INTRODUCTION

The subject of this Paper addresses, I believe, the greatest responsibility facing the Maritime Sector. There is an increasing public awareness of the effects of industrial activity within our rivers, seas and oceans thereby exerting considerable influence on legislators, operators and many others to act in a sustainable manner.

Within the limited opportunity presented by a single paper I will attempt to review some of the major activities directed towards protecting our offshore maritime environment.

The subject is vast and therefore I have concentrated on oil and gas activity with some reference to the exploitation of other minerals, which are likely to fall within the same regulations.

Given global demographics and the need to improve progressively the quality of life for a growing population it is essential for us to exploit offshore mineral resources but in a well managed and environmentally safe manner.

In the past, marine science has gathered a huge store of knowledge on the physics, chemistry and biology of the oceans. This knowledge is allowing us to move from a descriptive process to a predictive one and will continue to provide an ever-increasing source of decision-making data. However, despite being enormously important, knowledge remains in the intellectual zone until it is applied and this is essentially the role of the maritime engineer. We have all, in recent years, experienced tremendous changes in technology, global economics and political realignment. Much of the technical progress has been driven, by unfortunate major accidents, but this is an inevitable consequence of increased public awareness and debate. We do have the knowledge and ongoing research and development to provide adequate protection but as I will argue in the Paper it is the globalisation of regulations and practice that will have the most obvious and beneficial effect.

The Paper is sub-divided into five main sections; The Environment, Legislation, The Issues, The Industry and Conclusion.

I will shortly move on to the applications, legislation and regulations controlling them but first I would like to present some results of the many years of scientific work.

THE ENVIRONMENT

The oceans cover 71% of the earth's surface to an average depth 3.7 kilometres. The vastness of this occupied space drives our climate and weather and controls the global delivery of heat and fresh water. It also contributes enormously to the biodiversity of the planet and marine water quality is an important indicator of global environmental health. They provide a living for many millions of people around the globe. More than half of the world's population live near the sea at a density 10 times that of inland regions.

We know:

- The patterns of water circulation within the oceans and their contribution to the global budgets of carbon, nitrogen and sulphur.

- How sea levels and temperatures have changed over the past decades.

- The dependence on and productivity of plankton across the globe.

- The population and harvesting of fish, squid and crustaceans and the importance of protecting the sea mammal or cetacean population.

- The basic ecology and population dynamics of creatures that live within the marine environment.

Rightly or wrongly, and I say this realising that there are counter arguments, most waste disposal eventually ends up in the oceans.

There have been many recent important discoveries, for example: The deep outflow of water from the Arctic to the Atlantic has varied by a factor of 2 or 3 during recent decades, affecting circulation patterns in all the Earth's oceans.

Viruses are highly abundant in seawater and can affect, through the infection of plankton, the release of sulphur to the atmosphere.

New forms of bacteria have been found in rock pores and sediments over 750 metres below the seabed. These microbes have a potential as sources of novel products for biotechnology.

We also know how the continents are being affected by climate change allowing us to predict population movement in the future.

Global sea level is currently rising at 1 to 2 cm. every ten years as the oceans warm and expand. This increase is predicted to double in the next century with all of its ensuing consequences.

Many of us are well aware of the debates regarding climate change. Despite the uncertainty of the process some indicators of the disruption, which could be caused, are shown by El Nino, a frequently occurring phenomenon in which an ocean current suddenly switches off. Fisheries, agriculture and weather are affected across the globe.

Marine pollution comes in many forms and although the deeper colder waters are only marginally influenced, coasts and estuaries are in some cases severely affected. Some examples of this are:

- Nutrient and chemical waste discharges from industry and agriculture.

- Some chemicals such as hormone mimics can affect the physiology and reproduction of invertebrates and fish.

- Human sewage, litter, industrial and organic wastes e.g. from fish farms can severely deplete oxygen levels.

- Oil spills from shipping and the discharge or deposit of toxic chemicals in waste water, drill cutting and drilling mud can, if not properly managed, disturb bottom living communities and fish.

On top of the pollution threat almost 70% of the world's sea fisheries are already over exploited leading to a range of ecological problems.

The list of pollution sources to the marine environment is endless and must be very carefully managed under the umbrella of well-balanced, adequate and responsible legislation.

Pollution can also include disturbance of the environment without actually introducing foreign elements; for example, sea bottom trawling and the erosion and turbulence effects of fast ships in shallow waters.

Atmospheric pollution in the marine environment, usually in the form of products of combustion, can and in some cases does make a noticeable contribution to the total balance of environmental deterioration, SO_x. NO_x. and CO_2. being the main components.

One of the primary base line parameters now applied by responsible industry is the target of ‘sustainable development’. This concept came into prominence as a result of the Bruntland Commission, which defined it as: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

There are numerous interpretations of what sustainable development means but the availability of technology which can be applied to minimise to below, and sometimes well below, the derived threshold values of pollutants is well known. It is sensible resource management and the universal application of this technology and the evolution of even better designs and procedures, which are required. At the same time we must not forget that the quality of life for all the world's peoples must be subjected to a steady rate of improvement but within the parameters that our overall ecology can sustain. Within the foreseeable future the use of fossil fuels to produce the majority of our power requirements is essential, in particular if we stagnate or minimise the contribution from nuclear power stations. A massive investment in renewable sources, far above that currently programmed, would be necessary to even supply the additional needed capacity. Nevertheless these remain a promising opportunities for the future in terms of a calculated supply source balance.

There is ample evidence that the major oil and gas companies are now applying stringent environmental protection technology and procedures to their exploration and production processes. As stated in the introduction, the globalisation of this responsible approach together with uniform legislation should present the greatest opportunity for pollution minimisation from this sector. This, coupled with improved ship oil/water separation, ballast water treatment equipment and the careful management where possible of any activities which tend to scour the sea bed, will lead to continuing improvements in the marine environment.

This reference to globalisation is a very important issue. We, in the advanced nations, can rightly be subjected to effective legislation but the picture becomes blurred when we consider the needs of third world nations with known offshore oil, gas and other mineral deposits. At the same time they may not have access to sophisticated technology and desperately need to exploit these resources in order to supply the basic utilities to their people.

Fortunately, the number of responsible international operators is increasing and there is also a trend to apply a uniform approach to environmental protection wherever the project may be located. It is no longer possible for an international company to divorce itself from world opinion leading to damage to its reputation. This situation exerts pressure on and presents opportunities to developing countries to achieve responsible environmental protection objectives without undue additional cost.

In researching this paper I have accumulated a large amount of information referring to success stories in protecting and even enhancing the marine environment during production. Obviously because of the long history of offshore development, sometimes at minimal cost, there have also been many examples of damage, usually in the form of discharges containing toxins and the seabed deposit of drilling cuttings and mud containing chemicals.

Some examples, amongst many, of satisfactory performance in this country are BHP in Liverpool Bay, BP at Foinavon, the Forth Estuary, Witch Farm, Dorset, and Esso Petroleum at Fawley.

These, together with other examples in remote parts of the world such as Indonesia and Columbia show clearly that the responsible application of Environmental Impact Studies can support the continued development of offshore minerals without long term harm to the environment.

(Picture of Lophelia Pertusa by kind permission of National Environmental Research Council.)

In considering the flora and fauna or biota of the oceans I have made particular reference to LOPHELIA PERTUSA because of its sensitivity to pollution and its association with high densities of biota.

Lophelia is a cold water coral, which as can be seen is very beautiful and is an example of the seabed environment, which must be protected. Large areas of these coral banks occur in the Atlantic Ocean near the continental shelf break off at Ireland, Scotland, the Faroes, Norway and off the South coast of Iceland.

