

ENVIRONMENTAL GUIDELINES AND STANDARDS FOR THE PETROLEUM INDUSTRY IN NIGERIA (EGASPIN)

**ISSUED BY THE DEPARTMENT OF PETROLEUM
RESOURCES
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FOREWORD

As one of its statutory functions, the **Department** of Petroleum Resources is required to ensure that petroleum industry operators do not degrade the environment in the course of their operations. To effectively carry out these regulatory activities, the **Department** has been developing environmental guidelines and standards since 1981. These cover the control of the pollutants from the various petroleum exploration, production and processing operations. This publication is an update of these, guidelines and standards in light of the advancements in the current treatment and pollution control technology. It covers environmental control of various petroleum activities in Nigeria, including exploration, production, terminal operations, hydrocarbon processing plants, oil and gas transportation and marketing. It includes where applicable, a discussion of the sources and characteristics of gaseous, liquid and solid wastes generated, principal control methods and effluent limitation and standards. It is the intention of the Department of Petroleum Resources to update this publication periodically as new knowledge becomes available

PROFESSOR JUBRIL AMINU

HONOURABLE MINISTER OF PETROLEUM RESOURCES

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PART I. INTRODUCTION

- 1 The Petroleum Industry is a complex combination of interdependent operations, including exploration and production operations, the processing of the crude into consumer products, transportation and marketing activities. At each stage of operations, gaseous, liquid and solid waste materials are produced and discharged. These can adversely affect the air, water and soil media if not properly discharged and controlled.
- 2 Pollution control regulations in the oil and gas operations are governed by the Principal legislation of Petroleum Act 1969. The regulations are made pursuant to section 8(i)b (iii) of the Petroleum Act 1969 which empowers the Minister of Petroleum Resources to make regulations for the prevention of pollution of water courses and the atmosphere. Some of the specific regulations include: the Petroleum (Drilling and Production) Regulations 1969, Sections 25 and 36; the Mineral Oils (Safety) Regulation, 1963, Part III Section 7 and Part IV Sections 44 and 45; the Petroleum Regulations 1967; the Oil in Navigable Waters Decree NO.34/Regulations 1968; the Oil Pipeline Ordinance Cap 145 of 1956 as amended by the Oil Pipeline Act 1965, Section 17(3) and; the Petroleum Refining Regulations 1974, Section 43.
- 3 Authority exists within these Decrees and Regulations, to issue licences/permits and establish guidelines, standards and procedures for environmental control. Consequently, because of growing concern for adverse environmental impacts or damages arising from oil related pollution, the Department of Petroleum Resources in 1981 issued interim Guidelines concerning the monitoring, handling, treatment, and disposal of effluents, oil spills and chemicals, drilling muds and drill cuttings by leasees/oil operators. Tentative allowable limits of waste discharges into fresh water, coastal water, and offshore areas of operations were established.
- 4 The objectives of these Environmental Guidelines and Standards are as follows;
- (a) Establish Guidelines and Standards for the Environmental Quality Control of the Petroleum Industry taking into account existing local conditions and planned monitoring programmes.
 - (b) Provide, in one volume, for the operator and other interested persons a comprehensive' integrated document on pollution abatement technology, guidelines and standards for the Nigerian Petroleum Industry.
 - (c) Standardise the environmental pollution abatement and monitoring procedures, including, the analytical methods for various parameters.
- 5 In order to effectively evaluate and monitor the discharges into the environment, the petroleum industry is conveniently divided into six stages of operations namely, exploration, production, terminal operations, hydrocarbon processing, oil transportation and marketing operations. Each of the six stages of the petroleum industry has discussions on processes of operation, sources and characteristics of wastes, treatment and control of wastes, as well as monitoring, effluent limitations and standards.
- 6 It is pertinent to state that out of the three basic regulatory standards, namely, the effluent or end-of-the-pipe, management practices, and ambient quality standards, the first two sets of standards have been adopted while the third is been developed. The rationale is based on the fact that effluent or end-of-the-pipe standards provide some flexibility and knowledge of the type of materials to be discharged and also the choice of technology available to control pollutants. In addition, there are a lot of variations in the management practices

of the petroleum industry in Nigeria. However, ambient quality standards require detailed and comprehensive ecological data that are characteristic of the Nigerian conditions, which are currently not available but are beginning to accumulate in the literature.

7 The issuance of these guidelines and standards in no way absolves the operator or licensee to comply with other relevant legislation/regulations.

8 Any revisions and amendments to these guidelines and standards shall be issued as and when necessary.

PART II. EXPLORATION AND DEVELOPMENT OPERATIONS

A. BACKGROUND

1. The Exploration and Development activities for oil and gas involve seismic, drilling and well completion. Each phase differs to some extent in type and quantity of pollutants discharged. In Nigeria, the exploration and development activities may be found onshore, shallow (including swamps, coastal waters, estuaries, rivers, etc.) and deep offshore waters. These physical locations influence the manner in which the operations are conducted, and the effluents are treated and discharged.
2. The relevant legal authority is provided for by the Petroleum Act 1969 with the Petroleum (Drilling and Production) Regulation 1969, Sections 25 and 36. Also the Explosive Act 1964 and Explosive Regulation 1967 govern the use of explosives during seismic activities.
3. The main purposes of these guidelines and standards are to establish an effective uniform monitoring and control programme for the discharges arising from oil exploration and development and to ensure compliance with sound and efficient environmental management by all operators.

B. DESCRIPTION OF OPERATION

1 EXPLORATION

- 1.1 Exploration usually consists of special surveys, such as seismic, gravimetric & magnetic, to determine the subsurface structure and to estimate the potential for oil and/or gas accumulation. Having established the existence of favourable conditions, wells are drilled to determine the nature and extent of potential hydrocarbon reservoirs.
- 1.2 Exploratory drilling is performed with a rotary drill outfitted to a mobile rig for drilling wells and for determining the nature and extent of potential hydrocarbon reservoirs. Rig designs used in Nigeria are those for land, deep and shallow water drilling.
- 1.3 The main purpose of an exploration rig is to house rotary drilling equipment whose only function is to make a hole. There are four main subsystems to perform this function, power, hoisting, rotating, and circulating. In addition, facilities for supporting a work crew (living, dining, etc.) for extended periods must be available.
- 1.4 In Nigeria, two types of drilling muds - water based, and oil based (mineral/synthetic or pseudo) muds - are used. Drilling mud is a constantly circulating medium of communication to the surface of down hole conditions. It carries warnings of impending kicks, and formation leaks or fractures (lost-circulation).
- 1.5 In a physico-chemical sense, mud is a mixture of clays, chemicals, and either water or Oil, all carefully formulated for optimum performance in a given well. Basic mud components include bentonite (clays for proper rheologic properties), barium sulphate (barite) - a weighting agent, and lime or caustic soda for pH control. Additional materials for lubrication and emulsification may also be used at times.
- 1.6 Oil based mud represent a high potential source of pollution. A special approval for the use of oil-based muds must be obtained from the Department of Petroleum Resources before its use (See Appendix II-1).

2 DEVELOPMENT

- 2.1 Development drilling is usually performed from a fixed platform to produce the field by drilling a large number of wells (10 - 30) in a fixed pattern.
- 2.2 Development drilling produces quantitatively the same kinds of discharges as exploration drilling. However, because development drilling involves a greater number of wells, the volume of discharges may be much greater than exploratory well.

C. SOURCES AND CHARACTERISTICS OF WASTE

1 SEISMIC ACTIVITIES

- 1.1 The problems encountered with seismic activities are not limited to environmental pollution, but also, safety problems associated with the use of explosives. The requirements for the safe use of the explosives during seismic activities are provided under the Explosive Act 1964 and Explosive Regulation 1967.

2 EXPLORATION AND DEVELOPMENT

2.1 General

- 2.1.1 Exploration and development activities 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.

2.2 Air Pollution

- 2.2.1 Atmospheric emissions from rigs consist mainly of exhausts from diesel engines supplying power to meet rig requirements (drilling, hoisting, electricity, etc.). These emissions may be small amounts of sulphur dioxide (dependent upon fuel sulphur content) and exhaust smoke (heavy hydrocarbons). An unexpected formation over pressure encountered during drilling (i.e. formation pressure above normal hydrostatic pressure gradient of 0.465 psi/ft) may result in a blow-out 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 possible hydrogen sulphide may occur.

2.3 Drilling Fluids

- 2.3.1 Drilling fluids (mud) are suspensions of solids and dissolved materials in base of water or oil that are used to maintain hydrostatic pressure control in the well, lubricate the drill bit, remove drill cuttings from the well and stabilise the walls of the well during drilling or workover operations. Water based and oil based mud are used in Nigeria.
- 2.3.2 Water based mud consists of natural clays, and additives (organic and inorganic) to achieve proper density, viscosity and lubrication characteristics. Additives of particular concern from pollution viewpoint are ferrochrome lignosulphate (chromium pollution) and lead compounds (lead pollution).
- 2.3.3 Oil based mud contains oxidised asphalt, organic acids, alkali, stabilising agents and low toxic oil. Clay solids and weighting agents can also be added. Oil emulsion mud also used are either as oil-in-water or water-in-oil varieties.
- 2.3.4 Synthetic Drilling Mud Systems.**

There are about six generic synthetic mud systems, which are used to improve environmental performances:

- Acetal
- Internal Olefins (IO)
- Esters
- Linear Alpha Olefins (LAO)
- Poly Alpha Olefins (PAO)
- n-paraffin
- Other drilling mud.

2.3.5 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 well depth, rock formations, and other conditions change. The number and nature of mud components vary from well to well. Several products may be used at any given time to control the properties of a mud system.

2.3.6 For water based mud, direct discharges of the drilling fluids are generally in bulk form and occur intermittently during well drilling, though low volume discharges are made to maintain proper solid levels in mud systems. High volume discharges occur during changes in mud types, for dilution purposes, and when mud tanks are emptied at the end of drilling operations if fluids are not being reused. **These discharges are now prohibited in sensitive zones i.e. land, swamp, nearshore and shallow offshore areas.**

2.3.7 For the purposes of determining appropriate limitation and standards, the Director of Petroleum Resources shall require an operator to analyse samples of mud systems and components of mud thinners, weighting agents, fluid loss additives, corrosion and scale inhibitors, solvents, polymer additives, etc., to determine if and to what extent they contain such substances that may be toxic and hazardous.

2.4 Drill Cuttings

2.4.1 Drill cuttings consist of various rocks, particulate and liquids released from geologic formations in the drill hole. Table 11-1, shows the volume of cuttings produced and mud required in a typical drilling operation.

TABLE 11-1 - VOLUME OF CUTTINGS PRODUCED AND MUD REQUIRED IN A TYPICAL 4054-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)
0.35	61	600	223	fresh water/ Bentonite Mud	106
305-1372	56	1,700	631	-do-	136
1372-3350	38	1,500	557	+chrome free	228

				Ligno-sulphate	
3350-4054	23	190	71	-do-	41
TOTAL	-	3,990	1,482	-	511

2.4.2 The cuttings are coated with drilling fluid. The drilling fluid from the well discharges to a rig shale shaker where the cuttings are separated from the drilling fluid. This separation step does not completely remove drilling fluid from the cuttings. Some drilling fluid and additives remain on the drill cuttings. Consequently, the composition of the cuttings will be similar to the drilling fluid except for the down-hole formation particles, particle size distribution, and the relative amounts of the various drilling fluid constituents.

2.4.3 The Department of Petroleum Resources requires from the operators appropriate documentation on the presence of polynuclear aromatic hydrocarbons, purgeable organics, acid extractable and heavy metals from spent drilling fluids and cuttings, which may be toxic and hazardous.

