This, in effect, removes some of the burden of auditing and inspection from government, while allowing the operator flexibility in choosing practical measures to meet the environmental objectives. This in turn stimulates the development of new technology and practical solutions resulting in improved environmental performance. Proponents of self-regulation also claim that it enhances internationalisation of responsibility and accountability and increases cost-effectiveness.

In this context, covenants between industry and governmental authorities, one form of voluntary goal-setting instrument, are often seen as a more effective and appropriate instrument for achieving the objectives of environmental policy goals than existing or newly developed prescriptive legal instruments. Experience from The Netherlands confirms that this is due to the fact that covenants allow industry to accept its responsibility for environmental impacts and to take initiatives to control them, while taking into account the technical and economic feasibility of the policy.

It is, however, unlikely that voluntary and other "alternative" complementary mechanisms on their own will be able to solve all environmental problems. Just like overly stringent command and control instruments, some market-based approaches may be difficult for certain countries to apply. Economic incentives, for example, require a well developed mechanism for monitoring emissions which is not always present in developing countries. Moreover, the establishment of a goal-setting regime requires active communication between operators and the supervisory authorities. Similarly, a basis of confidence between operators and the competent authorities as well as a sophisticated, multidisciplinary skill profile on the part of the regulatory authorities is indispensable.

Combining the two approaches

In many countries, performance-based approaches are increasingly being adopted to complement existing prescriptive regulations. Goal-setting principles, in fact, are beginning to form the basis for new environmental legislation in a variety of countries. Since the early 1980's, for example, Norway has been moving from a heavily prescriptive system of regulation to a regime based on goal-setting. The Netherlands, where a Covenant between the offshore oil industry and the government was adopted in 1995, has been moving in a similar direction. Similarly, Australia's new offshore regime places greater responsibility on operators under a set of "objective" or goal based regulations, supported by non-mandatory guidelines. Under this scheme, operators must develop an environmental plan and submit it to the authorities for approval. Once accepted, this plan is legally binding and is subjected to regular reporting and auditing requirements. Penalties for non-compliance with the accepted environmental plan exist.

More information on how voluntary instruments work in practice and the differences between goal-setting, prescriptive approaches and self-regulation is needed. Likewise more information is needed to determine what role, if any, complementary mechanisms should play, alongside national legislation and schemes, taking into account cost-effectiveness considerations.

In this context, increased emphasis in recent years has been placed on industry-specific environmental guidelines. A number of national and international industry associations such as API, the International Association of Geophysical Contractors (IAGC) and the E&P Forum have developed guidelines to cover operations in a variety of environmental settings. These guidelines are increasingly regarded as complementary to regulations and are seen to be of particular value in countries with no established regulatory framework. and as a basis for self-regulation approaches. They are also actively used in goal-setting regimes. In this context, guidelines developed in consultation with other stakeholders, such as NGOs, may be of particular importance. The experience in developing the joint E&P Forum/IUCN and the joint E&P Forum/UNEP guidelines is regarded as especially important in this context.

Implementation and Enforcement

Although largely neglected in the past, attention is beginning to focus on the implementation and enforcement of legislation and regulatory standards, an international legal framework for which is provided by Article 214 of UNCLOS. Effective implementation and enforcement of regulations, in fact, is a crucial ingredient of any effective system of environmental policy and is essential in establishing a level playing field.

WORKING SESSION REPORT

Chaired by Mrs. Terttu Melvasalo (UNEP)

Key Note Presentation

Mr. Magne Ognedal (Norwegian Petroleum Directorate, Norway).
On the reasons and the challenges of employing a goal setting approach to regulatory supervision.

Introductory Papers

Dr. Steven de Bie (NOGEPA, The Netherlands).
The environmental covenant of the Dutch E&P Industry with Dutch authorities

Dr. Habib N. El–Habr (UNEP East Asian Seas, Thailand).
The East Asian Seas Action Plan: the development of a Transboundary Diagnostic Analysis (TDA) and Strategic Action Plan (SAP) for the South China Sea.

