ENVIRONMENTAL FACTORS IN THE MANAGEMENT OF THE OIL AND GAS INDUSTRY IN NIGERIA: By M.K. Ukoli

1.0 Introduction

For over four decades, Nigeria continues to experience remarkable increases in operational activities in her oil and gas exploration and exploitation, refining and products marketing. The onshore activities centered mainly in the Niger Delta area have generated massive wealth for the nation and it is nationally acknowledged, that the natural blessings of this area, known for its difficult land terrain of swampy rain and mangrove forests, have contributed most to the socio-economic development of the entire country especially in the areas of foreign exchange earnings, provision of job opportunities (employment), physical infrastructure in education, health, communications, power, etc. The euphemism, "crude oil is to the Nigerian economy as the Nile is to Egypt" appropriately describes the importance of this non-renewable resource to our nation. Behind this glossy facade of financial benefits however, the industry has created serious health and environmental pollution problems for the country in general and the host communities of the oil companies in particular. The environmental impacts of these activities have been of concern to government regulatory agencies, oil companies' operators as well as the host communities. Violent protests by communities are the most eloquent testimonies of the resistance to the general pollution of the environment by the activities of oil companies.

Consequently, various control programmes and policies have been articulated by government for the mitigation or amelioration of environmental problems associated with the oil and gas industry. It is however doubtful, whether the mitigation measures are being implemented efficiently and

effectively.

2.0 What is petroleum?

Petroleum is crude oil, a naturally occurring liquid that can be distilled or refined to make fuels, lubricating oils, asphalt, and other valuable products. Used in a broad sense, petroleum also refers to natural gas, asphalt or tar (obtained from tar sands - a mixture of tar and thick viscous heavy oils). Crude oil is refined into fuels, including petrol, kerosene, jet fuel, diesel fuel, furnace oil etc. It is also the source of greases and waxes. Crude oil and natural gas are used to make feedstock (ethylene, propylene, butadiene, benzene, toluene, xylene, ammonia and methane) for the manufacturing of hundreds of petrochemical products, including paints, plastics, synthetic rubbers and fibres, fertilizers, drugs, and explosives such as trinitroluene (TNT - by nitration of toluene obtained from coal tar and dynamite (nitroglycerin mixed with some absorbent substance to reduce danger of explosion by shock). TNT mixed with other chemicals such as ammonium nitrate, powdered aluminum and charcoal produces Amonal which is a more powerful explosive than TNT.

3.0 Characteristics of Crude Oil

3.01 There are many different varieties of crude oil, ranging from very fluid volatile liquids to viscous, semi-solid materials. Crude oil is mainly either black or green, but it can also be light yellow or transparent. Crude oil varies considerably in density and is described as heavy, average or light. The densities of different crude oils are usually compared using the degrees-API-gravity scale devised by the American Petroleum Institute(API). Oils with 10^{o} API gravity or less are heavier than water. Heavy oils have 5^{o}-20^{o} API gravities. Average crude oils have 20^{o}-25^{o} API gravities. Light crude oils have 25^{o}-55^{o} API gravities, they are very fluid and can be produced from sub-

surface reservoirs faster and in greater quantities than can the heavy crude oils. Light crude oils are more valuable because they contain more petrol- the most valuable product refined from petroleum.

3.02 Crude oils and natural gas are called hydrocarbons because they are composed of compounds made up of entirely carbon and hydrogen, along with some minor impurities - Sulphur, Nitrogen and Oxygen. The main difference between crude oils and natural gas is the size of the hydrocarbon molecules. Those in natural gas have one to four atoms of carbon each and at the earth's surface they exist as gas. Crude oil is composed of many different hydrocarbon molecules, each with five to sixty carbon atoms. The molecules are in straight chains, circles or chains with side chains.

3.03 Liquid hydrocarbons exist in deep reservoirs, where it is very hot. At these high temperatures, some hydrocarbons that are normally liquid occur as gas and natural gas mixtures. When the natural gas is brought to the surface, the gas cools and the liquid molecules condense, forming a liquid called condensate. Sulphur exists to varying extent as an impurity in some crude oils. When the crude oil contains less than 10% Sulphur it is called a sweet crude. When it contains more than 10% Sulphur it is called a sour crude. Sulphur is removed before refining and because it requires this extra processing, sour crude is worth less than sweet crude.

3.04 Crude oils are often classified according to their content. There are three types:

Asphalt-based crude	-	usually black in colour and when refined produces high quality petrol and asphalt.
Paraffin-based crude	-	usually greenish in colour and when refined they produce more paraffin wax and high quality motor lubricating oils.
Mixed-based crude	-	are a combination of the other two.