2.5 Deck Drainage

2.5.1 Deck drainage results from precipitation runoff, miscellaneous leakage and spills, and wash down of platform or drill ship decks and floors. It often contains petroleum-based oils from miscellaneous spills and leakage of oils and other production chemicals used by the facility. It may also contain detergents from wash down operations and discarded or spilled drilling fluid components.

2.6 Sanitary Wastes

2.6.1 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, fecal coliform and floating solids.

2.7 Well Treatment Wastes

2.7.1 Well treatment wastes are spent fluids that result from acidification and hydraulic fracturing operations to improve oil recovery. Workover fluids and completion fluids are also considered to be well treatment wastes.

2.8 Oil Spillage

2.8.1 Oil spillage from exploration and development may result from well blow-out and the characteristics of the crude will depend on the crude blend, or reservoir rock properties.

D. TREATMENT AND CONTROL OF WASTES

1 SEISMIC ACTIVITIES

1.1 The operational procedures for the safe use of explosives in the petroleum industry shall be as follows: -

1.1.1 A report shall be submitted quarterly to the Director of Petroleum Resources on the use of authorized explosives. (See APPENDIX II – 5A).

- 1.1.2 The handling, placing, and blastering or firing of seismic explosives shall be undertaken only by qualified and competent persons duly appointed, and notified to the Director of Petroleum Resources.
- 1.1.3 Smoking, naked lights or other sources of ignition should not be allowed within 45 meters (150 feet) of such explosives, whether loose or packed in cases.
- 1.1.4 In no circumstances should detonators be carried in the same conveyance with other class of explosives and no detoner should be inserted in a timing cartridge until immediately before use.
- 1.1.5 The exploder handle and the shot-firing leads should not be attached to the exploder until immediately before a shot is fired and should be detached immediately afterwards.
- 1.1.6 When shot-firing operations are in progress, warning notices should be prominently displayed at all approaches.
- 1.1.7 The only electrical circuit that should be used in seismic shooting is a series connected circuit.
- 1.1.8 No more than 50 (fifty) detonators should be connected in a series circuit, and where there is a risk of current leakage, it is preferable to keep the number down to thirty or less.
- 1.1.9 Seismic crews (the shooter) shall have a safety switch preventing firing before the shooter is ready to fire the explosive shot points.
- 1.1.10 Radio equipment and radio frequency transmission may present a potential ignition source, when shooting in the vicinity of radio transmitters, the minimum distances between the shot point and any transmitter is provided in Table II-2.

TABLE II -2 - MINIMUM DISTANCE BETWEEN SHOT POINT AND RADIO TRANSMITTERS

POWER (WATTS)	DISTANCE	
	METRES	FEET
0 - 50	75	250
50- 250	150	500
250- 1,000	300	1,000
1,000 - 10,000	750	2,500
10,000- 50,000	1,500	4,500
50,000- 100,000	2,300	7,500

- 1.1.11 No person should be allowed to approach a misfired shot until either it has exploded or a safe period of time has elapsed. This period should be at least 5 minutes in the case of electrical shot firing, and not less than 30 minutes in the case of shots fired by safety fuse.
- 1.1.12 The shot firer should inform the seismic observer of the occurrence of a misfire and erect danger notices giving warning of the location of the misfire, and such barriers as are necessary to prevent any person approaching the location.
- 1.1.13 Until such time as the misfire has been remedied, no drilling or any other site work should be carried out in the vicinity of the misfire, unless this is directly involved in the treatment of the misfire.
- 1.1.14 All misfires should be recorded and thereafter reported to the Director of Petroleum Resources on completion of blastering operations, stating the circumstances of the occurrence, together with other relevant details of the location of the misfires. **(See APPENDIX II – 5B)**
- 1.1.15 Similarly, if any explosives are lost or stolen, Regulation 22, Section 4 of the Explosive Regulation 1967 requires that a report shall forthwith be made by the person responsible for or in-charge of the explosives to the officer in-charge of the nearest Police Station or to the nearest Inspector. A copy of the report shall be submitted. to the Director of Petroleum Resources.
- 1.1.16 Noise And Vibration Associated with Seismic Operations
 - (i) Vibrations emanating from blastering operations on structures of buildings shall be maintained below a peak particle velocity of 50mm/sec. (2 in/sec.).
 - (ii) To protect buried pipelines and pumping stations of water wells of any type and construction in most subsurface condition and dyke structures, against vibration impacts resulting from seismic detonations, the safe distances in **Table II-3** are recommended.
 - (iii) Exposed submarine pipelines subjected to vibration impacts from seismic detonations should maintain the safe distances in **Table II-4**
 - (iv) For offshore operations non-explosives (e.g. air guns) shall always be used where possible instead of explosives.
- 1.1.17 **All the stuck radioactive tools abandoned shall be reported to the Director of Petroleum Resources. (See APPENDIX II –6).**

TABLE II-3 - SAFE DISTANCES (METERS) AGAINST VIBRATION IMPACT RESULTING FROM SEISMIC DETONATIONS

Objects to be protected	Up to 1kg Detonation	1 to 3kg Detonation	3 to 6kg Detonation
Pipes of any type	30	60	120
Pumping Station with pipe of any type	40	60	120
Water Wells of any type	100	200	Vimax =12mm/sec
Dyke Structures	50	100	=25mm/sec

TABLE II-4 - SAFE DISTANCES FOR SUBMARINE PIPELINE

Charge weight (kg)	Safe distance (metres)
1	120
2	140
5	190
10	250
50	400

2 EXPLORATION AND DEVELOPMENT

2.1 Atmospheric Emissions

2.1.1 Atmospheric emissions in both exploration and development activities are for the most part minor because of the level and nature of exploration and development activities. They occur mainly from vehicles and power generating plants or equipment.

2.2 Drilling Fluids

2.2.1 Water Based Fluids

- (i) When mud recirculation is used in water based systems a conventional recirculation system including pumps, mud pits and attendant conditioning equipment (shale shakers, desanders, desilters and degassers) are employed. Where water-based drilling fluids are contaminated with oil to the extent that they would cause sheen upon discharge, they should be treated for oil recovery.
- (ii) Less toxic drilling materials are recommended for usage; for example, water based generic muds as listed in Appendix 11-2, low toxicity special additives, low aromatic mineral oil instead of diesel oil for lubricity and spotting purposes and barite with low toxic metals content.
- (iii) The use of diesel oil for lubricity and spotting purposes is prohibited.

2.2.2 Oil Based Fluids (Mineral Oil Based/Synthetic or Pseudo-Oil Based)

- (i) The treatment and control of these oil-based fluids **are** more complex than that of water based mud. The economics of **their** use require that the fluid be recovered, reconditioned and recycled.

2.3 Solid Wastes

2.3.1 Drill Cuttings

2.3.1.1 Existing Practices for the handling of drill cuttings include:

- (1). On-site disposal of drill cuttings with an oil content that does not cause sheen on the receiving water,
- (2). Washing of drill cuttings that contain oil to a level that would **not** cause sheen so that they may be discharged to receiving water,
- (3). Transportation (if offshore) of drill cuttings to land for proper land disposal or treatment e.g. incineration or desorption /oil recovery.**

(4). Injection into properly prepared and approved formation.

2.3.2 Metals and Plastic Containers

2.3.2.1 Empty metal and plastic chemical and drilling fluid containers are often disposed of to third party users without appropriate treatment.

2.4 Deck Drainage

2.4.1 Deck Drainage is either collected and treated separately for oil removal by gravity separation or is handled by the produced water treatment system before discharge.

2.5 Sanitary Wastes

2.5.1 Current treatment systems for sanitary wastes include physical, chemical, biological or a combination of the above. Drilling rigs and production platforms operating in offshore and nearshore waters shall treat their sanitary wastes by biological wastewater treatment with residual chlorine of 0.8 to 2.0 mg/l, if manned continuously by ten (10) or more persons. **See limitations on other parameters as in Table II-6 for confirmation.** However, if these facilities are manned continuously by less than ten (10) persons, or intermittently by any number, the sanitary waste shall be macerated and dumped overboard with no floating solids. **On onshore rigs and production flowstations, sanitary waste shall as a minimum be collected and treated in properly engineered and monitored septic tanks. Biological Waste Water Treatment facilities are however recommended as the ultimate treatment process.(See Table 11-6)**

2.6 Oil Spillage

2.6.1 The treatment and control of oil spillage from exploration and development activities are provided under the contingency plan for oil spill control and prevention (See PART VIII-B).

2.7 Chemical/Hazardous Wastes.

2.7.1 These materials and wastes shall be treated and disposed of in accordance with the provisions of PART VIII-C.

E. ENVIRONMENTAL MANAGEMENT

1 ENVIRONMENTAL MANAGEMENT SYSTEM.

- 1.1 Licensees/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are contained and brought to an acceptable minimum.
- 1.2 Specific roles, responsibilities and authorities shall be well defined, documented and communicated in order to facilitate effective environmental management.

2 ENVIRONMENTAL MANAGEMENT SYSTEM MANUALS

2.1 A licensee/operator or DPR service company permit holder (whose operations affect the environment) shall have environmental management system.

- 2.1.1 The system manual shall document and describe a management system with organisational structure, policy, responsibility, objectives/targets, practices, procedures, processes and resources for the implementation of all environmental management issues peculiar to the organisation (See Part VIII – H)**

3 EFFLUENT LIMITATIONS, STANDARD AND MONITORING FOR EXPLORATION AND DEVELOPMENT OPERATIONS.

3.1 SCOPE

- 3.1.1 The limitations, standards and monitoring guidelines shall regulate **Seismic operations and** control the quality and quantity of industrial effluents associated with oil drilling activities/operations. They shall ensure that these discharges do not cause any hazards to human health and living organisms (fauna and flora) and do not impair the quality to use adjacent surface waters, land and groundwater.

3.2 ENVIRONMENTAL PERMIT FOR SEISMIC ACTIVITIES AND THE OPERATIONS OF DRILLING RIGS.

- 3.2.1 It shall be mandatory for a licensee or lessee to obtain an environmental permit from the Department of Petroleum Resources before **Seismic and** drilling operations can commence in Nigeria.

3.2.1.1 An EIA report shall accompany the application for environmental permit for seismic activities.

3.2.1.2 The following information shall accompany the application for an environmental permit for drilling rig operation:

- (i) **An approval letter obtained from DPR, of an Environmental Baseline studies or Seabed Survey Report for exploratory and appraisal wells for onshore, nearshore and offshore areas.**
- (ii) **An approval letter obtained from DPR, of an Environmental Impact Assessment (EIA) Report for development wells on field basis for onshore and nearshore areas.**
- (iii) **An Environmental Impact Assessment (EIA) Report for any dredging activity exceeding a cumulative of 500m², if applicable.**

- (iv) **The treatment and disposal programmes of all the effluents (drilling fluid, drill cuttings) from the drilling operation.**
- (v) **The detailed information on the type of water-, synthetic-, and ester- based mud systems and the additives to be used.**
- (vi) **A special application for the use of oil based muds as per Appendix II - 1.**
- (vii) **Detailed descriptions of the source and radiation properties of any sealed radioactive sources intended for use to perform well logging.**
- (viii) **An approval letter for the mud system to be used. (Oil -based mud system and its base oil must have been subjected to, and pass an LC₅₀ toxicity and biodegradability test s).**
- (ix) **Offshore (deep/shallow) Drilling Hazard Assessment (ODHA) report that considers both surface and subsurface features**

3.3 At the direction of the Director of Petroleum Resources, the operator shall be mandated to analyse samples of the mud system and/or base oil to determine whether and to what extent they contain toxic and hazardous substances, **such as aromatics and heavy metals** (based on the type of mud and additive) as the Director of Petroleum Resources may specify.