Mr. Moises Medleg Sumoza and Mr. Edgar Sigler Andrade (Mexico).
Politics and strategy to decrease the impact to environment from the offshore petroleum industry in Mexico.

Mr. Peter Smith (DPIE, Australia).
Ensuring good environmental practices in offshore E&P development in Australia.

Dr. Emmanuel Garland (E&P – Forum, Elf).
The oil exploration and production industry strategy.

Mr. Steve Sawyer (Greenpeace).
Environmental Strategies and Policies for the offshore oil and gas industry: an environmentalist view.

Discussions

Strengths and weaknesses of prescriptive regulations and performance-based, self-regulation methods used to achieve agreed goals and methods to control and enforce both of these regulatory approaches

During discussions it was pointed out that:

1. the effectiveness of prescriptive measures was doubted, as well as countries ability to enforce them due to lack of resources;
2. prescriptive measures tend to encourage a compliance mentality, and do not motivate industry to achieve higher goals than the minimum. Neither do they foster a spirit of co-operation between industry and government, and they require a heavy legislative apparatus to enforce compliance;
3. a goal - based regulation has proven to:
   - encourage continuous improvement;
   - be more simple and general in nature;

- be more flexible-allows adoption of appropriate technology and is not easily outdated by changing technology;
- stimulate collaboration between the authorities and industry (transparency);
- require personnel with an integrated knowledge of oil-producing operations both from the industrial side and from the controlling authorities;

4. prescriptive measures have proven to:
   - make the requirements clear for the operators;
   - simplify the inspection methods and thus requiring controls with a more narrow scope;
   - require more frequent control and be more resource consuming;
   - make it simpler to check whether the action taken is in compliance with the provisions;
   - be inappropriate in some cases to the specific environment setting;
   - discourage best practice and continuous improvement;
   - encourage the adoption of the lowest common denominator.
5. goal based regulations[1] are set by the regulators, the industry is then free to define a strategy to achieve them;
6. in many countries of the world, industry could take the lead in defining the strategy to meet targets, which in turn would make implementation more effective;
7. the goal based approach essentially is based on trust (this caused some speakers to question how this would be monitored. Examples were quoted of long term 'covenants' between industry and government, whereby checks and audits were regularly performed by the government agency concerned. Others questioned whether there was any real public accountability in these arrangements);
8. the relative costs of the two systems (illustrated by the Australian experience) show little difference in the early stages, but at a later stage, prescriptive regulations require increasing resources and time, and become costly; and
9. enforcement of either method of regulation often depend on the resources of national governments. Skilled personnel are not always available and pursuing legal action to enforce regulations was long and costly.

The role of industry guidelines

During discussions it was pointed out that:

1. the guidelines prepared by industry represent a valuable method of promoting best environmental practice, and should be widely distributed;
2. enforcement of legislation leading to criminal proceedings is long costly and often unsuccessful;
3. guidelines have proved extremely valuable, and have helped dialogue and co-operation between industry and its stakeholders. Furthermore, guidelines are often able to be formulated before national legislation;

[1] On the basis of presentations from Australia, the Netherlands and Norway, it appeared that the term 'Self Regulation', was misleading and it was suggested to use either 'Objective based regulation' or 'Goal Based regulation'.

4. guidelines still need to be 'anchored' somewhere, kept up to date, and be looked at critically by legislators; and
5. industry guidelines are not regulations. Like 'benchmarking', such guidelines would encourage the identification of best environmental practice and help environmental performance. The real objective is the best environmental outcome for a given site.

Best environmental practices and standards – levels of application and effectuation

During discussions:
1. it was pointed out that regional agreements, such as the OSPAR and Barcelona Conventions, have proven to be effective tools. In offshore areas where such agreements don't exist they should be developed;
2. it was pointed out that a goal based approach will normally be combined with the definition of environmental quality standards;
3. some experts argued that international standards should be based on Best Available Technology (BAT);
4. some experts argued that minimum global standards on a regional or national level should be established. Such standards would be particularly helpful in assisting developing countries to regulate offshore activities;
5. it was pointed out that universal global standards would not be appropriate as regards environmental quality standards;
6. it was pointed out that all companies operate within the legal regime of the countries and must at least comply with the current legislation; and
7. it was pointed out that it is recognised that the companies have their own responsibility for environmental sound and safe operations wherever they operate.