WHERE OFFSHORE HYDROCARBON AND USABLE MINERAL RESOURCES ARE FOUND

The main sources are in areas where deposited sediment is high either through the action of continental shift, glaciers or deep ocean currents. This is significantly qualified by the action of submarine landslides. These events are intermittent, and sediment deposits can be up to 10 km thick and 700 km in length and are sometimes rich in hyrodcarbons. In the North and Irish Seas for example much of the sea floor sediment is of recent glacial origin.

Of prime importance in identifying the opportunities for exploitation of offshore mineral resources are the rights accorded to each coastal State over the area of its Continental Shelf (CS), for the purpose of exploring it and exploiting its natural resources under the United Nations Convention on the Continental Shelf 1958 (CS58), often called the Geneva Convention. For the first time, this gave coastal States sovereign rights over the submarine areas beyond their Territorial Seas out to 200 nautical miles (nml) or to median lines measured from national base lines, irrespective of whether the continental shelf itself extended that far. CS58, which came into force in 1964 enabled interested countries to enact enabling legislation, in the case of the United Kingdom (UK) its 'Continental Shelf Act 1964'. The UK's first gas came ashore in 1967 and oil from further north eight years later, a remarkably short time scale.

The UN Convention on the Law of the Sea (UNCLOS82), which brought together all earlier relevant international conventions, including those of 1958, was opened for signature in December 1982 and came into force in 1994. The UK delayed its accession and the convention only entered into force formally in the UK on 24th August 1997, an early action of the present Government.

As explained later, Article 76 of UNCLOS82 extended the maximum breadth of national Continental Shelves to take account of the fact that some extend far beyond 200 nml. The main potential resources in this outer area comprise iron, manganese nodules and crusts, oil, gas and gas hydrates. Four elemental metals are the main components of value in manganese nodules and crusts: manganese, copper, nickel and cobalt.

Theoretically, the resource potential (excluding recovery and production costs) contained within these outer areas is estimated at some 12 thousand trillion dollars. However, most of this will never be realised owing to geographic sensitivity, regional treaties, the finite density of deposits and the difficulties and cost of extraction and waste disposal.

Seen in this framework, the present recoverable proven reserves of most minerals are relatively small when compared to the estimated recoverable offshore resource potential.

The existence of marine gas hydrates may well evolve into a very important source of energy. Japan and India already have active research programmes and the USA recently initiated a multi-million-dollar initiative. Gas hydrate is a crystalline compound, normally methane, encaged within water nodules to form a solid similar to ice. It forms within the sediment spaces, cementing the grains together. This dramatically changes the physical properties of the sediment. One volume of hydrate also stores 164 volumes of unpressurised methane - a measure of the value of this resource. Whether the methane in the hydrate or the free gas beneath the hydrate is targeted, they represent up to 10 times the fuel value of current conventional hydrocarbon resources. Although considerable uncertainty exists about the total gas resource potential of hydrates it is clear that the oceanic potential is far greater than the continental one; consequently as the technology or global need for these additional resources evolves, their exploitation will require a fully mature global regulatory regime if we are to ensure auditable protection for the environment.

It should be noted that although there is a general environmentally responsible convergence of approach, from oil and gas companies, the other identified mineral resources could bring in some mining companies that may not have been subjected to the same international attention.

LEGISLATION

Let us now look at the legislative and regulatory environment.

As I have already stated there is considerable variation in the application or even existence of national offshore environmental protection regulations. In north west Europe we have many regulations essentially centred around the 'Convention for the Protection of the Marine Environment of the NorthEast Atlantic (OSPAR 1992)'. This Treaty has been signed and ratified by all the contracting parties to the Oslo and Paris Conventions:

Belgium.
Denmark.
Commission of the European Community.
Finland.
France.
Germany.
Iceland.
Ireland.
The Netherlands.
Norway.
Spain.
Sweden.
United Kingdom of Great Britain and Northern Ireland.
Luxembourg.
Switzerland.

It came into force on 25th March 1998 and there are many other supporting regulations that I will refer to later.

However I would first like to present those regulations which have global jurisdiction because it is through these that we will be able to influence areas where national legislation is inadequate. The other influence in these areas is the globalisation of

practices by the major operators, using regional or national regulators such as OSPAR as the basis.

International law is the primary source of law developed throughout the world with Treaties, International Conventions and customs being the main methods to create binding legislation.

INTERNATIONAL TREATIES, CONVENTIONS AND GUIDELINES.

A brief outline of the relevant treaties and conventions relating to offshore oil and gas exploration and production is given below and summarized in Table I.

Essentially there are no specific international rules and regulations relating to operational discharges arising from offshore exploration and production activities other than those provided by the International Maritime Organization in the 1973/78 Protocol, relating to the International Convention for the Prevention of Pollution from Ships (MARPOL). Although MARPOL considers fixed and floating platforms to be 'ships', process discharges are not controlled and regulations are currently restricted to machinery space drainage, water and garbage which in general are of insignificant relative volume. The discharge of sewage is not controlled internationally at present, as Annex IV of MARPOL has not entered into force because it has yet to be ratified by the requisite number of countries. (*Entry into force requires ratification by not less than 15 States, the combined fleets of which constitute not less than 50% of the gross tonnage of the world's merchant shipping*.)

In addition it should be noted that: Although there are no current internationally agreed regulations covering ship's ballast water, the International Maritime Organisation published in 1997 Resolution A. 868 (20), 'Guidelines for the control and management of ship's ballast water to minimise the transfer of harmful aquatic organisms and pathogens.' These guidelines call for a ballast water management plan for each ship.

The implications of Annex VI (Regulations for the Prevention of Air Pollution from Ships) for the offshore industry include controls on the use of ozone depleting substances, including nitrous oxide(Nox) emissions from diesel engines and possibly incineration.

A Code for the Construction and Equipment of Mobile Offshore Drilling Units, known as the 1989 MODU Code, was drawn up by the IMO. Although this is primarily concerned with health and safety requirements and the prevention of casualties it does make reference to pollution by stating that such units comply with all international conventions in force.

The Geneva Convention (1958)

The original treaty governing the use of the continental shelf is the 1958 UN. Convention on the Continental Shelf. This defines that coastal states have inherent and exclusive rights to exploit their natural resources although these rights must be exercised without infringing on the rights and freedoms of other states and must not cause unjustifiable interference with navigation. In addition, all states have the right to lay pipelines in their continental shelf area. Consequently, the coastal state exploiting it's own natural resources must not impede the laying and maintenance of cables or pipelines more than is

necessary to protect it's own rights in taking reasonable measures for the exploitation of the continental shelf

International Convention for the Prevention of Pollution from Ships (MARPOL.) (1973/78)

Discharges of harmful substances arising directly from the exploration, exploitation and associated offshore processing of seabed mineral resources are not included under the MARPOL Conventions. Machinery space drainage and the disposal of garbage from offshore installations are covered under MARPOL within Annexes I and V respectively. Provisions within both Annex II and III are only applicable to offshore operations where noxious liquid substances and harmful substances in a packaged form, respectively, are transported to and from an installation. Similarly, offshore installations would not be excluded with regard to the disposal of sewage and this is dealt with under Annex IV. However, as noted earlier, at present Annex IV has yet to be ratified by the required number of States and consequently has not entered into force.