Crude oil volumes are usually measured in barrels. One barrel holds 42 gallons (159 litres) and weighs approximately 0.15 ton.

4.0 Operations of the Nigerian Oil Industry.

The operations of Nigeria's oil industry are in three major areas; crude oil exploration and exploitation (production), oil refining and petroleum products transportation and marketing.

4.01 Crude Oil Exploration and Production

Geologists are employed to explore for crude oil and natural gas and to help develop proven reservoirs. In Nigeria crude oil occurs at a depth of between 200-300 meters and offshore at a depth of about 200 meters (M.O. Ojo and B.S. Adebusuyi1996), below ground level, usually with associated gas, condensates and tar sands. Extensive exploration activities confirm that petroleum exists in seven prospective basins - Niger Delta Basin, Anambra Basin, Sokoto Basin, and the Benue trough, while condensate deposits are in the southeastern shelf. Tar sand deposits have been discovered in Ogun, Ondo and the western fringes of Edo State.

Nigeria's proven oil reserves now stand at approximately 30 billion barrels and tar sand estimated at 31 billion barrels of oil equivalent.

Present commercial activities in oil exploration and production are concentrated in the Niger Delta Basin and the continental shelf. These activities are mainly onshore in the dry or swamp lands of the Niger Delta Basin and deep offshore locations of the Dahomey Basin.

Relatively small fields characterize Nigeria's crude oil production; producing 500-5,000 barrels per day (bpd). About 65% of the oil produced is light sweet crude; very high quality crude with an

API- gravity of 35^{o} or higher. In 1992, Mobil's Oso condensate field came on stream with approximate average production of 110,000 bpd. Shell is responsible for over 50% of the crude oil produced in Nigeria, from it's over 100 different fields. The oil reserve of Shell stands at over 11 billion bpd. Mobil and Chevron joint ventures come next to Shell. Mobil Producing Nigeria operates offshore from Eket in Akwa-Ibom State, while Chevron Nigeria is principally an offshore producer with its operational base at Escravos, in Delta State.

The total combined average production, export and local consumption of crude oil, are indicated in annex 1.which indicated a mean annual production, export and domestic consumption of 642,476,750bls 574,190,890bls and 66,046,680 bls respectively between 1970 and 1997. While the export of crude oil averaged 89.21 % annually, only an average of 10.50 % of production was consumed locally.

During the same period, 1970-1997, the total gas production, local consumption and flared associated gas, are indicated in annex 2. This table indicated a mean annual production of associated gas, domestic consumption and flared associated gas of 23,261.36 million m^3, 3,673.43 million m^3 (14.86%) and 19,390.75 million m^3 (84.60%) respectively. The proportion of gas production consumed locally has been estimated at an average of 14.86 % while average flared gas stood at 84.60%.

4.02 Crude oil refineries.

Nigeria has four standard refineries with a total installed refining capacity of 445,000 bpd . The first and oldest refinery in Port Harcourt was commissioned in 1965 with an initial

capacity of 35,000bpd and later expanded to 60,000bpd. The majority shares of the refinery were held by Shell and British Petroleum with the Federal and defunct Eastern Region Governments having minority shares.

The Warri refinery with a capacity to process 100,000bdp and later expanded to 125,000bdp was commissioned in 1986. The Kaduna refinery with an installed capacity of 100,000bdp and commissioned in 1980 was similarly up graded to 110,000bdp in 1986. The second Port Harcourt refinery has a processing capacity of 150,000bdp. The refineries came under NNPC management and ownership in January, 1986.

All the refineries produce the normal range of products and these include Liquefied Petroleum Gas (LPG), Premium Motor Spirit (PMS), Dual Purpose Kerosene (DPK), Aviation Turbine Kerosene(ATK), and Automatic Gas Oil (AGO). In addition, the Kaduna plant produces lubricating Oils, base stocks for petrochemical plants, bitumen and waxes from 56,000bdp heavy crude blend imported from Venezuela and Saudi Arabia. The capacity utilization of the refineries has declined from 70.74 % between 1988 and 1992 to an average of only 27% in year 2000 (NNPC Report on Operations - January to December 2000), due essentially to prolonged neglect in refineries' Turn Around Maintenance (TAM). Total allocation of crude oil to refineries increased from 12,234, 000 barrels in 1970 to 108,777,558 barrels in 2000. During the period, January to December 2000, about 36,299,215 bls or 33.3% of the crude oil purchased by NNPC was allocated to domestic refining, while the balance of 72,568,343 bbl. or 66.7% was exported.