Conclusions

After further discussion the Chairman concluded that:
1. it is recognised that legislation targeted towards offshore operations should be goal based, and give incentives to industries to take a responsibility in achieving environmental goals (goal based regulation). Some complementary prescriptive measures are still required in order to address some specific issues;
2. one set of measures in one country would not necessarily be appropriate in other areas or countries;
3. a goal based approach requires the need to identify environmental impacts from the E&P activities, agreement on environmental objectives for a specific area or region and the establishment of plans on how the objectives should be reached;
4. a consultative process involving government, petroleum and environment agencies, the petroleum industry and environment NGOs would be an appropriate approach in order to establish environmental objectives, though it is the ultimate responsibility of the regulator. Some countries have established special agreements between the offshore industry and the government on how the environmental goals should be reached. These agreements may be "voluntary", but not without commitments;

5. industry guidelines can play an important role in meeting the commitments under a goal based regime. Such guidelines can be modified relatively easily, as technologies develop, and thus provide flexibility. The guidelines should be developed in a consultative process with governments and other relevant parties such as NGOs;
6. the principles of which a goal based approach is based upon give the industry more responsibility and accountability;
7. a goal based approach will normally be combined with the definition of environmental quality standards. There are, however, different views on what level minimum standards should be established. Some argued that the development of minimum global standards would be particularly helpful in assisting developing countries on a regional and national level to regulate offshore activities. Others argued that global minimum standards would not be effective;
8. it was recognised that regulatory agencies in many developing countries have limited economic resources to carry out sufficient control and enforcement. It is therefore a recognised need for instruments to improve such agencies role as supervisors and regulators. Companies in the areas should be proactive and operate in an environmental sound manner even if national legislation proves to be inadequate; and
9. information exchange and sharing of experience is a key point for further development of measures related to offshore industry. This work has to be built on experience and lessons learned in different countries. The information exchange between developed and developing countries is of particular importance.

9. future exchange of information and experiences

Scope

Exchange of views on the possibilities of future exchange of information and experiences between countries and organisations involved in E&P activities. Discussions on the opportunities for future expert meetings of the meetings with a view to improve the exchange of information and experiences among counties and organisations.

Background Information

During the meeting possible methods of continuing the exchange of information and experiences were discussed. The main objective was to ensure a flow of information: from industry to governmental agencies and vice versa; from industry and government to stakeholders (i.e., environmental groups and local people) and from countries with broad experience in offshore oil and gas production to countries with developing offshore oil and gas production.

working session report

Chaired by Mr. Paul L. Coutrier (Environmental Impact Management Agency, Indonesia).

Introductory Papers

Mr Kyaw Shane (DPSCD, UN)
Expectations of the United Nations regarding exchange of information and experiences in environmental practices in E&P activities

Dr Carlos Liumba (Ministry of Petroleum, Angola)
Environmental Issues in Offshore Oil Activities in Angola

Dr Maira Zhunoso (Kazakstan)
The Need for Sharing Experiences and Expertise, for Guidance towards Good Environmental Practices for Offshore Oil Activities

Mr Wu Jin Xiao (State Oceanic Administration, P.R. of China)
Environmental Protection Administration of Offshore Oil Exploration and Exploitation