TABLE I: INTERNATIONAL CONVENTIONS AND TREATIES RELATING TO OFFSHORE OPERATIONS

International Conventions and Treaties	**Comments**
1958 Geneva Convention	Main treaty governing the use of the continental shelf, giving coastal states inherent and exclusive rights for exploitation of natural resources.
1973/1978 International Convention for the Prevention of Pollution from Ships (MARPOL) – Annexes I, IV & V are most relevant but Annexes I & II may be applicable to chemicals transported by sea to the installation.	Annex I - UK legislation – Merchant Shipping (Prevention of Oil Pollution) Regulations 1983 Annex IV - not entered into force as yet Annex V - UK legislation – Merchant Shipping (Prevention of Pollution from Garbage) Regulations 1988 Annex VI – Text recently finalised. Ratification by requisite number of states required prior to entry into force.
1982 United National Convention on the Law of the Sea (UNCLOS)	Text adopted in 1982; entered into force 1994. See Part XII, Protection and Preservation of the Marine Environment.
1992 United Nations Framework Convention on Climate Change (FCCC)	No specific requirements for offshore activities though some measures adopted as a result of this.
1992 United Nations Conference on Environment and Development (UNCED) and the adoption of Agenda 21	Not legally binding but offshore activities addressed with respect to calls for minimization of pollution and re-assessment of existing regulations.

United Nations Convention on the Law of the Sea (1982)

After nine years of negotiations the text of UNCLOS82 was agreed and opened for signature in December 1982. This brought together all previous conventions and treaties affecting every maritime activity.

However, due to the growing urgency of safeguarding marine fisheries which were already seriously threatened by over fishing, most of what was to become Part V of UNCLOS, the Exclusive Economic Zone (EEZ), was declared unilaterally by most countries from 1st January 1977 as Fishing Limits only extending out to 200 nml from baselines or to median lines agreed with neighbouring countries, e.g. the UK's Fishing Limits Act 1976, and also declared unilaterally by every member State of the EEC (now EU) and by the commission (EC). Thereby providing the legal basis for what is now the Common Fisheries Policy. This was introduced on the 1st January 1983 to curtail fishing in EU offshore waters, effectively what is now the EU EEZ area, and so safeguard commercial fish stocks. The CFP was first reviewed in 1992, and now a decade later to be completed by the end of 2002, any changes to enter force on 1st January 2003.

Article 56 defines the Rights, Jurisdiction and Duties of the Coastal State in the EEZ, which goes much further than just fisheries. Note in particular that the sovereign rights over natural resources, whether living or non living, apply only within the waters superjacent to the sea bed and of the sea bed and its subsoil, i.e. the water column. Also with regard to other economic activities in the zone, such as the production of energy from the water, currents and winds it authorizes and regulates the construction, operation and use of artificial islands, installations and structures for the exploration and exploitation of the sea bed and other economic purposes. Article 80 in Part VI extends the exclusive rights and duties in Article 60 to each coastal State's CS; under this Article coastal States must establish a system for notifying relevant persons of the construction of such installations, including their abandonment/dismantling and removal. This paved the way for partial removal of installations as it changes the wording 'entirely removed' that was present in the Geneva Convention 1958. The guidelines adopted by the IMO for the removal of offshore installations are also based on Article 60 of UNCLOS 82.

Article 61, Conservation of the Living Resources, requires the coastal State to determine the allowable catch of the living resources in its EEZ. Other duties follow from this; Article 62 requires the coastal State to promote the objective of optimum utilization of the living resources and lays down duties of management and regulation.

Because the EEZ stops firmly at a maximum of 200 nml from baselines, the water column beyond the EEZ is currently a free for all, and there is great concern to extend regional controls over highly migratory and straddling fish stocks. The UN Agreement for the Implementation of the Provisions of the UNCLOS, of 10th December 1982, relating to the Conservation and Management of Straddling Fish Stocks, was adopted on 4th August and opened for signature on 4th December 1995. This indicates the great urgency of extending protection to fish stocks outside the EEZ. Many of the straddle stocks are likely to congregate around offshore rigs and platforms in some regions.

Part VI of UNCLOS 82 'Continental Shelf' incorporates the Continental Shelf Convention 1958, which it revises and greatly extends in Article 76 in favour of the sovereign rites of the Coastal State; in cases where its CS continues beyond 200 nml from baselines , the maximum breadth is set at 350 nml, or shall not exceed 100 nml from the 2,500 m isobath, which is a line connecting the depth of 2,500 m. What is important is that Article 77, Rights of the Coastal State over its CS, gives sovereign rights (paragraph 4) over the mineral and other non-living resources of the sea bed and subsoil together with living organisms belonging to the sedentary species.

A high proportion of the sea bed nodule deposits is found outside any States extended CS area, as defined in Article 76, some in very deep waters(e g, 5,500m) , a fair proportion on top of sea mounts. These deposits are under deep ocean waters 'High Seas'. The Area is established by Part XI of UNCLOS 82, which declares in Article 135 that, "Neither this Part nor any rights granted and exercised pursuant thereto shall affect the legal status of the waters superjacent to the Area or that of the air space above those waters". Article 136 states that, the Area and its resources are the common heritage of mankind as a whole. The international Sea Bed Authority (set up under Section 4, Article 156) shall provide for the equitable sharing of financial and other economic benefits derived from activities in the Area. The Authority is now established in Kingston, Jamaica; The Enterprise (Article 170) shall be the organ of the Authority which shall carry out activities in the Area directly, as well as the transporting, processing and marketing of minerals recovered from the Area.

Framework Convention on Climate Change (1992)

This Convention sets out general principles on the protection of the earth's atmosphere and all contracting parties to it are required to stabilize concentrations of greenhouse gases at a level to prevent anthropogenic interference to the world's climate system. Although it does not lay down any specific requirements with respect to atmospheric emissions from offshore oil and gas exploration and production activities there have clearly been some steps taken in the process of regulating greenhouse gas emissions from these sources. These include the introduction of fiscal measures in a number of countries, for example, the imposition of a 'carbon tax' in Norway and the Netherlands, and a review of permitting arrangements for flaring and venting operations in other countries.

United Nations Conference on Environment and Development (1992)

Agenda 21 was adopted as a result of the United Nations Conference on Environment and Development. Although not legally binding it addresses offshore exploration and production activities by calling on states to minimize pollution from sea-based activities and to assess existing regulations with respect to offshore oil and gas installations.

REGIONAL TREATIES, CONVENTIONS AND GUIDELINES

A number of regional treaties, which address the issue of marine pollution from offshore oil and gas exploration, have been adopted to date. Of these, a significant number, such as the Barcelona, Kuwait and Jeddah Conventions, have been sponsored under the United Nations Environment Programme (UNEP). Others, such as the Paris and Helsinki Conventions of 1992, specifically address pollution arising from both marine and land sources in the semi-enclosed seas of the Northern Hemisphere.

The Kuwait Regional Convention is perhaps one of the most effective of these instruments as it places an obligation on operators within its jurisdiction to take appropriate measures to prevent, abate and control marine pollution. Machinery space discharges in special areas are regulated within the Convention by an oil in water content of less than 15 ppm; whilst the Kuwait Regional Organization for the Protection of the Marine Environment sets out standards for other discharges associated with offshore

production and national laws control both oil and water based drilling muds.

Other regional operational discharges from offshore exploration and production, concerning produced water and drill cuttings are specifically addressed in the Helsinki and Paris Conventions, whilst the Mediterranean Seabed Protocol (Barcelona Convention) additionally refers to sewage, garbage and machinery space water. Table II provides a summary of the regional treaties and conventions, which are considered to be the most important.