3.4 CONTROL OF POINTS OF DISCHARGES

3.4.1 Except otherwise specifically permitted by the **Director** of Petroleum Resources, whole drilling mud/fluids, spent drilling mud/fluids, brine, drill cuttings, well treatment wastes, deck drainage or residues thereof, from water **and oil/synthetic based** muds from drilling activities shall not be discharged directly or indirectly into:

- (i) Any inland waters (fresh, brackish, (tidal or non-tidal) or (reservoir)
- (ii) Swamp, coastal or nearshore waters and **shallow offshore**
- (iii) Any pit on land/swamp other than **approved** temporary holding retention pit(s) **and/or steel tanks** so designed and utilized that there shall be no overflow, leakage or seepage.

3.4.1.1 Such discharges shall be permitted in offshore (discharge zones) areas 12 nautical miles away from the shoreline and of depth not less than 200 feet provided the limitations as specified in Article 3.5.6.1 are satisfied.

3.4.2 The temporary holding retention Pit(s) **and/or steel tank** as described in Article **3.4.1(iii)** shall be constructed to contain, confine and separate the entire drilling wastes by types.

3.4.3 The retention pit(s) shall be constructed such that the base and sides are either concrete or lined with suitable materials to prevent overflows and seepage of spent drilling fluid into adjacent land or into subsoil respectively.

3.4.3.1 The concrete or liner along the sides and bottoms of the retention Pits shall have the equivalent of 1 (one) continuous meter of re-compacted or natural clay having a hydraulic conductivity not greater than 1×10^{-7} cm/sec. Such liners include but are not limited to the following:

- (i) Natural clay having a hydraulic conductivity of less than 1×10^{-7} cm/sec.

- (ii) Soil mixed cement, clay-type, and/or other additive to produce a barrier with a hydraulic conductivity of less than $1 \times 10^{-7} \text{cm/sec}$.
- (iii) Manufactured liner (synthetic material) that exceeds the hydraulic conductivity requirement and that shall also satisfy the following definitions:

<u>Parameter or Test*</u>	<u>Standard</u>
▪ Thickness (average)	> 10 mm
▪ Breaking strength	6.33 Kg/m ²
▪ Bursting strength	9.85 Kg/m ²
▪ Tearing strength	1.76 Kg/m ²
▪ Seam strength	3.52 Kg/m ²

*Testing is to be performed according to ASTM Method D-751, latest revision or EPA Method 9100.

3.4.3.2 The retention pit shall be so located and constructed such that it shall not collect natural run-off water and is expected to provide a temporary holding for a period no more than three months after the drilling activities.

3.4.3.3 All the existing temporary retention pits shall be rehabilitated/remediated to the satisfaction of the Director of Petroleum Resources within six month of the issuance of this revised Guidelines and Standards.

3.4.3.4 The bottom of the retention pit must be at least 1.5 meters above the seasonal high water table.

3.4.3.5 Where the surface topography is such that satisfactory retention pit(s) of sufficient capacity cannot be constructed, the operator shall contain all such wastes in steel tank(s) or barge(s).

3.4.4 The discharge of such drilling wastes into any public drain or sewer is prohibited.

3.4.5 Toxicity

3.4.5.1 A 96hr LC₅₀ toxicity test shall be conducted for all mud systems (Water, oil, synthetic based) and base oil for oil based mud (Also see APPENDIX II-I and PART VIII-E), prior to usage.

3.4.5.2 Discharged drilling fluids shall meet both a daily minimum and a monthly average minimum 96hr LC₅₀ of at least 30,000ppm in a 9:1 seawater to drilling fluid suspended particulate phase (SPP) volumetric ratio using Palaemonetics africanus, a marine/brackish water organism.

3.4.5.2.1 Discharge Rate

- (i) All facilities are subject to a maximum discharge rate of 1,000 barrels/hour.
- (ii) Drilling fluids discharges, which are shunted to the bottom, are not subjected to this discharge rate.

3.4.5.2.2 The required sample (composite/ grab sample) shall be taken from beneath the shale shaker or from a location that is characteristic of the overall mud system to be discharged. (Composite samples from grab samples collected at every 305m and samples collected at the end of the well from the lowest section but no pay zone).

- 3.4.6 The operator of a drilling rig shall take necessary precautions to avoid blockage or obstacles to regular flow of water; suitable bridges and culverts should be provided.
- 3.4.7 The dumping/discharge of dredge spoil shall be controlled by the licensee or lessee during exploration and production operations. **Dredge spoils shall not be discharged as to endanger flora and fauna and to cause pollution to surface waters.**
- 3.4.8 At the discretion of the Director of Petroleum Resources, an operator, whose drilling activity/operation has been observed to cause significant and adverse environmental effects and impacts (including oil and hazardous materials spillages), shall be required to prepare an Environmental Evaluation (Post-impact) Report (See PART VIII-A).

3.5 TREATMENT AND DISPOSAL OF SPENT DRILLING MUD/FLUIDS, CUTTINGS, AND EMPTY METAL/PLASTIC CHEMICAL CONTAINERS

- 3.5.1 Wastes from drilling and workover activities from offshore, nearshore and inland areas, spent water-based mud/fluids, well treatment wastes, oil and water based drill cuttings, brine, deck drainages or residues - shall be treated to the satisfaction of the Director of Department of Petroleum Resources
- 3.5.1.1 Empty metals/plastic chemical and drilling fluid storage containers shall be properly treated to the satisfaction of the Director of Petroleum Resources and recycled.**
- 3.5.2 Spent oil based drilling mud/fluid shall be reprocessed or reconditioned for further utilization **and shall not be discharged into inland, nearshore, offshore and deep offshore waters.**
- 3.5.3 The quality of the liquid component (aqueous layer) of the treated wastes from drilling activities for nearshore and inland locations shall satisfy the following limitations as in Table 11 - 6

TABLE 11-5 (LIMITATIONS ON THE TREATED LIQUID COMPONENT (AQUEOUS LAYER) OF WASTES FROM DRILLING ACTIVITIES FROM NEARSHORE/INLAND AREAS) BEFORE THE DISPOSAL INTO WATER BODIES.

POLLUTANT OR CHARACTERISTICS	VALUES (ONCE/DAY DURING DISCHARGE)	
	INLAND WATERS)	(FRESH NEARSHORE (Brackish/Saline Waters)
PH	6.5-8.5	6.5-8.5
Temperature °C	25	30
Total Hydrocarbon content mg/l	10	20
Salinity as Chloride, mg/l	600	2,000
Chemical Oxygen Demand (COD), mg/l	10	125
Turbidity, NTU	10	15
Total Dissolved Solids (TDS), mg/l	2,000	5,000
Total Suspended Solid (TSS), mg/l	30	50
Odour	Unobjectionable	unobjectionable
Pb ⁺² , mg/l	0.05	No limit
Total Iron (Fe), mg/l	1.0	No Limit
Cu ⁺² , mg/l	1.5	-do-
Zn ⁺² , mg/l	1.0	5
Cr ⁺⁶ , mg/l (total)	0.03	0.5

3.5.4 On a random basis, samples collected to satisfy the compliance limitations of the liquid component (aqueous layer) of drilling wastes shall be accompanied by certificate of sampling duly issued by a competent officer of the Department of Petroleum Resources.

3.5.5 All drilling rigs shall be installed with efficient solids control equipment and be operated at all times in such a manner as to reduce the oil content of the cuttings to the limitations as provided in Article E.

3.5.6.1

3.5.6 Discharge Limitations for Drill Cuttings, Sand, Waste Oil and Sanitary Wastes

3.5.6.1 The discharge Limitations shall be as follows:

(a) Cuttings contaminated with water based mud may be discharged offshore/deep waters without treatment, provided the discharge does not contain free oil as determined by a visual sheen on the receiving water surface.

i) Discharge is authorised only at times when visual sheen observation is possible not at night, rough seas or fog periods.

ii) The discharge must have been on for at least 15 minutes, before such observation shall be made.

iii) Special approval shall be granted by the Director, Petroleum Resources, when such discharge is into vulnerable areas or close to shore.

(b) There is zero discharge of cuttings contaminated with water/oil based mud and /or esters in inland and nearshore areas.

(c) Cuttings contaminated with oil from Low Toxic Mineral Oil Based Mud System shall not be discharged into offshore discharge zone unless treated to a residual oil content less than 10g/kg cuttings, i.e 1% oil - on cuttings.

- i) The alternatives are grinding (slurrification) and injection into geological formation, shipment ashore for treatment and disposal or use of any other treatment technology so approved by the Director of Petroleum Resources.
- (d) Cuttings contaminated with oil from synthetic/pseudo oil based mud system, containing linear alpha olefins (LAO), isomerized olefins (IO), n-paraffin and polyalpha olefins (PAO), shall not be discharged into offshore discharge zone unless treated to a residual oil content of less than 50g/kg, i.e 5% of oil - on - cuttings.
- (e) Cuttings contaminated with esters may be discharged in offshore discharge zone only when the residual oil content is less than 100g/kg, i.e 10% of ester on - cutting.
- (f) Oil contaminated solids, e.g sand, shall not be discharged into offshore discharge zone, unless the oil content is less than 10g/kg dry weight.
 - (i) The alternatives are grinding and injection into geological formation, approved for that purpose, or shipping ashore for treatment and disposal or use of any other treatment technology approved by the Director of Petroleum Resources.
- (g) Reclaimed lube oil and other waste oils shall preferably be disposed of by injection into the crude stream, if not directly utilised.
- (h) Sanitary waste water may be discharged into inland, nearshore and offshore waters after the appropriate treatment, with the following limitation:-

TABLE II-6 LIMITATIONS ON TREATED SANITARY WASTEWATER

Effluent Characteristics		Discharge Limitations (Daily Maximum)	
		<u>Nearshore</u>	<u>Offshore</u>
(i)	Residual Chlorine (mg/l)	0.8	1.5
(ii)	BOD5 (mg/l)	30	45
(iii)	TSS (mg/l)	45	
(iv)	Fecal Coliform Colonies/100ml	200 MPN fecal Coliform/100ml	400 MPN/100ml
(v)	Dissolved Oxygen (DO) mg/l	4.0 - 5.0mg/l	4.0 - 5.0 mg/l

- (i) There shall be zero discharge of well treatment fluids, chemicals and cement slurries into inland and nearshore, rivers/areas.
- (j) Cakes/sludge from septic tanks and Waste Water Treatment Plant (WWTP) shall be disposed of at site approved for such purposes by Director, Petroleum Resources. Such wastes shall be backfilled, landfilled or incinerated.

3.5.6.2 Drill cuttings from the use of oil and water based mud which satisfy the limitation as in article 3.5.6.1(i) may be dumped or discharged deep offshore provided the following additional conditions are met:

- (a) Provision and maintenance by the operator of facilities for the sampling of drill cuttings discharged from the installation, as specified by the Director of Petroleum Resources.

- (b) Samples of the drill cuttings discharged shall be taken by the operator as specified by the Director of Petroleum Resources, (See Appendix II -1 - Use of oil-based mud systems and the conditions for the discharge of oil contaminated cuttings resulting from drilling operations in Nigeria and; Appendix 11-3 - The procedures for the sampling and analysis of drill cuttings to determine oil content), at least once per day **where** oil based mud **are** being used; each sample shall thereupon be analysed for its oil content by an approved method of analysis, by the operator. Records shall be kept.
- (c) The point of discharge of the cuttings shall be properly designated on the installation and shall be by shunting to the bottom.
- (d) The operator shall analyse samples of the drill cuttings from oil based mud system to determine whether and to what extent they contain toxic and hazardous substances as the Director may specify. The results of such analysis shall be reported to the Director of Petroleum Resources.
- (e) The operator shall supply to the Director of Petroleum Resources, samples of the drill cuttings, mud system or base oil, as at when requested for.
- (f) The operator shall submit to the Director of Petroleum Resources details of the sampling and analysis records detailed in Appendix II-3 - (The procedures for the sampling and analysis of drill cuttings to determine oil content), within two weeks from the date of completion of any well.
- (g) The operator shall carry out the first post-drilling seabed survey at the completion of five (5) wells or nine **(9)** months beginning with the date of the initial survey as required in Appendix II - 4 whichever is **shorter**, for both nearshore and offshore waters and; subsequent post-drilling chemical **Surveys every eighteen (18) months or 10 wells drilled**, whichever is **shorter** for nearshore waters. Further seabed surveys may be requested for at the discretion of the Director of Petroleum Resources. (See Appendix II-4 for the General Guidelines for Seabed Sampling and Chemical Analysis).
- (h) The Director of Petroleum Resources or his accredited representative shall be allowed, at all reasonable times, to enter, inspect, take samples and/or analyse such samples using the operator's equipment to ascertain whether these conditions have been complied with.