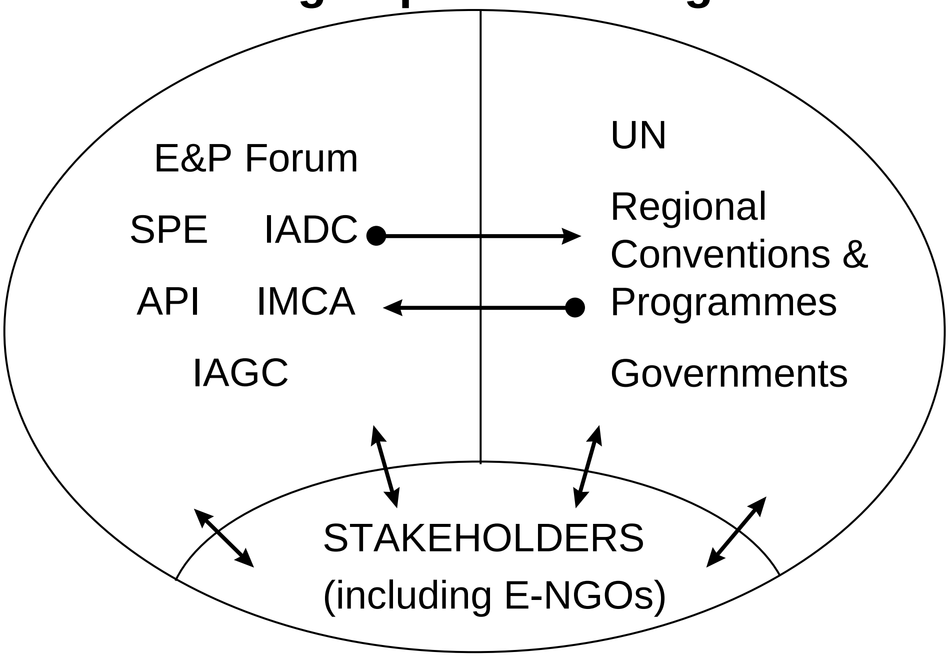
Mr Mike Cloughley (E&P Forum)
Progress towards Dialogue

Discussion

The presentations were followed by some general comments as regards the best means for the future exchange of information and experiences on environmental practices in offshore oil and gas activities. On the basis of the said comments, the Chairman concluded that:

- the success of the International Expert Meeting in creating a forum for the free exchange of information, experiences and ideas between regulators, the offshore petroleum sector and non-governmental organisations, suggests that efforts should be made to ensure that similar conferences take place on a periodic basis in the future. Exchange of information, experiences and expertise can be promoted by face-to-face contact in a way not possible on paper or by electronic means;
- regional meetings serve as a necessary complement to the existing information structure on a global level to ensure regional participation;
- recognising the challenges involved in gathering inter-governmental, industry and NGO organisations, the International Expert Meeting welcomed the suggestion from some members of the Society of Petroleum Engineers, that they should explore the possibility of including such a forum in the Society's biennial conference;
- future exchange of information should be based on the “Sharing Experience Diagram” (see below), by making use of existing fora, rather than creating new ones;
- information exchange can be facilitated through the use of tools such as
- a clearing house under the auspices of the United Nations
- directories
- Web sites
- data bases.

Sharing Experience Diagram



ACKNOWLEDGEMENTS

joint chair

The Netherlands - Brazilian Joint Chair, responsible for the Conclusions from the Meeting, were:
Sjef Jacobs (Ministry of Transport, Public Works and Water Management),
Luiz Rodolfo Landin Machado (Petrobras, Brazil)

Steering Committee

The Technical Meeting Document is issued by the Steering Committee of the Expert Meeting on Environmental Practices in Offshore Oil and Gas Activities. The Steering Committee defined the scope and topics for discussion for each of the working sessions.

The Steering Committee consists of:
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Luiz Molle (Petrobras, Brazil; co-chairman)
Rob Droop (Ministry of Housing, Physical Planning and the Environment, The Netherlands)
Leo R. Henriquez (State Supervision of Mines, The Netherlands)
Bob Oudshoorn (Ministry of Transport, Public Works and Water Management, The Netherlands)
Henk P. M. Schobben (Ministry of Transport, Public Works and Water Management, North Sea Directorate, The Netherlands)
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Aart Tacoma (Ministry of Transport, Public Works and Water Management, North Sea Directorate, The Netherlands)
Koos Visser (Health, Safety and Environmental Management Consultant, The Netherlands)
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The Technical and Scientific Group advised the Steering Committee on technical issues. They were also responsible for the synoptic compilation of background information.