4.03 Petroleum Product Transportation and Marketing

. Petroleum products marking activities have also undergone remarkable changes over the years. The

NNPC, through its subsidiary the Petroleum Products and Marketing Company, (PPMC), ensures that refined petroleum products are distributed nation wide. The various petroleum products emanating from the refineries are transported mainly through a national network of PPMC pipelines with 8 pump stations and over land distances totaling 5001 km and linking all the 21 petroleum products storage depots strategically located all over the country at Aba, Benin, Calabar, Enugu, Gombe, Gusau, Ibadan, Ilorin, Jos, Kaduna, Kano, Maiduguri, Makurdi, Moisimi, Ore, Port Harcourt, Satellite, Warri, Yola, Suleija and Minna. The major marketers: Total, AP, Unipetrol, NOLCHEM, Texaco, Mobil, AGIP, and ELF accounted for about 56% of the market in year 2000, while the balance of 44% was done by Independent Marketers.

The PPMC pipeline distribution network is made up of three separate systems for the supply of petrol, kerosene and diesel. Each of the pipelines links the refineries with the depots. The Kaduna refinery is also linked to the Escravos terminal through Warri by a crude oil supply pipeline. The pipelines are divided into 3 phases depending on the period of their construction.

Phase 1: represents pipelines that were constructed at inception linking Bonny with Port Harcourt refinery and Escravos to Warri refinery.

Phase 2: These pipelines commissioned in 1979, consists of systems 2A, 2B, 2C, 2D, and 2E.

System 2A = Warri - Benin - Ore - Moisimi line

System 2B = Moisimi - Lagos Sattelite - Atlas Cove

Moisimi - Ibadan - Ilorin

System 2C = Warri - Abudu - Auchi - Lokoja - Abaji - Izom - Sarkin Pawa - Kaduna

for crude

System 2E = Port Harcourt - Aba - Enugu - Makurdi

Phase 3: Consists of the 2CX, 2EX, and 2DX systems

2CX = Auchi - Suleija - Minna and Suleija - Kaduna

2EX = Port Harcourt - Enugu - Makurdi - Yola.

2DX = Jos - Gombe

The system of pipelines is complemented by coastal barges, road and rail haulage from the refineries and depots to over 10,000 marketers' outlets nationwide. The marine transport operations are carried out from four jetties located at Atlas Cove, Warri, Port Harcourt and Calabar.

5.0 Oil and Gas production and sources of Pollutants.

Despite precautions, accidents do occur periodically in the course of various processes and activities in the production, refining and distribution of petroleum products.

These may result from accidental discharges attributed to equipment failure, malfunctioning, deterioration occasioned by corrosion, ageing of pipelines, deliberate or wilful acts of vandalization (about 900 cases reported in year 2000), neglect in carrying out proper maintenance and or even human error. In the process of various production and marketing activities, different solid, semi-solid, liquid, gaseous materials may be released into the environment. These materials include,

(i) Drill cuttings, drilling mud and fluids used for stimulating production.

(ii) Well treatment fluids, oil and water, and chemicals injected into them to control corrosion, temperature, or assist in the separation of oil from water.

(iii) General industrial wastes; sanitary and domestic wastes.

5.01 Seismic activities

The problems encountered with seismic activities are not necessarily environmental pollution, but rather safety problems associated with the use of explosives. The requirement for the sale and use of explosives are provided for under the Explosive Act of 1964 and Explosive Regulation of 1967.

5.02 Exploration and development.

Exploration and development whether onshore or offshore generate wastes that include atmospheric emissions, wastes like drill cuttings, drilling fluids, deck drainage, well treatment fluids, sanitary and domestic wastes and accidental oil spills.

Atmospheric emissions from rigs consist mainly of exhausts from diesel engines supplying power to meet drilling and hoisting electricity requirements of rigs. These emission may and do contain small amounts of Sulphur dioxide, (dependent upon fuel Sulphur content), and exhaust smoke (heavy hydrocarbons). An unexpected over pressure formation encountered during drilling, may result in a blowout or gas discharge, if the mud in use does not provide adequate hydrostatic head overbalance over the reservoir pressure. If this occurs, transient emissions of light hydrocarbons and possibly Hydrogen Sulphide and or Sulphur dioxide may result.

Drilling fluids (muds) are suspension of solids and dissolved materials in base of water or oils that are used for maintaining hydrostatic pressure control during drilling or work over operations. Water based and oil based muds are used in Nigeria.