3.5.7 The solid component (sludge, cake, unsolidified cuttings from water based mud) shall be disposed of on land, after treatments by methods that shall not endanger human life and living organisms and cause significant pollution to ground and surface waters. Such approved methods are land farming, backfilling and landfilling. Any other method(s) acceptable to the Director of Petroleum Resources can be used after an approval has been sought for and given.

3.5.7.1 Land Farming

- 3.5.7.1.1 The solid components of water based mud (drill cuttings, sludge, cake, etc.) may be spread with subsequent incorporation into the soil, provided the following conditions are satisfied:

- (i) An application for site approval shall be made to the Director of Petroleum Resources.
- (ii) A feasibility study is conducted by the operator to determine the suitability of the area (site) for landfarming. The following information (characteristic) shall be made available to the Director of Petroleum Resources, with the application for site approval.
 - (a) Detailed description of site with relation to the following:
 - 1) Past and present land use
 - 2) Geology/soil properties/hydrogeology
 - 3) Hydrologic balance, and
 - 4) Highest seasonal groundwater level.
 - (b) Detailed description of the facility design including maps and drawings and a discussion of the following;
 - 1) Site layout
 - 2) Proposed waste application technique
 - 3) Drainage control, and
 - 4) Proposed waste loading rate.
 - (c) Detailed information concerning;
 - 1.) Sampling and testing of incoming waste
 - 2.) Complete physical and chemical Properties of waste, which should include,
 - i) pH
 - ii) Total metals contents, for example Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Silver, Zinc, Vanadium, Nickel.
 - iii) Oil and Grease Content (% dry weight)
 - iv) Soluble salts and cationic distributions:-
 - (a) Electrical conductivity - EC in mmhos/cm
 - (b) Sodium adsorption ratio - SAR
 - (c) Exchangeable sodium percentage - ESP (%)
 - (d) Cation exchange capacity - CEC (milliequivalents/100 gm soil).
 - 3.) Closure and post-closure monitoring.
 - (i) **Licencees/leasees operating onsite land treatment systems shall submit closure and post-closure maintenance and monitoring programmes to the Director of Petroleum Resources. The monitoring programme shall address sampling and testing schedules for soil in the treatment zone, water collected from the unsaturated zone monitoring system, surface runoff water and ground water.**

- (ii) **Sampling and testing shall be performed during the entire closure and post-closure periods.**
- (iii) **To certify closure of a land treatment system, water and soil collected from the unsaturated zone monitoring system and ground water shall meet background quality values.**
- (iv) **Post-Closure monitoring shall be performed on intervals of 6 months, 1, 2, and 3 years following appropriate certification that closure is complete.**
- (v) **The operator shall be liable for all financial (obligations) for onsite facilities.**

(iii) The following limitations are complied with:

- a) The oil and grease content of the waste/soil mixture is less than 1% dry weight.
 - b) pH of the waste/soil mixture is 6 - 12
 - c) The total metals contents of the waste shall not exceed that of the native soil conditions by 10%.
 - d) The moisture content of the waste is less than 50% by weight.
- iv) The operator shall avoid rainwater run-offs from entering any surface water in the immediate vicinity.
 - v) Provisions by the operator of sampling points for surface runoffs and leachate.
 - vi) Continuous weekly sampling and analysis by the operator of surface runoffs and leachates for two years and/or as requested by the Director of Petroleum Resources. All records shall be sent to the Director on monthly basis.
 - vii) The operator shall decontaminate/**remediate** the site if so requested by the Director of Petroleum Resources. The operator is liable for any outcome of the waste disposed in this manner.
 - viii) At the discretion of the Director of Petroleum Resources, the operator shall analyse samples of the wastes for toxic and hazardous substances, as specified.
 - ix) The Director of Petroleum Resources or his accredited representative shall be allowed, at all reasonable times, to enter, inspect, take samples and/or analyse such samples using the operator's equipment, to ascertain whether these conditions have been complied with.

3.5.7.2 Landfilling

3.5.7.2.1 The following conditions shall be satisfied, when and if, the option adopted is landfilling.

- i) An application for site approval shall be made to the Director of Petroleum Resources.

- ii) Feasibility study is conducted by the operator to determine the suitability of area/site for landfill. Detailed information/characteristics as outlined for landfarming (Article **3.5.7.1** shall be made available to 'the Director of Petroleum Resources.
- iii) The waste is mixed with soil.
- iv) The following limitations are complied with:
 - a) The oil and grease content of the waste/soil mixture is less than 1% dry weight.
 - b) pH of the waste/soil mixture is 6-9.
 - c) The total metals contents of the waste shall not exceed that of the native soil conditions by 10%.
 - d) The moisture content of the waste/soil mixture is less than 50% by weight,
 - e) Top of the buried mixture must be at least 1.5 meters below ground level and then covered with 1.5 meters of native soil.
 - f) Bottom of the buried cell of the landfill must be at least 1.5 meters above the seasonal high water table and shall also satisfy other conditions as provided in Articles **3.4.3- 3.4.4**.
- v) Provisions by the operator of sampling points for surface runoffs and leachate.
- vi) Continuous weekly sampling and analysis by the operator of surface runoffs and leachate for two years/or as requested by the Director of Petroleum Resources. All records shall be sent to the Director on monthly basis.
- vii) The operator shall decontaminate/**remediate** the site if so requested by the Director of Petroleum Resources. The Operator is liable for any outcome of the waste disposed in this manner.
- viii) The operator shall analyse samples of the wastes for toxic and hazardous substances.
- ix) The Director of Petroleum Resources or his accredited representative shall be allowed, at all reasonable times, to enter, inspect, take samples and/or analyse such samples using the operator's equipment, to ascertain whether these conditions have been complied with.

3.5.7.3 Backfilling

3.5.7.3.1 The solid components (sludge, cake, loose drill cuttings, etc) of the spent drillingfluid/mud, can be disposed in-situ in retention pits approved for that purpose in accordance with Articles **3.4.3 – 3.4.3.4**, provided the following conditions are satisfied:

- i) The waste is mixed with soil.
- ii) The following limitations are complied with:
 - a) The oil and grease content of the waste/soil mixture is between 1 - 3% dry weight.

- b) pH of the Waste/soil mixture is 6 - 9.
- c) The total metals contents of the waste/soil mixture do not exceed that of the native soil conditions by 10%.
- d) The moisture content of the waste/soil mixture is less than 50% by weight.
- iii) Bottom of the retention pit shall be at least 1.5 meters above the seasonal high water table.
- iv) Top of the buried mixture shall be covered with **1.5 meter** of native soil.
- v) The operator shall avoid rainwater runoffs and leachate from entering any surface water or underground water.
- vi) Provisions by the operator of sampling points for surface runoffs and leachate.
- vii) Continuous weekly sampling and analysis by the operator of surface runoffs and leachate for two (2) years and/or as requested by the Director Petroleum Resources. All records shall be sent to the Director on a monthly basis.
- viii) The operator shall decontaminate/**remediate** the site. The operator is liable for any consequences of the waste disposed in this manner.
- ix) The Director of Petroleum Resources or his accredited representative shall be allowed, at all reasonable times, to enter, inspect, take samples and/or analyse such samples using the operator's equipment, to ascertain whether the standards are being complied with.
- x) The operator shall analyse samples of the wastes for toxic and hazardous substances, as specified.

3.5.7.3.2 **The Preferred option for the disposal of cuttings and sludge from oil based mud, is by injection and incineration. However, landfarming, landfilling and backfilling when adopted** shall follow the conditions and requirements as specified in Articles **3.5.7.1 – 3.5.7.3** respectively. Other treatment technologies approved by the Department of Petroleum Resources, may also be used.

3.5.7.4 Solidification.

3.5.7.4.1 The cuttings and sludge from **water and** oil based mud may be solidified by appropriate waste to cement ratios. The solidified mixture shall undergo the following tests;

- a) Hardness (compressive strength) test and,
- b) Leachate testing **Toxicity Characteristic Leaching Procedure - (TCLP) For oil and grease and heavy metals (See APPENDIX VIII-D6)**

3.5.7.4.2 The solidified material shall meet the following criteria,

- i) **Unconfined comprehensive strength (QU): >20lbs/in² (psi)**
- ii) Permeability : $\leq 1 \times 10^{-6}$ cm/sec.
- iii) Wet/Dry durability: ≥ 10 cycles to failure.
- iv) **Moisture content** $\leq 50\%$ by Weight or Zero free moisture.

v) pH = 6.5 – 9.0

vi) Electrical conductivity (EC) = 8mmhos/cm

vii) Sodium Adsorption Ratio (SAR) = 12

viii) Leachate Testing (TCLP):

Oil & Grease	=	100mg/l
Chlorides	=	5000 mg/l
Arsenic	=	5 mg/l
Barium	=	100 mg/l
Cadmium	=	1 mg/l
Chromium (total)	=	5 mg/l
Lead	=	5 mg/l
Mercury	=	0.2 mg/l
Selenium	=	1 mg/l
Silver	=	5 mg/l
Zinc	=	50 mg/l

3.5.7.5 Incineration

3.5.7.5.1 The cuttings and sludge from oil based mud may be incinerated by using the best practicable technology currently available **as approved by the Director of Petroleum Resources**. Ash when produced may be landfarmed/landfilled in accordance with Articles E.3.5.7.1 and 3.5.7.2, if the leachate testing (TCLP) Characteristics do not exceed the regulatory levels.

3.5.8 Re-Usable Materials.

3.5.8.1 In addition to other applicable requirements, licensees/leasees seeking to **be permitted for the production of reusable materials from oil field waste shall have the following obligations:**

- (i) **Prior to permit approval or permit amendment approval, applicants must submit the following information:**
 - (a) a detailed description of the process to be employed for generation of reusable material;
 - (b) types of facilities and/or equipment to be constructed (or added);
 - (c) identification of the proposed uses for the reusable material;
 - (d) a description of the proposed monitoring plan to be utilized.
- (ii) **All proposed uses of reusable material must be approved by the Director of Petroleum Resources in writing, who shall be indemnified from damages arising from such permitted uses.**
- (iii) **The production of reusable material shall be conducted in accordance with monitoring plan approved by the Director of Petroleum Resources with issue of the permit for each facility or process.**
- (iv) **Testing Criteria for Reusable Material**

Reusable materials e.g. for daily cover in sanitary landfill or construction material (fill) shall comply with the testing criteria for reusable material, TABLE II - 7 (Also see Appendix VIII - C4)

TABLE 11-7 (TESTING CRITERIA FOR REUSABLE MATERIALS)

Parameter	Limitation
1. Moisture content	<50% (by weight) or zero free moisture
2. pH*	6.5 - 9.0
3. electrical conductivity (EC)	8 mmhos/cm
4. sodium adsorption ratio (SAR)	12
5. Exchangeable sodium Percentage (ESP)	15%
6. total barium: a) reuse/stockpile at commercial facility b) reuse at location other than commercial facility	100,000 ppm 40,000 ppm
5. Leachate testing * for: a. Oil and grease b. Chlorides c. Metals i) Arsenic ii) Barium iii) Cadmium iv) Chromium v) Lead vi) Mercury vii) Selenium viii) Silver ix) Zinc	100 mg/l 5000 mg/l 5mg/l 100mg/l 1mg/l 5mg/l 5mg/l 0.2 mg/l 1mg/l 5mg/l 50mg/l

- (v) If the materials from the treatment/disposal methodology, are to be re-used, the proposed uses of the re-usable material shall be approved by the Director of Petroleum Resources, who shall be indemnified from damages arising from such permitted uses. Such re-usable material shall also satisfy the testing criteria, as provided in ARTICLE 3.5.7.5.