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Appendices

APPENDIX I	**Basic Documents and Guidelines Concerning Environmental Practices in Offshore Oil and Gas Activities**
APPENDIX II	**Relevant International Agreements and Conventions**
APPENDIX III	**Waste Management Options (from Exploration and Production Waste Management Guidelines; E&P Forum 1993)**

APPENDIX I Basic Documents and Guidelines Concerning Environmental Practices in Offshore Oil and Gas Activities (indicated are the sessions for which each document is relevant)

		Session Number							
Organisation	**Document**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
E&P Forum/UNEP:	Environmental Management in Oil and Gas Exploration and Production (1997)	X	X						X
IUCN/E&P Forum:	Oil and Gas Exploration and Production in Mangrove Areas (1993)·		X	X	X	X	X	X	
ARPEL:	A Guideline for the Disposal and Treatment of Produced Water				X				
ARPEL:	A Guideline for the Treatment and Disposal of Exploration and Production Drilling Wastes			X					
ARPEL:	Guidelines for an Environmental Impact Assessment (EIA) Process					X			
AEPS (Arctic Council)	Arctic Offshore Oil & Gas Guidelines (1997)		X	X	X	X		X	
E&P Forum:	Exploration and Production Waste Management Guidelines (1993)·			X	X		X	X	
E&P Forum:	Guidelines for the Development and Application of Health, Safety and Environmental Management Systems (1994)·		X						
E&P Forum:	E&P Forum Guidelines for the Planning of Downhole Injection Programmes for Oil-Based Muds Wastes and Associated Cuttings from Offshore Wells (1993)			X					
E&P Forum:	Quantitative Risk Assessment Data Directory (1996)			X	X		X	X	
E&P Forum:	The Physiological Effects of Processed Oily Drill Cuttings (1996)·			X					
E&P Forum:	Technologies for Handling Produced Water in the Offshore Environment (1996)				X				
E&P Forum:	Production Water: Current and Emerging Technologies (1994)				X				
E&P Forum:	North Sea Produced Water: Fate and Effects in the Marine Environment (1994)	X			X				
Petroconsultants	Operational Discharges from Offshore Oil and Gas Exploration and Exploitation Activities: Regulatory Requirements and Enforcement Practices (1997)			X	X		X		X
Worldbank	Environmental Guidelines (1988, 1995)·		X			X			
Worldbank	Offshore Hydrocarbon Resource Drilling Operations –Effluent Guidelines (1983)				X		X	X	
API:	Chemical Treatments and Usage in Offshore Oil and Gas Production Systems, Offshore Effluent Guidelines (1989)				X				
API	Safety and Environmental Management Programme (Semp) (1993)		X						
IAGC:	Environmental Guidelines for World-wide Geophysical Operations (1992)	X	X					X	
The Joint Links Oil and Gas Consortium	Polluting the Offshore Environment (1996)	X		X	X		X		
WWF	The Application of Strategic Environmental Assessment in Relation to Offshore Oil & Gas Resource Exploration					X			
WWF	The Application of EIA in Relation to Offshore Oil and Gas Exploitation					X			
APPEA	Environmental Implications of Offshore Oil and Gas Development in Australia- The Findings an Independent Scientific Review (1994)	X	X	X	X		X	X	X

APPENDIX II: Relevant International Agreements and Conventions

1958 Convention on the Territorial Sea and Contiguous Zone

Date of adoption:	29 April 1958
Place of adoption:	Geneva
Entry into force:	10 June 1964
Secretariat:	United Nations

1958 Convention on the Continental Shelf (CSC)

Date of adoption:	29 April 1958
Place of adoption:	Geneva
Entry into force:	10 June 1964
Secretariat:	United Nations

1958 Convention on the High Seas

Date of adoption:	29 April 1958
Place of adoption:	Geneva
Entry into force:	30 September 1962
Secretariat:	International Maritime Organisation (IMO)

1972 Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (Oslo Convention)

Date of adoption:	15 February 1972
Place of adoption:	Oslo
Entry into force:	7 April 1974
Secretariat:	Oslo Commission

Note: When in force, the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) will replace this Convention.