TABLE II: REGIONAL CONVENTIONS AND TREATIES

Regional Conventions and Treaties	**Comments**
1976 Barcelona Convention	UNEP sponsored treaty. Standards for produced water, machinery space discharges, drill cuttings, sewage and garbage provided by the 1995 Mediterranean Seabed Protocol.
1978 Kuwait Convention	UNEP sponsored treaty. Specifically addresses operational discharges by implementation of the 1989 Kuwait protocol. Standards for machinery space drainage, produced water, chemicals, garbage and sewage.
1982 Jeddah Convention	UNEP sponsored treaty (1982 Red Sea and Gulf of Aden Convention). Focuses on control of pollution from offshore exploration and production but sets no operational discharge standards
1981 Western and Central Africa Regional Convention (Abidjan)	UNEP sponsored treaty. Focuses on prevention, reduction and control of pollution from offshore exploration and production but sets no operational discharge standards.
1985 Association of Southeast Asian Nations (ASEAN Agreement)	Focuses on regulation and control of marine pollution but nothing specific for operational discharges from offshore exploration and production.
1992 Paris Convention	Addresses marine and land-based pollution in the semi-enclosed areas of the northern hemisphere and specific operational discharges. Produced water and drill cuttings standards.
1992 Helsinki Convention	Addresses marine and land-based pollution in the semi-enclosed areas of the northern hemisphere and specific operational discharges. Produced water and drill cuttings standards.

A summary of specific environmental provisions and controls for operational discharges and emissions from offshore exploration and production activities is given in Table III.

TABLE III SUMMARY OF SPECIFIC PROVISIONS AND CONTROLS

Emission or discharge	International level	Regional level
• Atmospheric emissions	• No specific controls although will be covered to some extent when Annex VI of MARPOL enters into force • Montreal Protocol although greenhouse gases not covered by the Protocol	• Abijan Convention for West Africa 1981
• Oily water discharges	• MARPOL (Annex I) for machinery spaces only. Produced water not addressed • Special Area status	MARPOL or specific regional legislation • Kuwait Convention • Barcelona Convention • Produced water addressed under Regional Conventions and treaties
• Oil based mud and contaminated drill cuttings discharges	• World Bank guidelines	• Paris Convention • Helsinki Convention • Kuwait Convention
• Chemical discharges	• No specific rules or regulations	• Chemical use plans and chemical notification schemes • CHARM initiative • Paris Convention • Barcelona Convention • Kuwait Convention
• Garbage disposal	• MARPOL (Annex V)	• Barcelona Convention • Helsinki Convention • Kuwait Convention
• Sewage discharges	• MARPOL (Annex IV), entry into force still awaited	• Helsinki Convention • Barcelona Convention • Kuwait Convention

National Statutory Environmental Requirements:

I would now like to briefly present the spectrum of national regulations referring mainly to our own and their relationship to OSPAR and with some subsequent reference to the regimes in the USA and Australia, thereby covering the more sophisticated and advanced approach.

Broadly speaking most oil producing countries have enacted some national legislation for the control of polluting discharges from offshore activities. In addition, various guidelines exist throughout the world, which have been developed under the guidance of national operator associations.

Oil content of produced water

The oil content in produced water from offshore oil and gas production facilities has been specified at the national level throughout many of the oil producing regions of the world. For example, the United Kingdom, Denmark, Germany, the Netherlands, Norway and Spain, all of which have offshore installations in the maritime area of the Oslo and Paris Conventions, have implemented national legislation with respect to produced water discharges. These countries have set a limit of 40 ppm. (monthly average) with a maximum peak discharge of 100 ppm. The average oil in water content of produced water discharged into the North Sea during 1991 was 34 ppm. A 30 ppm. standard has been mooted in the past by the Paris Commission and is likely to come into force in the not too distant future and continuous review of this standard is likely to occur. However, the UK Offshore Operators Association (UKOOA) continues to lobby for a target setting initiative in preference to a prescriptive approach.

Other national authorities may also review this standard whilst some, by legislation, have already imposed more prescriptive standards than those defined within regional treaties and conventions. In the developing countries of the Far East and other areas of the world discharge limits currently tend to be higher than elsewhere.

Atmospheric emissions

There are currently no statutory environmental requirements at the national level, other than the fiscal measures that have been mentioned earlier, although there is some emphasis on the review of permitting and consent arrangements. The text of the recently adopted Annex VI, which is open for ratification from early 1998, will lead to some additional controls for the offshore industry with respect to NO_x emissions from diesel engines. However, despite this the greenhouse gas CO_2 (which arises from flaring and is a major offshore atmospheric pollutant) is currently largely uncontrolled by legislation.

Chemicals

In general, regulation for the use, storage and disposal of chemicals is by Chemical Use Plans and Chemical Notification Schemes. In some countries the Environmental Impact Assessment is used to support the use of certain chemicals whilst others tend to adopt an approach of 'approval for use' by a competent authority. Vietnam, for example, has adopted this latter approach where only chemicals having approval from the Ministry of Science, Technology and the Environment can be used offshore.

Oil contaminated drill cuttings and fluids

Very few of the major oil producing countries, other than the Netherlands and Norway, completely prohibit the offshore disposal of oil contaminated drill cuttings. Some national legislation has been enacted, for example, in those countries in the maritime area of the Oslo and Paris conventions where limits of 10% and 1% have been set for development and production wells respectively. The 92/2 PARCOM decision has changed this to 1% oil on all cuttings, except in 'exceptional circumstances' from the beginning of 1997. Furthermore, other countries have completely prohibited disposal in

environmentally sensitive areas or have geographical restrictions on disposal in place. As the issue of drill cutting and fluids disposal is very much related to the offshore use of chemicals, approval following toxicity testing is a requirement in some countries.

Deck drainage, sewage and garbage

Regulation for the disposal of machinery space drainage and garbage have generally been implemented in most countries within the requirements of the merchant shipping industry under MARPOL regulations. Some countries have gone further than this and have implemented specific regulations that go beyond these requirements.

OSPAR QUALITY REPORT

Much of the guidance that I obtained for writing this paper came from the OSPAR Draft Quality Report 2000.

It comprehensively addresses the environmental issues in the 5 OSPAR regions:

1. Arctic Waters
2. The Greater North Sea
3. The Celtic Seas
4. The Bay of Biscay and Iberian Coast
5. The wider Atlantic

The Ministerial Meeting of the OSPAR Commission at Sintra (Portugal) in July 1998, in which the UK DETR participated fully, agreed strategies aimed at guiding the future work of the Commission.

In 1999 the Commission then adopted strategies for the purpose of directing in the medium to long term the following five main objectives:

Protection and conservation of ecosystems and biological diversity
Hazardous substances
Radioactive substances
Eutrophication (nutrient rich, oxygen depleting)
Environmental goals and mechanisms for offshore activities.

The aims and scope of the Report are, and I quote:

"Take all possible steps to prevent and eliminate pollution and take the necessary measures to protect the marine area against adverse effects of human activities so as to safeguard health and conserve marine ecosystems and where practicable restore marine areas which have been adversely affected".

The OSPAR Convention and the Report provides in summary form

1. A description of the Impact of Human Activities on the Maritime Area
2. Effectiveness of the measures that have been taken to safeguard the marine environment.
3. Limitations of knowledge which constrain these descriptions and evaluations.
4. Identification of "Priorities for Action".

In addition, in the natural environment there are numerous features of archaeological importance such as ancient tombs, buildings and historic wrecks. Examples are the submerged villages off the South Coast of England and submerged ancient sites in the Mediterranean.

Archaeological remains and shipwrecks are subject to the risks of disturbances and destruction by mineral extraction, dredging, pipe laying and pollution. Special legislation for their protection exists in all regions. The European Convention on the Protection of the Archaeological Heritage regulates sites both on land and at sea. A draft Convention on the underwater cultural heritage is also under debate in the UN system.