Water based muds consist of natural clays, organic and inorganic additives for the achievement of proper density, viscosity and lubrication characteristics. Additives of particular pollution concern are

those of Ferro chrome lignosulphate (chromium pollution) and lead compounds (lead pollution). Oil based muds contain oxidized asphalt, organic acids, alkali, stabilizing agents and low toxic oils.

Drilling fluids are specifically formulated to meet the physical and chemical requirement of a particular well. Mud composition is affected by geographic location, well depth, and rock type and is altered as rock depth formations and other condition change. The number and nature of mud components vary by well and several products may be used at any given time to control properties of a mud system.

For water-based muds, direct discharges of the drilling fluids are generally in bulk form and occur intermittently during well drilling. High volume discharges occur during changes in mud types, for dilution purposes, and mud tanks are emptied at the end of drilling operations if fluids are not being reused.

The Department of Petroleum Resources requires from the operators appropriate documentation on the presence of polynuclear aromatic hydrocarbons, purge-able organic acid extractables and heavy metals from spent drilling fluids and cuttings which may be toxic and hazardous.

Deck drainage result from precipitation runoff, miscellaneous leakages and spills, and wash down of platforms or drill ship deck or floors. It often contains petroleum-based oils from miscellaneous spills, leakage of oil and other production chemicals. It may also contain detergents from wash down operations and discarded or spilled drilling fluid components.

Domestic sanitary wastes originate from toilets, sinks, showers, laundries and galleys. The volume and concentration of sanitary wastes vary widely with time, facility occupancy, and operational situation. The pollutants of concern are oxygen consuming organic matter, faecal coliform and

floating solids.

Well treatment wastes are spent fluids that result from acidification and hydraulic fracturing operations to improve oil recovery.

TABLE 1: VOLUMES OF CUTTINGS AND MUDS REQUIRED IN A TYPICAL 4,054 METER DRILLING OPERATION.

Drilling Interval (Meters)	Hole Size (cm)	Volume of Cuttings Produced bbl	Weight of Cuttings Produced (mt)	Mud Used	Weight of Components (mt)
0-305	61	600	223	Fresh water Bentonite mud	106
305-1372	56	1,700	631	-do-	136
1372-3350	38	1,590	557	Chrome free Lignosulphate	228
3350-4054	23	190	71	-do-	41
Total		**3,090**	**1,482**		**511**

5.03 Refining

Apart from pollutants introduced into the environment from production operations, refinery wastes

have characteristics which constitute potential water, land (soil) and air pollutants. Atmospheric pollutants arising from refinery operations include oxides of Nitrogen, Carbon, Sulphur (NO_2, CO_2, SO_2) and Hydrogen Sulphide (H_2S). Liquid refinery effluents contain oils and greases, phenol, cyanide, sulphide suspended solids, and biological oxygen demanding organic matter (BOD).

5.04 Transportation and Marketing Operations

Transportation and marketing operations generate oil spills and hydrocarbon emissions. The major source of oily waste is transportation and storage systems. Used lubrication oils constitute the greatest type of waste oil in Nigeria. Other waste oils are in the form of sludge, bitumen and slop oils.

5.05 Summary of significant pollutants from various sources in the oil industry are listed below:

A Exploration and Production

Drilling muds and cuttings

Oil and greases

Salinity

Sulphides

Turbidity

Suspended solids

Temperature

pH (Acidity & alkalinity)

Heavy metals

Biological oxygen demand

COD

B Petroleum refining

Oil & greases

BOD & COD

Phenol

Cyanide

Sulphide

Suspended solids

Toxic additives

Hydrocarbons

Total suspended solids

6.0 Environmental Impact of Pollutants.

Efforts to improve the standard of living of man through the control of nature and the development of new products have also resulted in the pollution or contamination of the environment. Most of the world's air, water and land are now partially poisoned by chemical wastes from industrial processes, including those of crude oil and gas. The pollution exposes people to new risks from diseases. Many species of plants and animals have become endangered or are on the verge of extinction. As a result of these developments, governments have passed laws to limit or reverse the threat of environmental pollution. The effects of environmental pollution are diverse and varied, and

the physical, biological, chemical and socio-economic effects or impacts have been very well documented. While some of these may be observed, the major impacts as they affect microorganisms and ecosystems may never be fully estimated or completely understood.

6.01 Physical, Biological and Chemical Impacts.

(i) Effects of spillage.