1972 Convention on the Protection of Marine Pollution by Dumping of Wastes and Other Matter

Date of adoption:	29 December 1972
Place of adoption:	London, Mexico City, Moscow, New York
Entered into Force:	30 August 1975
Secretariat:	International Maritime Organisation (IMO)

1973 International Convention for the Prevention of Pollution from Ships (MARPOL)

Date of adoption:	2 November 1973
Place of adoption:	London
Entry into force:	Not in Force
Secretariat	International Maritime Organisation (IMO)

1974 Convention for the Prevention of Marine Pollution from Land-Based Sources (Paris Convention)

Date of adoption:	4 June 1974
Place of adoption:	Paris
Entry into force:	6 May 1978
Secretariat:	Paris Commission (PARCOM)

Note: When in force, the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) will replace this Convention.

APPENDIX II (Continued)

1974 Convention on the Protection of the Marine Environment of the Baltic Sea Area

Date of adoption:	22 March 1974
Place of adoption:	Helsinki
Entry into force:	3 May 1980
Secretariat:	Helsinki Commission

Note: When in force, the 1992 Convention for the Protection of the Marine Environment of the Baltic Sea Area will replace this Convention.

1976 **Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft**

Date of adoption:	16 February 1976
Place of adoption:	Barcelona
Entry into force:	12 February 1978
Secretariat:	United Nations Environment Programme (UNEP)

1978 Protocol Relating to the International Convention for the Prevention of Pollution from Ships (MARPOL PROTOCOL)

Date of adoption:	17 February 1978
Place of adoption:	London
Entry into force:	2 October 1983
Secretariat:	International Maritime Organisation (IMO)

1981 Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region

Date of adoption:	23 March 1981
Place of adoption:	Abidjan
Entry into force:	5 August 1984
Secretariat:	United Nations Environment Programme (UNEP)

1982 Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment

Date of adoption:	February 1982
Place of adoption:	Jeddah
Entry into force:	16 November 1994
Secretariat:	United Nations Environment Programme (UNEP)

1982 UN Convention on the Law of the Sea

Date of adoption:	30 April 1982
Place of adoption:	Montego Bay
Entry into force:	16 November 1994
Secretariat:	United Nations

APPENDIX II (Continued)

1983 Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention)

Date of adoption:	24 March 1983
Place of adoption:	Cartagena
Entry into force:	11 October 1986
Secretariat:	United Nations Environment Programme

1985 Agreement on the Conservation of Nature and Natural Resources

Date of adoption:	9 July 1985
Place of adoption:	Kuala Lumpur
Entry into force:	Not in Force
Secretariat:	Association of South East Asian Nations (ASEAN)

1989 Protocol Concerning Marine Pollution from Exploration and Exploitation of the Continental Shelf

Date of adoption:	29 March 1989
Place of adoption:	Kuwait
Entry into force:	17 February 1990
Secretariat:	Regional Organisation for the Protection of the Marine Environment (ROPME)

1991 Convention on Environmental Impact Assessment in a Transboundary Context

Date of adoption:	25 February 1991
Place of adoption:	Espoo
Entry into force:	Not yet in force
Secretariat:	United Nations Economic Commission For Europe (UN/ECE)

1992 Convention on the Protection of the Black Sea Against Pollution

Date of adoption:	21 April 1992
Place of adoption:	Bucharest
Entry into force:	15 January 1994
Secretariat:	Istanbul Commission

1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area

Date of adoption:	9 April 1992
Place of adoption:	Helsinki
Entry into force:	Not in Force
Secretariat:	Helsinki Commission

<u>1992 Convention for the Protection of the Marine Environment of the North-East Atlantic</u>

Date of adoption:	22 September 1992
Place of adoption:	Paris
Entry into force:	Not yet in force
Secretariat:	OSPAR