In any discussion regarding the marine environment the question of the management of the fishing industry is of enormous importance. Currently approximately 3 million tonnes are obtained from the North Sea. Landings from industrial fisheries (mostly sandeels) account for 55% of this total weight. The finite nature of this paper does not allow space to present any details of this critically important industry. Management within the OSPAR region is regulated within EU waters by the Common Fisheries Policy, described earlier, and within Faeroes, Icelandic and Norwegian waters by national policy and legislation.

Commercial shipping, its navigational requirements and land-based installations have various impacts on the marine environment. These include large-scale coastal development for port facilities, the dredging and disposal of sediments, the transfer of non indigenous species through ship's ballast water, hull fouling and the operational, accidental and occasionally illegal release of oil. In addition shipping causes inputs of hazardous substances through the cleaning of tanks, the burning of fuel which may contain waste products, losses of antifoulants containing biocides, release of waste water and garbage, loss of cargo and dumping of litter.

In north west Europe the seas around Ireland and their approaches have received the status of a Special Area under MARPOL Annex 1 (oil) as from 1st August 1999. This means that the discharge of oily cargo residues into the sea from any oil tanker is prohibited. Limits for bilge water from machinery spaces remain 15 ppm, although a "Special Area" demands modern oily water separation equipment.

The International Maritime Organisation has a comprehensive regulatory regime administered mainly through the Maritime and Coastguard Agency, or its equivalent abroad, and the classification societies to control pollution from ships. The success of this regime has been greatly assisted by the development of onboard equipment, storage and reception facilities in ports and a general consciousness within the shipping industry.

Some 95% of the world's trade is carried in ships and volume is increasing. This amounts to approximately 6,500 million tonnes of cargo in 2000 and is predicted to double by 2012 with a corresponding increase in ships. In Europe alone there are 500,000 shipping movements per year. Fortunately this industry has had a long period of regulatory evolution and is subjected to a relatively intensive regime of hands on audit and survey; involving, amongst many others, Flag State, Port State and classification surveys. Accidents at sea such as the Torrey Canyon, Braer, Amoco Cadiz and Erika have resulted in enormous public interest and demand for enquiries with binding recommendations. In my opinion the current regime with its dynamic nature, in line with technological advances, is adequate for this industry given the practical nature of change. When OPA 90 was introduced in the USA it obviously had a political dimension and I believe that in Europe it would be detrimental to the economy and to European competitiveness if we followed a similar route.

The environmental policy framework for the OSPAR area is developed through the International Conference on the Protection of the North Sea; under the OSPAR Convention, in the framework of the European Union, by the Trilateral Governmental Wadden Sea Conferences, under the Bonn Agreement, and indirectly under the London Convention and in the framework of the IMO.

It takes into account the Rio Declaration and policies developed under the Convention on the Protection of the Marine Environment of the Baltic Sea (1997/1992) and interrelated river conventions for the Elbe, Rhine, Scheldt and Meuse.

The environmental policy objectives of the European Union are contained in the "Amsterdam Treaty" of the EU (1997). These fully comply with the regulations contained within the OSPAR Convention.

There is also ample evidence of Regional Conventions and Regulations being compatible with and complementary to the actions of the United Nations. For example:

- The UN Conference on Environment and Development (UNCED 1992 Rio de Janeiro) which made sustainable development an underlying principle in the development of environmental policy.

- At UNCED the Convention on Biological Diversity (CBD) was signed.

In 1994 the UN Convention on the Law of the Sea (UNCLOS) entered into force, setting out the overall legal framework for the Governance of the Oceans, also including environmental issues.

The IMO, which is a UN body, deals with the safety of shipping and the protection of the marine environment against risks related to shipping. The IMO Marine Environmental Protection Committee (MEPC) addresses issues relating to the prevention and control of pollution from ships. As well as conventions relating to ship safety, IMO has agreed on the "International Convention for the Prevention of Pollution from Ships (Marpol 73/78) which relates to operational discharges from ships.

Of particular importance to the activities of the OSPAR Commission is its intention to "Identify Priorities for Action". This programme is outlined in QSR 2000 and covers such important issues as:

a) The effect on the marine environment of harmful algae blooms.
b) The effect of climate variability and changes in physical conditions.
c) Bacteria associated with the (treated and untreated) discharge of sewage.

The 'OSPAR Strategies' offer the possibility for making real improvements, over the next generation, in the condition of the marine environment of the 'North East Atlantic'.

It is initiatives such as this that will influence similar regulations in other parts of the world. This I believe will evolve in the less developed regions through the globalisation of company policies associated with all their commercial activities in the marine environment and compliance with regional treaties.

In general NW Europe, Australasia and North America apply the relevant codes and conventions of the IMO. These have been ratified by some 158 countries and are the international basis for safety and environmental protection in the marine environment. They form an integral part of the comprehensive regulations for most nations such as the three groupings mentioned above. In themselves they are not adequate to provide protection to the marine environment with regard to mineral workings. This responsibility is however vigorously pursued by national administrations in the EC countries, Australasia and North America. Despite the fact that the regulations are written into different national codes they generally address the same issues and there is evidence, from the adoption and authorisation process, that the trend is towards a common set of objectives with similar threshold limit values and practices during all operations, including decommissioning.

These practices are increasingly being applied as global uniform policies by the major and responsible operators; therefore when a project is being established in a less developed region there is a tendency to apply these converging strict regulations and practices.

For example, in operations around the Faeroe Islands the international operator has been strongly guided by the limited administration to apply a hybrid of the best practices for the NW European region.

Off West Africa, which generally has immature environmental protection administrations, the major operators are increasingly using the best practices. Not only out of a sense of responsibility but also to protect their own reputation.

NORTH AMERICA.

In the USA the regulation of offshore oil and gas activity is shared between the Minerals Management Service and the United States Coast Guard. The division of responsibility is defined in a 'Memorandum of Understanding' between the two authorities. To date, offshore exploration and production has involved fixed platforms, spars, tension leg

platforms and semi-submersibles. In line with practices in the rest of the world, the USA is now seriously investigating the use of Floating, Production, Storage and Offloading vessels, in particular for deep-water operations in the Gulf of Mexico. These are essentially a less expensive, more versatile and operationally more practical solution for offshore production. However, because they are considered as a new technology for the region an Environmental Impact Statement will be necessary before the first FPSO can be located. Operators must also submit a Deepwater Operations Plan to demonstrate that the facility can operate in a safe and pollution free manner.

The operators have recognised the significance of the EIS in terms of time and resource. Through the Deep Star (Deepwater Staged Recovery) project, they jointly funded the EIS study. This is now available in draft form and is to be the subject of a "Public Hearing Schedule". The approach has been generic and not site specific. Specific site proposals will have to undergo review by the MMS and Coast Guard as well as affected States, for consistency with their 'Coastal Zone Management Plans' and will require permits from the Environmental Protection Agency.

Federal regulatory agencies have established certain requirements for the asset design, fabrication, installation, layout and for operational facilities. In addition to federal regulations, certain state municipal and local regulations and conventions may be applicable.

One of the primary documents to be applied is the American Petroleum Institute Recommended Practice 75, which identifies all the relevant IMO Conventions, Codes of Federal Regulations and API standards. Particular reference is given to API. RP 14J. Recommended Practice for Design and Hazard Analysis for Offshore Production Facilities.

As an ongoing procedure the API on behalf of the regulatory bodies carries out an annual survey of the industry to determine the degree of compliance with all federal regulations. Compliance with IMO and other regulations are usually audited by the classification societies.