3.6 DEVELOPMENT OPERATIONS

- 3.6.1 It shall be mandatory for a licensee or leasee to conduct an EIA for every development activity, such as:
- i) Onshore and nearshore development drilling. **A seabed survey is required for offshore development drilling.**
 - ii) Construction of onshore, nearshore **and offshore (shallow/deepwater)**flow lines, delivery lines and pipelines in **cumulative** excess of **20** kilometres in length.

- iii) Construction/installation of onshore, nearshore **and offshore** (shallow/deepwater) flowstations, production stations (production platforms/FPSO).

3.7 ABANDONMENT AND CONTROL OF RADIOACTIVE SOURCES IN WELL LOGGING

- 3.7.1 A licensee or operator may perform well logging with sealed radioactive sources.
- 3.7.2 During well logging activities, an operator shall monitor the radiation levels in the environment, on equipment and personnel, and in the circulating fluid/mud system where appropriate, on an hourly basis. The results shall be made available to the Director of Petroleum Resources on a weekly basis and in the final well report at the end of the drilling operations.
- 3.7.3 In the event tools containing sealed sources of radioactive materials including minitron tubes and tracer tools, are stuck in oil or gas well(s), the following steps shall be taken:
 - 3.7.3.1 The Department of Petroleum Resources **shall** be informed within twenty-four (24) hours, with all available information;
 - 3.7.3.2 The services of a licensed and qualified radiological handler/radiologist shall be engaged by the licensee or operator, who shall be responsible for the monitoring of radiation in the circulating fluid/mud system, in the environment on equipment and personnel, on an hourly basis. Such monitoring will continue until such a time that the radio-active source(s) is either retrieved or abandoned/encapsulated. Reports of such monitoring shall be submitted to the Department of Petroleum Resources on a **weekly** basis;
 - 3.7.3.3 Reasonable effort will be made by the operator to recover it. The attempt to recover the radioactive sources should not result in the rupture of the sealed source(s);
 - 3.7.3.4** If the circulating fluid/mud system, environment, equipment and/or personnel are contaminated with the radioactive materials, they must be decontaminated before release from the site. Such decontamination efforts shall be discussed with and approved by the Department of Petroleum Resources (**See Part VIII – C**).
 - 3.7.3.5 If the sealed source is classified as irretrievable after reasonable efforts at recovery have been expended, a planned abandonment scheme/proposal shall be submitted to the Department of Petroleum Resources for discussion and approval.
- 3.7.4 In all abandonment schemes, except when otherwise stated, the following procedures must apply and should be accomplished within thirty (30) days:
 - i) Each irretrievable well logging source must be immobilised and sealed in place with a cement plug.
 - ii) A mechanical device to prevent inadvertent intrusion on the source must be set at some point in the well above the cement plug unless the cement plug and source are not accessible to any subsequent drilling operations, and

- iii) A permanent identification plaque, constructed of long lasting material such as stainless steel, brass or bronze must be mounted at the surface of the well. The sale of the plaque must contain:
 - a) The word 'CAUTION'
 - b) The radiation symbol
 - c) The date the source was abandoned
 - d) The well name and identification
 - e) An identification of the sealed source(s) by radionuclide quantity and activity.
 - f) The depth of the source and depth of the top of the plug, and
 - g) An appropriate warning, such as "DO NOT RE-ENTER THIS WELL".

3.7.5 A written report shall be provided by the licensee or operator to the Department of Petroleum Resources, within thirty (30) days of the abandonment, detailing recovery attempts, radiation monitoring, isolation procedures, well operator/location information and a copy of the permanent plaque affixed on the well head.

3.8 MONITORING

3.8.1 Waste generators shall be responsible for the management of the wastes from cradle to grave.

3.8.1.1 There shall be mandatory monitoring requirements for drilling fluids/cuttings, well completion/treatment and workover fluids, produced sand, deck drainage, sanitary sewage and blow-out prevention (BOP) fluid, during drilling and workover operations as follows. (See Table 11-8):

TABLE II-8. MONITORING REQUIREMENTS FOR DISCHARGES FROM WELL-DRILLING OPERATIONS.

DISCHARGE TYPE	MONITORING REQUIREMENT			
	MONITORED PARAMETER	SAMPLE TYPE/METHOD	MEASURING FREQUENCY	RECORDED VALUES
1. Drilling Fluids	(i) Volume/ Discharge Rate	Estimate	Once/hour when discharging	Max.Hourly rate
	(ii) Total Hydrocarbon Content	Grab	Two sets of analysis on a composite sample collected at every 305m, and the other at the end of the well from the lowest section but not in the pay zone	Mg/l
	(iii) Toxicity 96-hr LC ₅₀	Grab	Once/month and once/end of well (sample taken after the final log run and prior to bulkdischarge).	96-hr LC ₅₀
	(iv) Mercury and Cadmium	Absorption Spectrophotometry	Once prior to Drilling each well on each new stock of barite used.	Mg mercury/kg Barite mg Cadmium/Kg barite
2. Drill Cuttings	(i) Oil-in- Cuttings	Dean and Stark Reflux Method	Two sets of analyses on a composite sample made of samples collected at every 305m, and the other at the end of the well from the lowest section but not in the pay zone	g/kg
	(ii) Toxicity 96-hr LC ₅₀	Grab	Once/month and once/end of well (sample taken after the final log run and prior to bulk discharge).	96-hr LC ₅₀
	(iii) Free Oil	Static Sheen	Once/week during discharge	No. of days sheen observed
	(iv) Volume/Discharge Rate	Estimate	Once/hour when discharging	Maximum hourly rate
3. Deck Drainage	(i) Volume/Discharge	Estimate	Once/hour when discharging	Maximum hourly rate
	(ii) Total Hydrocarbon content	Grab	Once/day during discharge	Mg/l
4. Sanitary sewage	(i) Discharge Rate	Estimate and record	Once/day when discharging	Maximum daily rate

(Continuously manned by 10 or more persons)	ii) Residual chlorine	Grab	Once/week when discharging	Concentration in Mg/l
	iii) BOD ₅	Grab		
	iv) Total Coliform Count	Grab		
	v) Total Suspended Solids	Grab		
	vi) Dissolved oxygen	Grab		
	Volume	Estimate		
5. Blow-out Prevention (BOP) Fluid	Volume	Estimate	Once/hour when discharging	Maximum hourly rate
6. Well Treatment Fluid	Volume	Estimate	Once/day when discharging (No discharge of hazardous chemicals)	Maximum daily rate
7. Workover Fluids/Wastes	(i) Volume	Estimate	Once/day during discharge	Concentration (mg/l)
	ii) pH	Grab		
	iii) Chloride	Grab		
	iv) Total Hydrocarbon Content	Grab		
8. Radioactive substances	i) Background Radiation Level	Estimate	Once/hour during well logging activities	Exposure rate (Specific activity and dose limit)
	ii) Radiation Levels in the:- *Circulating Fluid/mud *Equipment Environment *Personnel	Estimate		

3.8.1.2 Except otherwise specified, the result and report of the parameters monitored as in Table II-8, shall be submitted to the Director of Petroleum Resources as and at when appropriate, (i.e. every month and at the end of the drilling operations per well).

3.8.1.3 On completion of the well, the types, composition, quantity of mud, mud additives employed, volume of drilling fluids discharged and the drill cuttings produced and discharged shall be embodied in the final well report to be submitted to the Director of Petroleum Resources.

3.8.1.3.1 Waste Release Inventory.

3.8.1.3.1.1 Licencees/Leasees shall at the end of each year submit to the Director, Petroleum Resources, the total releases of onsite effluent discharges (volume/mass) to:

- i. air (any fugitive or stack emissions);
- ii. water (surface);
- iii. underground injection and;
- iv. land disposal (landfill, land treatment, surface impoundments, etc).

3.8.1.4 The method of sampling and measurement employed in connection with the monitoring of drilling and workover operations shall be those approved and issued by the Department of Petroleum Resources. (See PART VIII-D).

4 ENVIRONMENTAL AUDITS/REVIEWS.

4.1 Licencees/operators shall conduct Environmental audits to facilitate the management control of environmental practices and assessing compliance with the management system and regulatory requirements (See PART VIII-I).

5 SPILL PREVENTION AND COUNTER MEASURES PLAN.

5.1 Drilling operations shall have comprehensive spill prevention and counter measures plans, approved by the Director of Petroleum Resources. See PART VIII-B.

5.1.1 All spillages of crude oil/chemical/oil products shall be reported to the Director of Petroleum Resources, in accordance with the Oil Spillage/Notification Reporting Formats, 'A', 'B' and 'C'. See APPENDIX VIII-B2).

5.1.1.1 In addition, a Joint Spillage Investigation (JSI) team, comprising of the Licencee/Operator/Spiller, Community and DPR shall be constituted, within 24 hours, of spillage notification to investigate the spillage.

5.1.2 Crude Oil/Chemical Spillage and Contamination Clean-up Certification

5.1.2.1 Clean-up efforts for all inland and nearshore spillages of crude Oil, Products and Chemicals, shall be subjected to Clean-up Certification, as provided for in the Oil/Chemical Spill/Contamination Clean-up Certification Forms, PARTS 'A' and 'B' (See APPENDIX VIII-B3).

5.1.2.2 Appropriate approval shall be granted by the Director, Petroleum Resources for any remediation/rehabilitation method used to clean-up/restore impacted site(s). (See PART VIII F).

5.1.2.3 Licencees/operators shall keep a register of Potentially Polluted Site(s) (PPS) or Past Impacted Site(s) (PIS). Such sites are to be cleaned up, remediated and certified accordingly by the Director, Petroleum Resources.

6 USE OF ABRASIVE AGENTS IN BLASTING ACTIVITIES.

6.1 The use of sand as an abrasive agent in blasting activities for cleaning of steel structures - tanks, pipelines, etc., **shall be controlled by the Department of Petroleum Resources.. Abrasive agents of less than 1% free silica, which also conform with ISO 1126/N/CS/G, are recommended.**

7 SANCTIONS

7.1 The conditions as stipulated in PART IX shall apply.

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USE OF OIL BASED MUD SYSTEMS AND THE CONDITIONS FOR THE DISCHARGE OF OIL CONTAMINATED CUTTINGS RESULTING FROM DRILLING OPERATIONS IN NIGERIA

1 INTRODUCTION

The conditions set out below are required for all oil companies wishing to seek permission for the use of oil based muds and the discharge of oily wastes resulting from the drilling operations.

2 APPLICATION FOR AN EXEMPTION

A formal application for the use of oil-based muds **shall** be made to the Department of Petroleum Resources. The use **shall** be justified on:

- (a) Geological
- (b) Safety and/or
- (c) Economic grounds.

The following shall be noted:

- i. For exploration and appraisal wells, the mud programme shall include consent application to enable the Department of Petroleum Resources assess the geological reasons for using oil based mud.
- ii. For development drilling, a single justification for using oil based mud covering all wells will be sufficient,
- iii. The use of oil based muds will not be approved in the upper section of the hole, where drill cuttings are produced in the greatest quantity and at the highest rate, unless there is a clear and justifiable need to do so.