APPENDIX II (Continued)

1994 Protocol for the Protection of the Mediterranean Sea against Pollution resulting from Exploration and Exploitation of the Continental Shelf and the Sea-Bed and its Sub-Soil

Date of adoption:	14 October 1994
Place of adoption:	Barcelona
Entry into force:	15 May 1995
Secretariat:	United Nations Environment Programme (UNEP)

1996 Protocol to the Convention on the Prevention of Marine Pollution by dumping of Wastes and Other Matter, 1972

Date of adoption:	7 November 1996
Place of adoption:	London
Entry into Force:	Not yet in force (so far 4 states have expressed their consent, 26 consents are needed)
Secretariat:	International Maritime Organisation (IMO)

APPENDIX III: Waste Management Options
(from Exploration and Production Waste Management Guidelines; E&P Forum 1993)

Treatment and Disposal Methods

A = Deep Well
B= Evaporation Ponds
C = Specialised Waste Disposal facility
D = Incineration
E = Land Treatment
F = Landfill
G = Biological Treatment
H = Road Application
I = Soldification
J = Bioremediation
K = Surface Water Discharge (may require pre-treatment)

	Minimisation Options			Treatment and Disposal Method										
Waste Name	**Reduce**	**Reuse**	**Recycle**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Acid	X	X	X	X	X	X								X
Activated Carbon	X		X			X	X	X	X					
Batteries, Lead Acid, Wet NI CAD			X			X			X					
Catalysts	X	X	X	X					X					
Caustic	X	X	X	X					X					X
Chemical Waste	X	X	X			X	X		X			X		
Construction & Demolition Material	X	X	X				X		X					
Containers-Drums/Barrels		X	X			X	X		X					
Contaminated Debris & Soil-Chemicals	X		X			X	X		X			X		
Contaminated Soil-Hydrocarbon/Fuel	X		X			X	X	X	X			X	X	
Desiccant	X	X	X				X		X					X
Filter Backwash Liquids	X		X	X	X									X
Filters, Chemical Treatment	X					X	X		X					
Filters-Lube Oil	X					X	X		X					
Filters-Other (Raw gas, fuel, air)	X					X	X		X					
Filters-Water	X						X		X					
Garbage-Domestic Waste	X		X				X		X			X	X	
Hydrotest Fluids		X		X		X								
Incinerator Ash			X	X		X			X			X		
Insulation		X				X			X					

APPENDIX III (Continued)

Treatment and Disposal Methods

A = Deep Well
B= Evaporation Ponds
C = Specialised Waste Disposal facility
D = Incineration
E = Land Treatment
F = Landfill
G = Biological Treatment
H = Road Application
I = Soldification
J = Bioremediation
K = Surface Water Discharge (may require pre-treatment)

	Minimisation Options			Treatment and Disposal Method										
Waste Name	**Reduce**	**Reuse**	**Recycle**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Ion Exchange Resins	X	X	X						X					
Ion Exchange Resin-Regenerant Liquids	X	X	X	X										
Iron Sponge								X	X					
Laboratory Chemicals	X		X	X		X	X		X					
Lubricating Oil-Hydrocarbon	X		X				X							
Lubricating Oil-Synthetic			X			X								
Molecular Sieve			X						X					
Paint Associated Wastes	X	X	X			X	X		X					
PCB-Contaminated Solids & Liquids						X								
Pigging Waste Liquids/Wax			X			X	X							
Produced Sand	X					X		X	X		X			X
Produced Water	X	X	X	X	X					X				X
Rags-Oily	X	X	X				X		X					X
Rainwater Drainage	X	X								X				X
Scrap Metal	X	X	X						X					
Sludge, Glycol systems			X			X	X	X	X					
Sludge, Gas Sweetening	X		X			X	X		X			X	X	
Sludge, Tank & Vessel Bottoms	X	X	X			X	X	X	X		X			
Sludge, Water Treatment							X		X			X	X	
Sanitary Wastes	X		X											X
Well Workover Fluids	X	X		X		X	X							X