Canada, which has the largest administered offshore area has a very comprehensive and effective administration. As the result of a complete reorganisation in the 1990's which included 'The Oceans Act 1995', all the offshore and administrative assets were brought together under a single organisation –fisheries and oceans environment, attorney general (RCMP), transport and defence; without disturbing the departmental responsibilities of each.

It is an important feature of the equivalent UK compliance practice that the classification societies operate a Standards Verification Regime, which can extend beyond a minimum scope and is used by the operator to strengthen submissions and improve procedure control.

AUSTRALIA

The situation in Australia is complex mainly due to the enormity of the offshore regions for which it is responsible. Much of their legislation and regulations are based upon UK North Sea practice and as befits an advanced and environmentally highly responsible country the practices required from operators are comprehensive.

Australia has the second largest administered offshore area in the world. As a result of the United Nations Convention on the Law of the Sea (UNCLOS) Australia has a 12 nautical mile territorial sea, 24 nml.contiguous zone and 200 nml.exclusive economic zone (EEZ). Some disparity exists between Australia's declared fishing zone and the EEZ, which will be resolved by the legislative process in 2004.

The mechanism by which the seabed is made available for oil and gas exploration is the Commonwealth Offshore Gazette Programme.

The Australian Geological Survey Organisation, a unit of the Commonwealth Department of Industry, Science and Resources, performs broad regional geological surveys and then releases the data at the annual Petroleum Production and Exploration Association Conferences in April.

The Commonwealth of Australia is a federation of six states, one of which is Western Australia. The Commonwealth also administers 10 territories (Christmas Islands, Cocos Islands etc).

The states were constituted at a time when the view prevailed that the laws of a country extended offshore for 3 nautical miles after which existed high seas or international waters. This situation stills exists in the context of the states, thereafter responsibility lies with the Commonwealth.

Australia operates various arrangements between the Commonwealth and the States with respect to 'delegated authority' where the state administers a Commonwealth responsibility. Many of these arrangements impact the marine industry particularly in the area of oil and gas.

The rather arbitrary north south boundary between Western Australia and the rest of the country has its origins in the Treaty of Tordesillas (1494, revised 1506) dividing the unexplored world between Portugal and Spain. The Treaty line was defined as 370 leagues west of the Cape Verde islands (the exact location of which was at that time in some doubt).

East Timor was the most eastern possession of Portugal in the exercising of its rights under the Treaty. This is very significant in the current geographical relations between Australia, Indonesia and East Timor. The Timor Sea covers an area rich in oil and gas yet is very complex in terms of maritime boundaries due to a number of historical accidents.

As a result of the emergence of the new state of East Timor, and from responses to questions raised in the Australian Federal Parliament in late 1999, it is believed that the existing co-operation treaty between Australia and Indonesia, which defines amongst other things mineral responsibilities, will revert to the new State.

The NW of Australia now ranks in the top 5 or 6 offshore exploration provinces in the world due to a combination of political stability, equitable fiscal regime, regional geography and good discovery statistics.

The overlying systems are complex but do work effectively. High labour costs, which came with a high standard of living, are not resulting in additional operating costs. For most operators the big deficit in the system is shore-based infrastructure.

Petroleum operations beyond the 3 nml. limit are governed by the Commonwealth Petroleum (Submerged Lands) Act 1967. PSLA administration is largely delegated to the States. For example the State of Western Australia and Northern Territory have the responsible authority, The Department of Minerals and Energy. Other states have similar bodies.

We all appreciate the very great responsibility that the Australian Authorities have in protecting such an enormous region. Nevertheless they are effective and also exert considerable influence in the Zones of Co-operation, in particular the environmentally sensitive shallow seas areas.

THE EUROPEAN COMMISSION.

It is of course essential to make reference to the EC when debating European Legislation and Directives. The latter are in good time being enacted into the various national legal frameworks.

Currently the member states, including the UK, are working with the Community on, amongst many other directories, Council Directive 1996/61/EC of 24th September 1996 concerning integrated pollution prevention and control. This Directive is based upon a clear philosophy in preventing, reducing and as far as possible eliminating pollution by giving priority to intervention at source and ensuring prudent management of natural resources in compliance with the polluter pays principle and the principle of pollution prevention.

The Directive is not directed solely towards the marine environment. It covers all industrial and social activity.

As far as I can determine the Directive has a high level application in that the underlying Codes and Regulations, such as described for the UK, must provide the level of protection and philosophy required by the Directive. In no way does it prescribe in detail the practices, procedures and limiting values for compliance by an independent audit or survey.

THE ISSUES

This paper presents the opportunity to refer to just some of the issues relating to dangers to the marine environment that are more commonly discussed:

1. *Drilling Muds and Cuttings*

   When a well is drilled, just like drilling wood with a domestic bit, small pieces of rock called cuttings are produced. These cuttings vary in size and texture from fine silt to gravel. They are carried back to the surface by drilling mud; a special fluid used to lubricate and cool the drill bit and to plug the well and prevent 'blow outs' of oil or gas. At the rig the cuttings are separated from the mud which is recycled to use again. The small rock cuttings are discharged to the seabed, taken ashore for treatment or re-injected into the well.

   There is an historical legacy of drill cuttings, which have accumulated beneath offshore installations both in the North Sea and elsewhere. The United Kingdom Offshore Operators Association (UKOOA) 'Drill Cuttings Initiative' will identify the best environmental practice and techniques available for dealing with these accumulations in accordance with the principles set out by the OSPAR Convention.

   It is estimated that a total of between 1 million and 1.5 million tonnes of cuttings have accumulated in the UK northern sector of the North Sea in over 30 years of drilling activity. This compares with 26 million tonnes of household waste produced in the UK each year and about 400 million tonnes per year from all sources.

   Accumulations have not occurred in the southern sector where the higher water currents and wave actions have dispersed them, enhancing natural degradation.

   In the northern UK and the Norwegian sectors, because of deeper water, the seabed currents are far weaker. The cuttings have accumulated on top of each other preventing oxygen and other degrading seawater constituents from penetrating to those below.

   Drill muds serve a number of purposes and may be water based, oil based or synthetic. Synthetic and water based muds are now used on most installations; they are expensive and therefore considerable effort is made for efficient use and recycling and the content is controlled by strict regulation.

   It should also be noted that new drilling techniques, such as slim hole and long distance horizontal drilling are reducing the quantity of cuttings produced.

2. *Oil in Produced Water*

   In the North Sea this originates from two sources. First water, which has been trapped within the oil-bearing rock, is brought to the surface during routine production operations; oil and gas reservoirs usually have a natural water layer at the bottom called formation water. The second is injected seawater, which is used to

increase the pressure in the well and thereby maximise oil and gas recovery. As wells become older increasing amounts of seawater are injected.

The mixture of oil, gas and water is separated on the platform and, provided that the oil content in the first water stream is within the threshold regulations, it is discharged over board.

As the North Sea oilfields mature it is a characteristic of the well product that the fraction of water increases. The regulatory limit for oil in the water to be discharged is 40 ppm . Nevertheless the UK industry has set a voluntary target of 30 ppm which it strives to maintain.

The volumes of both the produced water and the oil discharged with it have shown a slow but steady rise as more and more fields mature.

3. *Metals*

As stated earlier, drill cuttings are the material bored out on the way to the well and it is inevitable that they will contain some metal concentrations.

The presence of detectable concentrations of metals in the environment does not necessarily indicate the existence of pollution. I have not been able to identify any significant additions to the naturally occurring concentrations as a result of drilling or oil/gas production activities. At their natural concentrations many metals play an essential role in biochemical processes: organisms are also able to adapt themselves, at least partly, to changing metal levels.