Crude oil or refined products spillages are of common and persistent occurrence in oil and gas operations. Some historical spillages include the Funiwa number 5 oil blow out of 1st January, 1980 (400,000 barrels); Oyakama oil spillage of 10th May 1980 (about 30,000 bbl.): Oshika oil spill in 1979 (5,000 to 10,000 barrels); Forcados terminal oil spillage of 6th July 1979 (570,000 bbl.); NNPC oil spills of 2nd November 1982 (18,000 barrels), and between 1982 and 1984, NNPC reported 37 spillages (27,235 barrels) of mainly automotive gas oil (AGO).

Crude oil or refined petroleum product spillage may cause damage to the environment in many ways. In water oil film floating on the water surface could prevent natural aeration and lead to the death of fresh water or marine life. Fish may ingest spilled oil or other food materials impregnated with oil. Such fish have been observed to be unpalatable (N.Nwankwo & C.N. Ifeadi). Oil spillage on land may lead to retardation of vegetation growth and cause soil infertility for a long period of time until natural processes re-establish stability.

(ii) Effects of petroleum products' induced fires.

In the last 5 years (1996-2000), various spillages of petroleum products caused by willful

acts of vandalization, neglect of maintenance of oil pipelines or accidents had occurred at Jesse in Delta State, other areas of the Niger Delta, Ibadan in Oyo State and other flash points along the pipelines. The Jesse (1998) and (Adeje Oviri Court) fire incidents which resulted from spilled petroleum products led to the loss of over 1,000 human lives, reduction of other unquantifiable animal and biological populations, destruction of bridges and electrical installations, devastated vegetation, and caused extensive disequilibria to the ecosystem of the host community environment. These incidents made national and international headline news in the mass and electronic media that attracted the world's attention to the dangers posed to human beings by the activities of the oil industry.

Burnt vegetation, also exposes the land to wind sheet and gully erosion and consequent loss of soil fertility by leaching and eradication of agriculturally useful soil organisms and nutrients.

(iii) Effects on human health and other biological lives.

In oil drilling operations, corrosive acid wastes, toxic chemicals and other harmful industrial wastes (discussed earlier) are intermittently released into streams, rivers and seas. Emissions of Sulphur dioxide, Nitrogen dioxide, Carbon dioxide, Hydrogen Sulphide, lead and other noxious gases from power plants that burn high sulphur oil are usually released into the atmosphere. These together with injected particulate matter (soot, ash and other solids), and unburned hydrocarbons undergo series of chemical reactions in the presence of sunlight, resulting in dense characteristic of smog. The cost of air pollution is enormous. Sulphur dioxide is cited by the American Lung Association as the third leading cause of lung

disease after active and passive smoking. Contaminants in the air have been implicated in the rising incidence of asthma, bronchitis, and emphysema; a serious and debilitating disease of the lung sacs.

Heat can be unnaturally added to the environment, lakes and streams as a consequence of gas flaring, burning of forest and farmland vegetation as a result of spillage and production activities of oil companies. This thermal or heat pollution raises atmospheric temperatures (green house effect) and of water bodies which can kill fish or other aquatic life and cause discomfort in habitable human environment.

(iv) Economic and social impacts,

Pollution induces loss of farmlands, economic crops, soil fertility and poisoning of fresh and marine waters. All constitute massive and unquantifiable losses to farmers, fishermen, and hunters who depend on these sources for their livelihood. This in addition, creates conditions of social disharmony, unemployment, squabbles, and rivalry due to intense competition for scarce farmlands or fishing grounds, general disaffection and anti-government sentiments in oil-producing communities. The rise in criminal activities and social unrest in the Niger Delta may not be unconnected with these problems.

Violent protests by youths of oil-producing communities, hostage taking of oil company executives and workers are some of the most eloquent testimonies of the resistance to the general pollution of the environment by the activities of oil companies.

(v) Impact on surface and underground water sources.

When harmful chemical compounds used in the oil industry are not properly disposed off,

there is the general belief, backed up by scientific evidence that, they cause pollution to surface and underground water, with dangerous consequences to human health, animals and underground organisms. Spilled oil and petroleum products do seep gradually into sub soils and may pollute underground water. Cases of contamination of underground water were reported in Sherada Industrial area of Kano in July 1984, and Kachia Local Government Area of Kaduna State in October 1984. Later investigations revealed that the contamination in Kano was caused by gradual seepage of petroleum products at the premises of the Nigerian Bottling Company while that in Kaduna resulted from a previous AGO spillage.

Water has the capacity to breakdown or dissolve many materials, especially organic compounds, which decompose during prolonged contact with bacteria and enzymes. Waste materials that are biodegradable are less of long-term threat to the environment than are the more persistent pollutants such as metals, plastics and some chlorinated hydrocarbons. These substances remain in the water and can make it poisonous for most forms of life.