3 GENERAL INFORMATION ABOUT THE RIG

The conditions relating to production and development drilling are to be applied to all installations where a number of wells are to be drilled either from a fixed platform or from a mobile rig through a template. Exploration drilling is taken to be the drilling of a single well at any given location. Detailed information should be provided on:-

- i) Well number or names of fixed installation/template.
- ii) Rig name and co-ordinates.
- iii) Spud date.
- iv) Name of mud system and base oil.
- v) Depth and diameter of hole to be drilled using oil based mud.
- vi) Distance from shore, and water depth.

4 DETAILED INFORMATION ABOUT LOW TOXICITY BASE OIL AND MUD SYSTEMS

To be acceptable as a low toxicity base oil and mud system, both must have been subjected to toxicity testing under Nigerian conditions, and shown to have an acceptable low acute toxicity. Base oils alone may be tested and offered for substitution in an already approved mud system.

4.1 Base Oils

The 96-hr. LC₅₀ to two local organisms must be determined at two laboratories using an approved protocol for carrying out the standard tests. (The 96-hr. LC₅₀ is the concentration calculated to kill 50% of the test population when exposed for 96 hours). A **500ml.** sample of the base oil submitted for toxicity testing **shall** be sent to the Department of Petroleum Resources. This sample will be used as a reference standard. The laboratories for the test must be approved by the Director of Petroleum Resources.

4.2 Muds

The 96-hr. LC₅₀ to two local organisms must be determined at two laboratories using an approved protocol for carrying out the standard tests. A 100 ml. sample of the mud system should be sent to the Department of Petroleum Resources as a reference standard. All muds will be retested at **the discretion of the Director of Petroleum Resources as and when necessary. The laboratory for such tests shall be approved by the Director of Petroleum Resources.**

4.3 Analytic Work

In addition to providing the toxicity determinations, the Properties of the base oil should also be given, such as:

- (i) Initial B. P., 0/C
- (ii) Final B. P., C.
- (iii) Kinematic Viscosity kV @ 40°C.
- (iv) Aromatic Content, %
- (v) Sulphur Content, o/o
- (vi) Flash Point, °C
- (vii) Specific Gravity
- (viii) Aniline Point, °C.
- (ix) Heavy metals Hg, Cd, Cr, Pb, Ba, Fe, Sb, Ni V)

5 SOLID CONTROL EQUIPMENT

Efficient solids control equipment must be installed and properly operated. The primary solids control equipment (shale shakers, desanders, desilters etc.) must have the capacity to separate the mud from cuttings in an efficient manner at the highest drilling rates and return the mud system. Adequate screening area must be available at all times to prevent the discharge of whole mud with the cuttings. Equipment performance will be assessed through reporting to the Director of Petroleum Resources as specified in the discharge exemption conditions. The Department of Petroleum Resources may also exercise its rights to inspect equipment in operation and obtain samples as necessary.

6 DISCHARGE OF MUDS AND CUTTINGS

6.1 WHOLE MUDS

No whole mud shall be discharged from offshore drilling operations.

6.2 CUTTINGS SAMPLE ANALYSES

Facilities must be available on the installation to determine the oil contents of the cuttings discharged **offshore**. The oil content of the discharged cuttings must be determined every 305 meters drilled. Qualitative and quantitative check analyses must be carried out as required. The results of the analyses which must be submitted to the Director of Petroleum Resources as drilling operation is going on, will enable the performance of the solid equipment to be monitored and provide data on which to base estimate of quantities of oil discharged to the environment. The procedures to be followed for the sampling and analysis of drilling cuttings to determine their oil content are detailed in Appendix 11-3.

6.3 OTHER ANALYSIS

For each production or development well drilled with oil based mud a 5 kg. sample of cuttings from the lowest section will be taken (not in the pay zone) and analysed for total hydrocarbons (by UVF or IR), and for 2 - 6 ring aromatic hydrocarbon (by GC/MS or any equivalent method). A 100 gm. sample of mud should be taken from the active mud pit at the same time. Prior to analysis the bulk of the cuttings shall be stored at 0 - 5°C and the mud and 100 gm. of cuttings stored at 18°C. Analysis will be carried out by the operator, and samples then stored at the above temperatures until the Director of Petroleum Resources has been notified that they are satisfied with the analysis. (For more details see APPENDIX 11-4, section 4).

6.4 CUTTINGS DISCHARGE AND DEPTH

The location and depth of the discharge point **shall** be taken into account when assessing the acceptability of any control system. It is noted that the positioning of the discharge caisson and in particular the depth of discharge has a strong bearing on the spread of the cuttings and hence the area affected. Since the objective is to minimise the environmental impact, it will also be necessary to take into account the scale of the drilling programme proposed in relation to the location and hydrography of the installation.

APPENDIX 11-2 - GENERIC DRILLING FLUIDS LIST

Type of Fluid and Base	Typical Concentration of Components (Pound per Bbl)
1. Potassium/Polymer Mud: Barite Caustic Soda Cellulose Polymer Drilled Solids Potassium Chloride Seawater or Freshwater Starch Xanthan Gum Polymer	0 - 450 0.5 - 3 0.25 - 5 20 - 100 5 - 50 (1) 2 - 12 0.25 - 2
2. Seawater/Lignosulfonate Mud: Attapulgate or Bentonite Barite Caustic Soda Cellulose Polymer Drilled Solids Lignite Lignosulfonate Seawater Soda Ash/Sodium Bicarbonate	10 - 50 25 - 450 1 - 5 0.25 - 5 20 - 100 1 - 10 2 - 15 (1) 0 - 2
3.	

2.	10-50	
.....		
Barite.....		25-450
Caustic Soda.....		1-5
Cellulose Polymer.....		0.25-5
Drilled Solids		20-100
Lignite		1-10
Lignosulfonate.....		2-15
Seawater.....		(1)
Soda Ash/Sodium Bicarbonate.....		0-2
3. Lime Mud:		
Barite.....		25-180
Bentonite.....		10-50
Caustic Soda.....		1-5
Drilled Solids.....		20-100
Fresh Water or Seawater.....		(1)
Lignite		0-10
Lignosulfonate.....		2-15
Lime.....		2-20
Soda Ash/Sodium Bicarbonate...		0-2
4. Nondispersed Mud:		
Acyclic Polymer.....		0.5-2
Barite.....		25-180
Bentonite.....		5-15
Drilled Solids.....		20-70
Fresh Water or Seawater.....		(1)

APPENDIX 11-2 - GENERIC DRILLING FLUIDS LIST (contd.)

Type of Fluid and Base per Barrel)		Typical Concentration of Components Range (Pound per barrel)	
5.	Spud Mud (Slugged Intermittently with Seawater)		
	Attapulgate or Bentonite.....	10-50	
	Barite.....	0-50	
	Caustic Soda.....		0-2
	Lime.....	0.5-1	
	Seawater.....		(1)
6.	Seawater/Fresh Water L-al Mud:		
	Attapulgate or Bentonite.....	10-50	
	Barite.....	0-50	
	Caustic Soda.....	0.5-3	
	Cellulose Polymer.....	0-2	
	Drilled Solids.....	20-100	
	Lime.....	0-2	
	Seawater or Fresh Water.....		(1)
	Soda Ash/Sodium Bicarbonate.....		0-2
7.	Lightly Treated Lignosulphate Fresh Water/Seawater Mud:		
	Barite.....	0-180	
	Bentonite.....	10-50	
	Caustic Soda.....	1-3	
	Cellulose Polymer.....	0-2	
	Drilled Solids.....	20-100	
	Lignite	0-4	
	Lignosuifonate.....	2-6	
	Lime.....	0-2	
	Seawater-to-freshwater Ratio....	(1)	
	Soda Ash/Sodium Bicarbonate....		0-2
	Caustic Soda1.....	2-5	
8.	Lignosuifonate Freshwater Mud:		
	Barite.....		0-450
	Bentonite.....		10-50
	Cellulose Polymer.....	0-2	
	Drilled Solids.....	20-100	
	Fresh Water.....		(1)
	Lignite.....	2-10	
	Lignosuifonate	4-15	
	Lime.....	0-2	
1.	As Needed.		
2.	1:1 Approximately-		

THE PROCEDURES FOR THE SAMPLING AND ANALYSIS OF DRILLING CUTTINGS TO DETERMINE OIL CONTENT.

1.0 SAMPLING

The sample point (points) will depend on the type of oil mud used and on the solids control plant installed.

- 1.1 A representative bulk sample of at least 0.5kg to 1 kg should be taken and must include material from each deck of all the shale shakers. This is best achieved by scanning a suitable container, preferably a wide tray which will retain all the material i.e. both solids and liquids, beneath the discharge from the shakers.
- 1.2 The samples should then be transferred to a smooth, clean surface, (e.g. heavy gauge polythene, 2-3mm in thickness) ensuring that all drain oil is transferred with the solids. The whole bulk sample(s) should then be thoroughly mixed ensuring that any drained oil is fully incorporated. Quickly dip the sample material and fill the sample containers of Teflon capped borosilica glass bottles. The containers used will depend on the analytical method and whether the samples are to be analysed immediately or taken ashore for check analysis or reference.

2.0 ANALYSIS

- 2.1 Offshore: Analysis can be satisfactorily carried out using the standard mud retort equipment. Since this method is essentially volumetric in its standard form some modifications are required to the procedure.

Apparatus

- 2.1.1 Proprietary mud, oil and water retort kit with at least three mud chambers. 20ml or 50ml mud chambers may be used but 50ml is to be preferred as this will improve the accuracy.
- 2.1.2 The distillate receiver must be an accurately calibrated 20 ml or 50 ml measuring cylinder calibrated in 0.1ml divisions. (In place of the receiver normally used with the retort).
- 2.1.3 A balance capable of weighing to an accuracy of 0.1g under offshore conditions. An integrating balance system is recommended.

Method

- 2.1.4 Weigh the distillate receiver and mud chambers with lids. Record the weighing.
- 2.1.5 Fill the mud chambers with cuttings as completely as possible, replace the lids and clean off any adhering mud and oil. At least three chambers should be filled, one for immediate analysis and the others to be held in reserve in case of accidents etc.
- 2.1.6 Reweigh the filled chambers and record the weighing.
- 2.1.7 Place the chamber in the heating compartment, switch on the heater and allow to distil for at least 25minutes. Collect the distillate in the weighed, graduated receiver.
- 2.1.8 Switch off the heater, remove the mud chamber and allow to cool. Read off the volume of the water collected and reweigh the distillation receiver with its contents and record the results. The cylinder should be at ambient temperature before the readings are taken.

Calculation

- 2.1.9 The content of oil in the cuttings should be expressed as grams of oil per kilogram of DRY RETORTED SOLIDS:
That is: $\text{Weight of oil (g) / Weight of dry retorted solids (g) * 1000}$

3.0 Check Calibration

- 3.1 The heating element in the retort kit can decline in efficiency over a period of time and this needs to be checked. Such checks should be carried out, for each well drilled with oil based mud:
- (i) Prior to drilling with OBM;
 - (ii) At the completion of the well.

- 3.2 To calibrate a retort, the following mixture should be mixed on a Hamilton Beech Mixer at the high speed setting, adding each component in order as listed below:

Base oil	106ml
Organophillic Clay	1.0 g
Emulsifier	3.0 ml
Lime	2.0 g
Fresh Water	28 ml
Wetting Agent	3.0 g
Barite	750 g

3.2.1 Mixing Notes:

- i.) The Barite should be added in stages, until the mixer can no longer incorporate the solids (approx. 650 g), the remaining Barite should be thoroughly mixed in with a spatula.
- ii) The final mixture should be of a highly viscous, grainy- looking, semi-solid nature, but fluid enough to allow proper filling of the retort cup. The above mixture should yield a measured oil/water ratio of 80/20. Solids content is 56%. Total volume of the mix is 320 ml and thus one mix should be sufficient for calibration of a 50 ml retort six times (allowing for the inevitable losses).