The input of metals varies from region to region. For offshore areas remote from riverine and direct discharges, atmospheric input is likely to dominate. Nevertheless there was a reduction in riverine input between 1990 and 1996. Specific examples include mercury inputs from two chlor-alkali plants in Portugal where inputs decreased from 284 to 45 kg/year.

Atmospheric inputs of metals to the North Sea have decreased by 50-65% between 1987 and 1995 so that the dominant source can be traced to rivers. Decreasing atmospheric lead inputs have been attributed to a reduction in the use of alkyl lead derivatives in petroleum. In oceanic areas cadmium and to a lesser extent copper behave similarly to nutrients. Biological activity in surface water incorporates the elements into particulate material. The decomposition of the particulate material as it sinks leads to a regeneration of the incorporated elements. By contrast the depth profile of lead (with a dominant atmosphere source) exhibits a surface maximum in concentration, followed by a decrease with depth associated with dilution and scavenging by particles.

Examples of situations where metal (except copper) concentrations exceed the upper Ecotoxicological Assessment Criteria (EACs) are unusual. Such instances are limited to cadmium in estuaries of the North Sea and mercury in some near shore areas. In areas where monitoring has taken place for copper, the EAC limit is routinely exceeded almost everywhere. The EAC for copper is however less useful as a

criterion because the toxicological value is only slightly higher than the value needed to avoid biological deficiency.

The question of the toxicity of metals is central to the arguments surrounding the decommissioning, abandonment and toppling or sinking of redundant offshore installations.

To put the metal toxicity into context, it should be noted that the natural release of metals is several orders of magnitude greater than could be experienced by sinking all known offshore installations. The Broken Spur hydrothermal vent field in the North Atlantic range alone releases up to 5 million tonnes of metals per year.

Ocean floor sediment lying on new mid ocean crust can be extremely rich in metals. For example in the North East Pacific a small areas measuring 600 metres x 1200 metres was found to contain 1.5 tonnes of uranium within its top metre of sediment as well as 4000 tonnes of magnesium together with many other base metals. Thriving biological communities exist around many metal rich seabed deposits for which the supply of heavy metals is essential. Nevertheless it would be disastrous for the food chain to involve fish that had existed in metal rich environments. By this I mean those metals with high toxicity such as lead, mercury, cadmium and tin etc.

The ocean floor environment is diverse and for any analysis addressing metallic pollution it is essential to consider water depth and geographical structure. Nevertheless there is much informed opinion that dumping of redundant structures can with careful choice of location and prior cleaning of process spaces be beneficial to the bacteriological and planktonic environment and subsequently to more advanced forms of marine life such as base fish populations.

DECOMMISSIONING

There is much debate and counter opinion within the industry and scientific community regarding the disposal of redundant offshore installations. Nevertheless, and possibly as the result of an unbalanced argument, the situation has now been finalised in the form of OSPAR Decision 98/3. Paragraph 2 of the Decision states that, "The dumping and leaving wholly or partly in place of disused offshore installations within the maritime area is prohibited."

A disused offshore installation is defined as one which is neither "serving the purpose of offshore activities for which it was generally placed within the marine area" nor "serving another legitimate purpose in the marine area authorised or regulated by the competent authority of the relevant Contracting Party".

However, it excludes any part of an offshore installation which is located below the surface of the seabed or any concrete anchor base associated with the floating installation which does not, and is not likely to, result in interference with other legitimate uses of the sea.

This will allow the competent authority (in the UK's case the DTI) to issue a permit to an operator to leave part or all of the footings in place.

However, the intention of the 'Decision' is to make derogations increasingly difficult to achieve. It is the intention of the Convention to "strive to avoid using such derogations of footings of steel installations, by returning to land for recycling and disposal all steel installations where it is safe and practicable to do so."

I have no doubt that this decision will be strongly argued against in future. Its opposers state that it is flawed for the following reasons:

- It is not based upon adequate scientific evaluation of the environmental problems posed by the rigs themselves, their value if left in position or used as artificial reefs, or the environmental impact of their removal or disposal.

- No best practice environmental option evaluation was undertaken.

- The decision, it is claimed, is estimated eventually to cost the British taxpayer some £22bn to implement.

Obviously any changes which may result from counter argument will take considerable time, therefore the only option in the OSPAR region is to comply with the regulations. This is the current practice.

There is substantial historical, scientific and experimental evidence to support the concept of increasing biodiversity, improved fishing opportunity and protection of the ocean environment. Thousands of ships have sunk for a variety of different reasons, sometimes large warships, over the past 300 years in particular. Often these have formed habitats in which crustaceans, cetaceans and fish have thrived. As an experiment, artificial reefs composed of lime coated discarded tyres were formed off the coast of Columbia by Texaco, thereby transforming a barren sea bed into an oasis of fish life and returning to the indigenous coastal people an opportunity for an additional food supply.

As an Engineer rather than a marine biologist, I have attempted to analyse opinion from as many sources as possible including environmental pressure groups. The overwhelming conclusion that I have is that this debate should be re-opened with balanced argument and scientific evidence from all parties. It is not just a financial issue, it may well be on balance, an environmentally negative legislative Decision.

There are a number of innovative solutions towards the removal of installations some of which weigh in excess of 20,000 tonnes and may have large templates or gravity support structures. For the removal of large platforms these are mainly at the design stage and are likely to be very expensive systems.

THE INDUSTRY APPROACH

As you can imagine with such a well-funded, high technology industry there will be ongoing research and development, which will introduce more environmentally safe methods of production. For example Asea Brown Boveri (A.B.B.) are developing sea bed

located production installations. They have now installed their first SUBSIS separation system in the Troll field, about 60km. west of Bergen in the Norwegian sector of the North Sea.

SUBSIS separates oil and gas and pumps solids and oil free water from the oil stream directly back into the reservoir. It is claimed to reduce the amount of chemicals needed by conventional surface systems to maintain the flow of oil, allows considerable energy savings and improves the oil recovery rate by as much as 50%. This technology should result in reduced total field investments, operating costs and development time. To the best of my knowledge this is the first significant step towards offshore oil and gas production running from the seabed directly to shore.

The unit operates by electrical power from the surface through an umbilical supply.

SUBSIS would appear, in particular applications, to be a considerable improvement on many surface installations and is claimed to present major environmental impact benefits.

SHELL ENVIRONMENTAL IMPACT STUDY

A single paper presents very little opportunity to present actual examples of a well development projects, however for completeness I will give some details of a very successful recent case carried out by Shell UK Ltd on a block licensed equally to Shell and BP.