In large quantities, nitrogen and phosphorus cause tiny water algae to bloom, or grow rapidly. When the algae die, oxygen is required to decompose them. This creates oxygen deficiency in the water, which causes death of many aquatic animals.

(vi) Acid Rain

When Sulphur dioxide emissions from petroleum production and refining combine with particles of water in the atmosphere, they fall to the ground as acid rain. Storms with pH

values of 2.1 have been recorded in the United States. In Canada, Scandinavian countries and the United States acid rain is blamed for the deaths of thousands of lakes and streams. These lakes had absorbed so much acid rain that they can no longer support the algae, plankton, and other aquatic life that provide food and nutrients for fish. Scientists are concerned that the death of trees in the forests of Europe, Canada and the United states may be the result of acid rains. Though the Sulphur content in Nigerian crude is very low, all the ingredients responsible for the precipitation of acid rain, elsewhere in the world are present in the Nigerian atmosphere, particularly in the Niger Delta. The rapid deterioration and rust of the bodies of cars easily noticed by residents of Warri and Port Harcourt may not just be as a result of salt water but perhaps acid rain. This is a challenging subject for further scientific investigations by ascertaining the pH values of rainwater in these areas.

7.0 Prevention and Control of Petroleum Pollution

The mitigation and control of pollution from the petroleum industry is of serious concern to Government, going by the number of legal and policy instruments put in place since 1963 to address issues of pollution in the oil industry. These include;

a. Mineral Oil safety Regulations 1963
b. Oil in Navigable Waters Regulations 1968
c. Oil in Navigable Waters Act No. 34 of 1968
d. Petroleum Regulations 1967
e. Petroleum Decree 1969
f. Petroleum (Drilling and Production) Regulations 1969

g. Petroleum (Drilling and Production) Regulations Amendment Regulation 1973

h. Petroleum Refining Regulations 1974

i. Environmental Guidelines and Standards for the Petroleum Industry in Nigeria issued by Ministry of Petroleum Resources 1991

j. National Environmental Protection Management of Solid and hazardous Wastes Regulation 1991 (FEPA)

k. Establishment of the Federal Environment Protection Agency (FEPA) Decree No 58 of 1988 and Amended in Decree No 59 of 1992

l. National Policy on the Environment (FEPA Revised Edition) 1999.

m. Elevation of FEPA to a Ministerial Status in 1999.

These various legal and policy documents seek to prohibit or control

(I) Discharge of petroleum into waters of ports and recreational areas.

(ii) Specified materials for the construction of storage tanks,

(iii) Discharge of petroleum into any inlet or drain leading to sewer

(iv) Enclosed areas whose floors are made of concrete or non-porous materials should be drained by pipe fitted with an externally actuated valve

(v) Adherence to the international convention for the prevention of sea pollution by oil (1984)

(vi) Regulation of oil pollution arising from refining operations

(vii) Prevention of oil pollution, well abandonment procedures, maintenance of apparatus,

(viii) Prevent the pollution of inland waterways, rivers, watercourses, the territorial waters of Nigeria or the high seas by oil,

(ix) Address conditions for issuance of licenses for oil

(ix) Address pollution issues of international convention to which Nigeria is a signatory, e.g.

- International Convention of the law of the Sea,
- International Convention for the Prevention of the Sea by Oil Pollution
- Civil Liability Convention of 1969
- Fund Convention of 1978

Going by the number of these regulations, legal and policy instruments in place, the immediate conclusion is that the oil industry is over regulated and one wonders whether the Government and its agencies are able to enforce them. However each document addresses specific issues of concern to the government in its desire to safeguard human and animal lives and thus prevent or control pollution. The quality of the liquid component (aqueous layer) of treated wastes from drilling activities from inland, near-shore and offshore locations must satisfy the following limitations as shown in table 2 below:

Table 2 Standards of Acceptable Limits of Pollutants.