- 3.3 The measured figure of oil on dry retorted solids should be within 10g/kg of the calculated value.

4.0 REPORTING

In order to simplify reporting and subsequent processing of data by the Department of Petroleum Resources, the format attached at the end of this Annex should be used.

5.0 ONSHORE ANALYSES

- 5.1 A more accurate analysis should be carried out onshore as a means of checking the regular offshore method or as a means of determining an accurate oil and water solids content. Two methods are recommended; any others should be notified to the Department of Petroleum Resources for acceptance.

5.1.1 Water Solids and Oil by Dean and Stark Method

- (i) Water Content

- (a) Apparatus

500 ml heating mantle Dean and Stark Apparatus with 10 ml receiver and 500 ml distillation vessel. (Ref. IP Standards for Petroleum and its Products, Part 1, Methods for Analysis and Testing, Section 1, IP 74/70.)

- (b) Reagents

Toluene

- (c) Procedure

Accurately weigh approximately 50g of sample into a clean, dry distillation flask, add 100-200 mg antibumping granules, accurately weighed, then add 200 ml toluene. Assemble apparatus as shown in reference, inserting a loose cotton wool plug in the top of the condenser to prevent condensation of moisture inside it. Apply heat to the still, adjusting the rate of boiling so that condensate discharges from the condenser at the rate of 2 to 5 drops per second. Continue the distillation until no water is visible in any part of the apparatus, except in the trap and the volume of water in the trap remains

constant for 5 minutes. If there is a persistent ring of water in the condenser carefully increase the rate of distillation or cut off the condensed water for a few minutes. When the evaporation of water is complete allow the trap and contents to cool to room temperature. Dislodge any drops of water adhering to the sides of the trap with a coiled platinum wire. Read the volume of the water in the trap. Water (g) = Vol. of water in trap x SG of water (= 1.0)

(ii) Solids Content

(a) Apparatus

150 ml centrifuge tubes, Centrifuge, Glass Rod.

(b) Reagents

1, 1, 1-trichloroethane (Genklene)

(c) Procedure

Transfer the toluene and solid from Dean and Stark Water determination to two clean, dry, weighed glass centrifuge tubes. Centrifuge until the supernatant is clear and then decant and discard the toluene. Add approximately 100 ml 'Genklene' to each tube using some to rinse out any solid remaining in the Dean and Stark distillation flask, then mix well using a glass rod. Centrifuge and discard supernatant. Repeat twice more. Evaporate over a boiling water-bath to remove 'Genklene' then dry in an oven at 100°C constant weight.

Dry solids (g) = Wt dry solid (g) - wt anti-bumping granules (g)

$$\frac{\text{Oil Content by difference}}{\text{Oil (g/kg dry solids)}} = \frac{\text{Wt. of Solids (g) - Wt. of water (g)}}{\text{Wt. of Solids.}}$$

(iii) Reflux Method

(a) Apparatus

500 ml round-bottomed flask, Heating mantle, Double -walled reflux condenser, Buchner flask and funnel, suitably sized volumetric flasks, infra-red spectrophotometer. NB: All glassware must be solvent-cleaned.

(b) Method

Accurately weigh about 20g of sample into a clean, dry round-bottomed flask. Add approximately 120ml of Freon 113 (1, 1, 1-trifluoro trichloro ethane) purified grade (Arklone) and boil under reflux for about 30 minutes. Cool and filter into a Buchner flask to obtain a clear solution, wash the solid with Arklone and then dilute the filtrate and washings to 250 ml in a volumetric flask. Transfer the solid to a clean, dry weighed clock glass, dry in an oven at 110°C cool in a desiccator and weigh. Make a suitable dilution of the solution with Arklone and scan at wavelengths between 2600 cm⁻¹ to obtain an adequate baseline and measure the peak height at 2940 cm⁻¹. Use the linear absorbance mode with 1cm silica cells and Arklone as reference.

(c) Calibration

Weigh 0.5g of reference oil and dilute to 500 ml with Arklone. Transfer accurately 10, 20 and 30 ml volumes of the standard oil solution to 100 ml volumetric flasks and dilute to the mark with Arklone. Scan as sample solutions and plot a calibration graph of peak height against concentration of oil.

OIL ON CUTTINGS ANALYSIS

Well No:.....
Spud Date:.....
Completion Date:

Operator:.....
Mud System:.....
Base Oil:.....
Retort Size:.....

Installation

Name:.....
Owner:.....
Type:.....
(mobile installations)

SUMMARY OF USE OF O B M

17 in from----- (ft/cm)to(ft/cm)
12 in from----- (ft/cm)to(ft/cm)
8 in from -----(ft/cm)to(ft/cm)

OIL ON CUTTINGS ANALYSIS

Well No..... Sheet of

Date (Day, Month, Year)
Time of Sample
Hole of Depth at
Depth Drilled Since Last Sample (ft/cm)
Weight of Dry Retorted Solids (g)
Weight of Water (g)
Weight of Oil (g)
Weight of Oil on Dry Retorted Solids (g/kg)
Formation Type
Bit Type
Speed of Rotation (rpm)
Rate or Penetration (M/hr)
Screen Size (s) (mesh) Upper
Lower

Calibration Sample
Calculated oil on dry retorted solids g/kg.
Measured: (i) Prior to drilling with OBM g/kg.
(ii) At completion of well g/kg.

GENERAL GUIDELINES FOR ECOLOGICAL SEA BED SURVEY SAMPLING AND ANALYSIS

1.0 The analytical method to be used and the form in which the results will be presented should be part of the proposal submitted in advance to the Department of Petroleum Resources.

2.0 FREQUENCY OF SURVEYS

2.1 A programme of seabed **ecological survey shall** be carried out prior to commencement of drilling operations in order to define the baseline conditions; this **shall** include **physico-chemical characterisation of seawater and sediment and a survey of benthic organisms, including microbes during the dry and wet seasons.** After drilling has commenced, a second survey shall be carried out after **9 months** or after 5 wells have been drilled, whichever is the **shorter** period of time. Subsequent chemical surveys **shall** then be carried out after a further **18 months** or further 10 wells. Based upon the results, companies may be asked to undertake a more detailed survey, including the sampling of benthic organisms **and oceanographic characteristics.**

3.0 SAMPLING

3.1 For each survey the following will be required:-

The surface top 1-2 cm only will be sampled (and stored at -4°C or below) from at least **three** successful grabs or cores to be taken at stations approximately 100, 200, 500, 800, 1,200, 2,500 and 5,000 metres from the platform or template, along the directions of most persistent bottom current. **The sampling points shall be determined with the GPS (or preferably DGPS) and coordinates clearly stated in order to make post-drilling monitoring at exact location possible.** Where information on bottom water or sediment movements is insufficient to establish the transect directions, additional stations will be required **and the preferred method of sampling shall be unstratified and randomized.** Three clean stations are also to be successfully sampled in the same area at a minimum of 6,000 metres from any platform or template. It is important that these are not contaminated by other drilling activities unrelated to that being studied, but otherwise one of these clean stations should be at 8,000 - 10,000 metres along the transect directions). In more sensitive sites/area as determined by the DPR, operators are advised that more transects stations or successful samples per station may be required.

4.0 CHEMICAL ANALYSIS FOR HYDROCARBONS IN SEDIMENTS

(i) Sediments will be analysed to determine the level of 'total Hydrocarbons' by UV fluorescence (or IR) measurements against standard dilutions of diesel fuel oil and crude oil, and reported as total oil concentrations in µg-g dry weight. Care should be taken that 'quenching' has not occurred in UVF measurements, and IR measurements are made within the linear calibration range. Alternatively 'total hydrocarbons' may be quantified by capillary GLC on a sub-sample of the total extract following 'clean up' (e.g. by passage through a florisil column).

(ii) Aliphatic hydrocarbons should be determined by capillary GC using heptamethy-Inonane, 1 chloro-octadecane, and squalane as internal standards to cover the boiling range of compounds measured. The alkanes should be reported as g/g dry weight. The chromatograms should be fully annotated indicating amounts of internal standards/unit weight of sample. If 'total hydrocarbons' are determined by capillary GLC then the alkanes may be quantified from the same chromatograms.

(iii) The concentration of 2-6 ring aromatic hydrocarbons **shall** be determined by GC-MS using (**where available**) D10-naphthalene, D10-anthracene and d10-pyrene as internal standards, or an equivalent method to cover the boiling range of compounds to be measured and reported as ug-g dry weight as outlined below:-

m/e;

128 and	C1-C4	alkyl	derivatives
178	"	C1-C3	"
184	"	"	" (dibenzthiophenes)
202	"	"	"
228	"	C1-C2	"
252	"	"	"

GC-MS will be expected on baseline surveys only but may be required in future surveys where very high levels of hydrocarbons are indicated by other parameters measured. Alternatively UVF scans may be required.

- 4.1 Copies of any calibration graphs, UVF (or IR) scans, chromatograms and mass spectrographs which have been made during analysis should be included in the report.
- 4.2 After analysis, samples should be stored at 18°C until the Department of Petroleum Resources has notified the operator that it is satisfied with the report.
- 4.3 Physico Chemical analysis among others **shall** also be performed for the following parameters:
 - (i) Particle size and organic content
 - (ii) Redox potential
 - (iii) Major and trace metals.

5.0 BENTHIC MACROFAUNAL SAMPLES

- 5.1 **Analysis of macrobenthic organisms shall establish and record species diversity and abundance (population density) including identification of numerically dominant and other biologically important species based on frequency of occurrence.** Each sample for faunal analysis shall have a minimum volume of 5 litres. Accepted macrofannal grab samples will be sieved immediately after retrieval; the grab contents would be emptied on to the sieving table and screened through a 0.5mm or 1.0mm mesh sieve, using seawater. The sediment and faunal material retained by the sieve would then be transferred to a scalable container, labelled and fixed in 20% buffered formol saline (formalin in seawater) for transport to the laboratory.

5.2 Benthic microbial community

Grab sediment samples in sterile containers shall be analysed to establish the presence of microbes that are hydrocarbon utilizers within the existing microbial community, describing species diversity and density.

6.0 PHYSICOCHEMICAL CHARACTERIZATION OF SEA WATER.

Each sample for the physicochemical characterization of the seawater shall be analysed for total hydrocarbon (THC) and all the major and trace metals as determined in sediment samples.

7.0 SUBMISSION OF REPORT

- 7.1 **Field Survey** reports must be submitted to the Department of Petroleum Resources within **one month** of sampling.