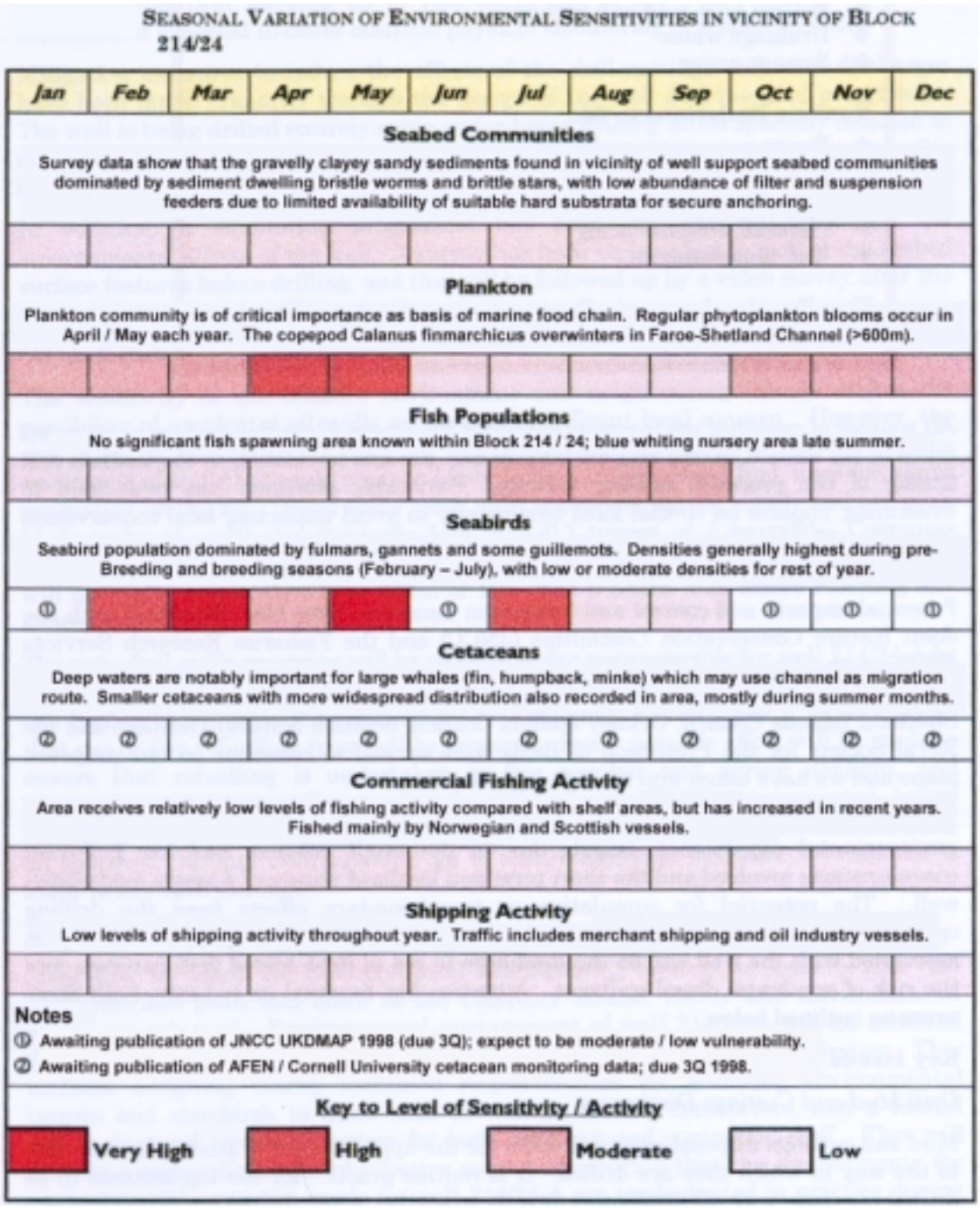
It is a requirement under the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1998 to submit an environmental statement as part of an environmental management process.

The well is identified as 214/24A and lies on the mid West Shetland slope in 653 metres of water. It was drilled vertically to a depth of 3508 metres and was expected to yield gas rather than oil.

The seabed is covered by a veneer of gravelly sand overlaying a thicker layer of soft silty clay and occasional pebbles. The cold water coral Lophelia Pertusa although present on some steeper Atlantic slopes occurs very rarely on the West Shetland Slope and has not been recorded in the vicinity of the well.

A considerable amount of environmental information is accumulated for an E.I.S. eg.

Table IV: Seasonal Environmental Sensitivities



(Courtesy of Shell U.K. Ltd.)

All known sources of potential environmental impact were identified and an assessment made of any effects in relation to the location and timing of the proposed drilling activity.

These were discussed with:

- Joint Nature Conservation Committee

- Fishery Research Services (FRS) of the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD)
- In addition a wide range of other organisation including:
  Shetland Island Council
  Orkney Islands Council
  Scottish Natural Heritage
  Royal Society for the Protection of Birds

All the organisations were invited to submit their comments on the proposed plan and these were incorporated into the management process.

The E.I.S. was conducted by an independent consultant.

The exploration company has been certified to the International Standards Organisation (ISO) Environment Management Standard 14001 which is a very demanding audit procedure carried out by a limited number of accredited independent certifying organisations.

Table number IV identifies elements of the biological environment from which it can be seen that:

There is a significant plankton population mainly in the Spring, when it rises to the surface and circulates into the North Sea and is an important food source for fish stocks.

There are significant populations of fish (haddock, monkfish, blue ling etc). Due to the confluence of different temperature currents, the deeper waters have commercial quantities of Greenland halibut and Arctic skate.

The waters between the Shetlands and Faeroe Islands hold internationally important numbers of seabirds and are also visited regularly by whale and dolphin. Of the larger whales, fin whales are the most frequently recorded species followed by minke and humpback.

The Shetland Islands are also home to significant populations of seals and sea otters.

The well was drilled by the semi-submersible rig Ocean Alliance. This has an all steel twin hull construction and is self- propelled. It employs a dynamic positioning system, which obviates the need for any anchoring arrangements.

The well is designed to be plugged and temporarily abandoned at the end of the drilling operation. Sealing will be with a series of cement and mechanical plugs and all casing strings will be cut to a minimum depth at 3m below the seabed. In addition a Remotely Operated Vehicle (ROV) survey, after completion, will be carried out to ensure that no debris remains on the seabed.

A very detailed analysis is then made to determine the environmental impact of routine or accidental occurrences based upon the following parameters:

Table V

Routine Discharges to Sea

- ❖ Top hole mud and cuttings
- ❖ Cementing
- ❖ Bottom hole mud and cuttings
- ❖ Drainage Water
- ❖ Sewage water

Routine Emissions to Air

- ❖ Power generation emissions

Routine Physical Presence

- ❖ Physical presence of rig
- ❖ Well abandonment

Non-Routine Losses to Sea

- ❖ Accidental oil spills

In the drilling, as previously stated, process chemicals are regularly used to improve the efficiency of the drilling mud. The UK Revised Offshore Chemical Notification Scheme (OCNS) groups chemicals according to their environmental affect. Groupings are from A-E (0-4) with A and 4 being those with the greatest potential for adverse environmental effect. In this particular well all fall within the least damaging groupings D or E. These chemicals are therefore some combination of non-toxic and/or rapidly biodegradable and/or non-bio accumulating elements and their use and discharge for this particular exploration well will have no significant environmental effects.

In summary the achieved Environment Targets were:

Table VI

Environmental Targets – Well 214/24-A

- Use of WBM in all hole sections.
- Selection of mud chemicals in OCNS Categories E/0 or D/1.
- Pre-drill side scan sonar to check seabed fauna.
- Post-drill video survey to determine cuttings pile formation.
- No well testing.
- Strict fuel loading procedures to minimise diesel spill risk.
- Provision of approved Oil Spill Contingency Plan and resources.

CONCLUSION

As stated in the Paper and in accordance with evolving legislation, operational practice and societal requirements, it is essential to protect the global environment. I suggest that the following parameters will have the greatest effect towards achieving this goal in the maritime area:

1. Maintaining the current practice of strong environmental regulations and practices within Western Europe, North America and Australasia.

2. Best option for Environmental Protection from globalisation of standards and practice.

3. Causes of marine pollution must be carefully identified and dealt with at source.

4. At a detail level the requirement for an Environmental Impact Assessment is universally essential.

5. International loans, guarantees and technical assistance to be geared to adequate environmental protection.