	Values		
Pollutant or Effluent Characteristics	**Inland fresh Surface waters**	**Near-shore**	**Offshore**
pH	6.5-8.5	6.5-8.5	No limit
Temperature, ^{o}C	35	35	-do-
Oil and Grease Content, mg/l	10	20	48

Salinity as chloride, mg/l	600	2,000	No limit
Chemical Oxygen Demand (COD), mg/l	40	No limit	-do-
Biochemical Oxygen Demand (BOD), mg/l	10	No limit	-do-
Turbidity, NTU	10	15	-do-
Total Dissolved Solids, (TDS) mg/l	2,000	5,000	-do-
Total Suspended Solids (TSS) mg/l	30	50	-do-
Odour	Unobjectionable	Unobjectionable	-do-
Pb^{+2}, mg/l	0.05	No limit	-do-
Total Iron (Fe), mg/l	1.0	-do-	-do-
Cu^{+2}, mg/l	1.5	-do-	-do-
Zn^{+2} mg/l	1.0	-do-	-do-
Cr^{+6}, mg/l	0.03	-do-	-do-

Similar control standards are imposed on virtually all operations that constitute environmental threat in the areas of seismic, atmospheric emissions, water based fluids, oil based fluids, points of discharges, spent drilling muds, land filling, backfilling, solidification, development operations etc. These standards are used to access compliance during monitoring exercises conducted by the Department of Petroleum Resources and other relevant agencies of government such as the Federal Ministry of Environment. The complexity of the operations in the oil and gas industry no doubt impose limitations on the monitoring activities of agencies with the necessary statutory mandates,

both from point of view of staff with the necessary technical knowledge, numerical sufficiency and who can carry out rather complex analysis of sampled materials. Large numbers of oil and gas installations are widespread over extensive difficult land and marine terrain. All of these constitute difficulties why government monitoring may not be very effective. A good example of non-compliance is the inability of oil companies to comply with the policy of complete utilisation of produced associated gas, gradual reduction of flaring and production of greenhouse gases. Gas flaring is expected to stop in 2004 or 2008. Today as much as 84.60% of total gas produced is still being flared; while only 14.86% is being used locally; an enormous waste of a very important non-renewable natural resource.

8.0 Recommendations and Conclusion

(i) Harmonisation and Regulation of Oil and Gas Industrial Pollution.

In order to eliminate duplication and conflicts, there should be a memorandum of understanding between the Department of Petroleum Resources and the Ministry of Environment to streamline areas of operation of each agency. Matters related to technical supervision of oil and gas exploration and exploitation, refining etc should remain with the Department of Petroleum Resources while those concerning environmental pollution should to a great extent be attended to by the Ministry of Environment.

(ii) National Oil Spill Contingency Action Group.

There is need to set up a National Oil Spill Contingency Action Group consisting of representatives from the oil companies, National Relief Agency, Department of Petroleum Resources, Federal Ministry of Environment, the Ministry of Transport and the Nigerian Navy to quickly intervene in

emergency cases involving oil spillage.

(iii) Greater Involvement of the Oil producing Areas.

An emerging and prevalent issue in the upstream and oil operations generally, is the increasing volatility and hostility in the oil producing areas. The people are angry, because the Niger Delta, has gradually taken on permanent features of an environment whose natural characteristics have been degraded and perhaps indeed violated. The economic boom of Nigeria has become the doom of that geographical area that produces the crude oil that sustains the wheel of all socio-economic development in Nigeria. It is time for the people of this area to have a substantial stake in the oil sector in terms of investment, a deliberate and sustained quota policy on employment of indigenes, and in other auxiliary operations of the oil companies. The problem of the Niger Delta people is real and should be addressed by Government and it is in the interest of the country to enhance the prospect of peace and stability in the area. The immediate funding and take-off of the NDDC will help to address multiple problems; reduce youth aggression and hostility, social tension and perhaps to some extent contain the issues of unemployment, marginalisation and agitation for resource control.

(iv) Strict implementation of government policies.

It is apparent that one of the ways to address environmental pollution in the oil industry is the strict implementation of government policies. For example, if the policy of zero gas flaring must stop at year 2004 or 2008 as respectively claimed by the Ministry of Environment and the Department of Petroleum Resources, then, government must ensure strict compliance of oil companies with such policy instrument. However recent conflicting claims of terminal dates of zero gas flaring by these

agencies of the same government on very important policy statements are undesirable.

(v) Long term monitoring and surveillance.

It is important in the long term to strengthen the capacity of monitoring agencies such as the Ministry of Environment and the Department of Petroleum Resources to carry out regular and effective monitoring of all participants in the oil industry to ensure compliance with government policies, regulations and other legal instruments. Those found wanting should be sanctioned.

(vi) Application of Environmental Impact Statements (EIS) and Environmental Impact Assessment (EIA)

All projects or investment activities should be subjected to EIS and EIA at the beginning, midterm or at the end. This function should be a joint responsibility of the various agencies that have specific statutory mandates in the oil industry. EIS and EIA will provide necessary data and information on periodic assessment or evaluation of the activities of the oil companies. The EIS and EIA should be undertaken strictly on a scientific basis, by qualified and competent scientists. There must be no room for political considerations in these matters.

(vii) Funding Research on Pollution in Universities.

A special fund for pollution research should be put in place with contributions from government and oil companies. This will enable universities to carry out research into the socio-economic and human health aspects of pollution. Such research will provide necessary information on those areas and at the same time suggest solutions.

Conclusion.

It is evident and in our best interest that this country must adopt measures that would provide a

reasonable degree of protection of its ecological human environment from pollution, whether it emanates from the oil industry or other sources. Such measures should discourage discharge of harmful effluents, into the environment through the adoption of appropriate prevention techniques using the most effective and current technologies on erosion control. The human resource is the greatest resource endowment of any nation and must be protected.

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Annex 1: Crude Oil Production, Export and Domestic Consumption ('000 Barrels)

Year	Production	Export	Export %	Domestic Consumption	Domestic Consumption %
1970	395,689	383,455	96.91	12,234	3.09
1971	558,689	542,545	97.11	16,144	2.89
1972	665,295	650,540	97.80	14,655	2.20
1973	719,379	695,627	96.70	23,752	3.30
1974	823,320	795,710	96.65	27,610	3.35
1975	660,148	627,638	95.08	32,510	4.92
1976	758,058	674,125	66.93	21,236	2.80
1977	766,055	715,240	93.37	50,815	6.63
1978	696,324	674,125	96.81	22,199	3.19
1979	845,463	807,685	95.53	37,778	4.47
1980	760,117	656,260	86.34	103,857	13.66
1981	525,291	469,095	89.30	56,196	10.70
1982	470,638	401,658	85.34	68,890	14.66
1983	450,961	392,031	86.93	58,930	13.07
1984	507,487	450,580	88.79	56,907	11.21
1985	547,088	486,580	88.94	60,508	11.06
1986	535,929	486,584	90.79	49,345	9.21
1987	483,269	390,514	80.81	92,755	19.19
1988	529,602	435,797	82.29	93,805	17.71
1989	625,908	522,481	83.48	103,427	16.52
1990	660,559	548,249	83.00	112,310	17.00
1991	689,850	585,838	84.92	104,012	16.08
1992	711,340	604,300	84.95	107,040	15.05
1993	691,400	563,614	81.52	127,786	18.48
1994	696,190	578,044	83.03	118,146	16.97
1995	715,400	616,900	86.23	98,500	13.77
1996	740,190	648,690	87.64	91,500	12.36
1997	759,710	673,340	88.63	86,370	11.37
Average	**642,476.75**	**574,190.89**	**89.21**	**66,046.68**	**10.50**

Source: Nigerian National Petroleum Corporation (NNPC)

Annex 2: Associated Gas and Utilisation in Nigeria (Million Cubic Meters)

Year	Production	Utilisation	Utilisation %	Flaring	Flaring %
1970	8,039	72	0.90	7,957	98.98
1971	12,975	185	1.43	12,790	98.57
1972	17,122	274	1.60	16,848	98.40
1973	21,882	395	1.81	21,487	98.19
1974	27,170	394	1.45	26,778	98.55
1975	18,656	323	1.73	18,333	98.27
1976	21,276	659	3.10	20,617	96.90
1977	21,924	972	4.43	20,952	95.57
1978	21,306	1,866	8.76	19,440	91.24
1979	27,619	1,546	5.60	26,073	94.40
1980	24,551	1,647	6.71	22,904	93.29
1981	17,113	2,951	17.24	14,162	82.76
1982	15,382	3,442	22.38	11,940	77.62
1983	15,192	3,244	21.35	11,948	78.65
1984	16,255	3,438	21.15	12,817	78.85
1985	18,569	3,723	20.05	14,846	79.95
1986	18,739	4,822	25.73	13,917	74.27
1987	17,085	4,794	28.06	12,291	71.94
1988	20,253	5,516	27.24	14,737	72.76
1989	25,053	6,323	25.24	18,730	74.76
1990	28,163	6,343	22.52	21,820	77.48
1991	31,587	7,000	22.16	24,588	77.84
1992	32,465	7,058	21.74	25,406	78.26
1993	33,445	7,536	22.53	25,908	77.46
1994	32,793	6,577	20.06	26,216	79.94
1995	32,980	6,910	20.95	26,070	79.05
1996	36,970	10,150	27.45	26,820	72.55
1997	36,754	4,696	12.78	26,548	72.23
Average	**23,261**	**3,673.43**	**14.86**	**19,390.75**	**84.60**

Source: Nigerian National Petroleum Corporation (NNPC)