- 8.0 When the analytical programme is designed, the following points should be noted:-

- (i) Gravimetry is not considered a suitable method for quantification of hydrocarbons either in or on sediments.
- (ii) Sediments would not be dried before extraction takes place. A separate portion of sediment may be used to determine the moisture content and dry weight.
- (iii) Internal standards should be added before extraction takes place.
- (iv) Solvents used should be as low boiling as possible.
- (v) Evaporations should be avoided or kept to a minimum especially before total hydrocarbons estimations are made. None is necessary before UVF measurements.
- (vi) When evaporations are necessary, solvents should be reduced or removed with great care and at temperatures no higher than 30°C.
- (vii) Quantitative measurements by UVF should be made within the linear range rather than using self-absorption effects and log-log calibration over wide concentration ranges. **This will avoid self absorption effects and** consequent changes in the synchronous spectra recorded.
- (v) For the UVF scans (range 230-500 nm) $\Delta \lambda = 20 \text{ nm}$ or 25 nm will be

APPENDIX II –5 (A)

DPR MONTHLY ENVIRONMENTAL SEISMIC REPORT

The Director,
Department of Petroleum Resources,
7, Kofo Abayomi Street,
Victoria Island
P. M. B. 12650,
Lagos

FROM:
COMPANY:
ADDRESS:
REF:
DATE:

1. Location (OML/OPL): -----
2. Contractor: -----
3. Other Sponsor(s): -----
4. Type/Make of Explosive(s): -----
5. Inventory of Explosive(s)
Stock-piled: -----
(Attach sheet (s) If necessary):
6. Number of Explosives
Lost/Stolen: -----
(Attach Police Report(s))
7. Safety Records:
(i) Total Number of Misfired Shots: -----
(ii) Please complete the table on Appendix II – 5B.
9. Other Remarks (Lines Shot or Degree of Activity): -----

Reporting Officer: -----
Designation: -----

Signature: -----
Date: -----

APPENDIX II – 6

STUCK RADIOACTIVE TOOLS ABANDONMENT REPORT
(Submit to DPR within 2 weeks of abandonment)

Ref:-----

- (i) **Company Name/Address:**

- (ii) **Well Name/Location:----- Date Abandoned:-----**
Dd/mm/yy
- (iii) **Stuck Tools:-----**
- (iv) **Recovery Attempts:-----**

- (v) **Radiation Monitoring:-----**

- (vi) **Isolation Procedures:-----**

- (vii) **Other Remarks:-----**

A copy of the permanent plaque affixed on the wellhead must be attached to this report.

Reporting Officer:-----
Signature:-----
Designation:-----

PART III PRODUCTION OPERATIONS

A. BACKGROUND

1. Production operations begin as wells are completed during the development (drilling and completion) phase. The production phase involves the active recovery of hydrocarbons from producing formations. During this phase, discharges are composed principally of produced formation water and also drilling fluids and drill cuttings while concurrent development drilling is in progress. The discharge of drilling fluids and drill cuttings, stops when development and well reworking operations end. Production operations are **practised** on land, swamp, nearshore and offshore environments of Nigeria.
2. The relevant pollution regulations on production operations are provided under Sections 25 and 36 of the Petroleum (Drilling- and Production) Regulations, 1969.
3. The primary objective of the foregoing guidelines and standards shall be to regulate the **environmental management practices** in the production and discharge of produced formation waters, oily waste waters, **sludges** and accidental spills of oils from oil and gas production installations within the territory and territorial waters of the Federal Republic of Nigeria.

B. DESCRIPTION OF OPERATIONS:

1. After a well is drilled, and has proved that oil can be produced commercially and economically, the well is prepared for sustained operations, and a permanent installation replaces the mobile unit.
2. Hydrocarbon fluids move to the surface through tubing contained within the cased borehole. For oil wells, energy required to lift fluids can be provided by natural formation pressures or various induced mechanical means. The most commonly used induced methods are: fluid (water or gas) injection to maintain pressure, forcing gas into the oil stream for overall reduction in hydrostatic fluid density with a subsequent 'lift', and lastly the use of pumps.
3. At the surface, oil, gas and water are separated: gas from any liquids, oil from water. Fluids produced from oil reservoir normally consist of oil, natural gas, and salt water (brine) which in turn, contains suspended and dissolved solids. A gas well can produce dry gas, but, usually it produces varying quantities of light hydrocarbons (called gas liquids or condensate). In both oil and gas production, suspended solids in production waters are normally clays, sand, or similar materials.
4. Gas, oil and water are commonly separated in several stages. Gas dissolved in oil, is released as the pressure above the liquid phase is reduced. Oil from high pressure wells requires several stages of decompression to become gas free. Oil and brine are sometimes present as emulsion, either by natural occurrence or from the vigorous mixing experienced in bringing the fluids to the surface. The emulsion may be broken (i.e. separation of oil and water phases) by moderate heat, chemical addition, electric charge, or quiescent settling.
5. Gas and oil separated in the above manner can be considered as inputs into commercial gas pipelines and as crude petroleum feed stocks (for export and refinery inputs), respectively.

C. SOURCES AND CHARACTERISTICS OF WASTES

1. The discharges from production operations include effluents (solids, liquids and gases) and accidental oil spills.
2. Atmospheric emissions may result from fuel combustion necessary for any heat required for oil water separations, or for any heating requirements in the crew living quarters. Also any electric power generation facilities needed for pumps etc., may also produce emissions. Amount of gaseous and particulate emissions depend upon fuel(s) used, power and heat requirements and levels of emission control employed.
3. Continuous emissions may also be produced if there is any gas flaring. Emissions of concern from such flaring consist primarily of carbon monoxide, (CO), Oxides of nitrogen (NO_x), and sulphur (SO_x) and particulate.

4. Liquid wastes may occur from oil leaks (at producing and abandoned well, piping, or storage facilities), accidental spills, produced water, deck drainage, and domestic sanitary waste water. Effluents generated from leaks, accidental spills, and deck drainage, are primarily polluted with oil and grease.
5. Produced water, derived in extracting oil from fluids emanating from a well, contains several hundreds to perhaps one thousand or more parts per million (ppm) of oil and grease. In addition, produced water may be high in total dissolved solids (TDS), oxygen demanding organic materials, heavy metals, and other toxics (notably phenolics). On a general note however, the characteristics of produced water vary from one formation to another, and are affected by the following factors:
 - i. the type of crude produced,
 - ii. the total hydrocarbon concentration,
 - iii. the amount of suspended and settle-able solids,
 - iv. the size of suspended hydrocarbons and solid particles,
 - v. the salinity, temperature and oxygen content
 - vi. the amount of such additives as demulsifiers, biocides, corrosion inhibitors, foam inhibitors, scale and precipitation inhibitors, used in the treatment of the oil..
6. Various chemicals are stored and used in production operation. Some of these chemicals are hazardous to health, unstable, corrosive, and may end up being discharged as wastes.
7. Radioactive elements and their daughter products, primarily radium 226/228 can be leached from geologic formations by reservoir fluids and transported to the surface with produced water, oil and gas. Radioactive material in the process stream can precipitate out as scale in tubing and processing equipment through which the production stream passes. The sludge that accumulates in the bottoms of tanks and vessels may also contain elevated levels of radioactivity.

Sands and other solid materials may be produced with normal effluents from the wells. Such solids usually have high oil contents **and may contain LSA or NORM**. These materials are produced at varying **quantities/concentrations** of up to one tonne per day.

D. TREATMENT AND CONTROL OF WASTES

1.0 PRODUCED FORMATION WATER

- (i) In production, produced water represents the largest volume of polluted effluent. The effect of effluent discharged offshore may be diluted and dissipated by currents, reducing the hazards to the environment. Effluents discharged on land or into brackish waters may undergo comparatively little dilution, especially during the dry season, and may pose a hazard to aquatic organisms. The threat to human population may occur through consumption of contaminated organisms and through drinking of water from contaminated rivers or wells.
- (ii) Existing technologies for the on-site removal of oil and grease from produced water include gas flotation, parallel or tilted plate coalescers, loose or fibrous media filtration, gravity separation, and chemicals addition to assist oil-water separation. Three groups of chemicals have been found useful in this regard-surface active agents (surfactants, foaming agents, demulsifiers, and emulsion breaker), coagulating agents, (Floc promoters) and; polyelectrolytes - see more details on **Table IV - I**.
- (iii) Produced waters can have significantly higher levels of trace metals, phenolic compounds and other toxic materials. Therefore, to preserve, restore and maintain the chemical, physical and biological integrity of the nation's waters, oil and gas installation operators shall be required to ensure that the levels of pollution control technology are fully in line with the Best Practicable Control Technology Currently Available (BPT) which represents the average of the best existing performances of well known technologies for the control of these specific pollutants.

2.0 SOLID WASTES

- 2.1 Control of solid wastes such as oily sludges, produced sand, domestic wastes, **empty metals/plastic chemical containers, etc** includes the use of techniques like incineration, sanitary landfilling, landfarming encapsulation, **solidification, slurrification and injection, chemical treatment, recycling, etc.**

3.0 GASEOUS EMISSIONS

3.1 Air pollutants can be controlled for:

- (i) Particulates:- Venturi/impingement scrubbers, etc;
- (ii) Flue gases:- Wet scrubbing, catalytic **combustion**, etc;
- (iii) Hydrocarbons:- Integrated hydrocarbon vapour recovery systems, activated carbon.

4.0 CHEMICAL/HAZARDOUS WASTES/LSA OR NORM

4.1 **These materials and wastes shall be treated and disposed of in accordance with the provisions of PART VIII-C. Encapsulation in abandoned well bores and injection into depleted reservoirs on a case-by-case basis (as appropriate) shall be the preferred options.**

5.0 SEWAGE

5.1 **Sewage of toilets from production facilities continuously manned by 10 or more persons shall be treated biologically, otherwise septic tanks shall be used. (also see PART VIII-C).**

E. ENVIRONMENTAL MANAGEMENT

1.0 Environmental Management Systems

- 1.1 Licences/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are contained and brought to an acceptable minimum.
- 1.2 **Specific** roles, responsibilities and authorities shall be defined, documented and communicated in order to facilitate effective environmental management.

2.0 Environmental Management System Manuals

2.1 **The provisions of Part II, Sections E. 2.1. E. 2.1.1 and Part VIII-H.**

3.0. EFFLUENT LIMITATIONS AND STANDARDS FOR PRODUCTION

OPERATIONS.

3.1 SCOPE

3.1.1 These effluent monitoring and limitations, standards and guidelines, shall regulate and control point source discharges and the ambient environments for production operations.

3.2 CONTROL OF EXISTING/NEW SOURCES

- 3.2.1 All existing point sources of produced formation water/oily waste water and solid effluents shall be registered with the Director of Petroleum Resources and permits for discharges obtained, (see PART IX).
- 3.2.1 Construction of new Treatment Systems or modification of existing ones **for** produced formation water, **oily waste** water, **sludge**, chemicals/hazardous substances, sanitary and solid wastes shall be approved by the Director of Petroleum Resources from design to commissioning stages. **Environmental Impact Assessment and/or Evaluation Report as appropriate shall accompany the application for Environmental permit to construct or modify.**
- 3.2.3 The holder of a Permit/Approval shall not make or cause to make any change in any operation or process carried out at the premises, which may change or is intended or is likely to cause a material increase/decrease in the quantities and quality of effluent or both, discharged from the premises, unless prior written approval of the Director of Petroleum Resources has been obtained for the changes. Such changes may include:

- (i) Any change in the construction, structure, arrangement, alignment, direction or condition of any channelling device, system or facility serving the premises and;
- (ii) Any change of, to, or in any plant, machine or equipment used or installed at the premises for the purpose of treatment of produced formation water and other associated wastes

3.3 PERFORMANCE OF EXISTING SOURCES/TREATMENT TECHNOLOGY

- 3.3.1** Performance of all registered existing sources/treatment technology shall be determined by:
- (i) Compliance limitations based on the approved control technology and as provided on **TABLE III - I** and;
 - (ii) Information supplied to the Director, on: the estimates of quantities, concentrations and loading rates into the environment of the waste streams and the condition or state of the recipient medium - water, atmosphere or land.
- 3.3.2** The operator shall analyse samples of the produced water, produced sand, **oily sludge**, etc. to determine whether and to what extent they contain toxic and hazardous substances.

3.4 Control of Points of Discharges

- 3.4.1** Except when otherwise specifically permitted by the Director of Petroleum Resources, produced formation water, produced sand/sludge, **solid/sanitary wastes** and oily wastes shall not be discharged directly or indirectly into:
- i) any inland waters (fresh, brackish, tidal or non-tidal or reservoir)
 - ii) swamp, coastal or offshore waters
 - iii) any well other than a well drilled or converted specifically to receive a discharge of formation water and oily water and to channel the waters into subsurface stratum or strata approved for the purpose (**APPENDIX VIII-C**).
 - iv) any pits on land other than temporary holding retention pit(s), so designed and utilised that there shall be no overflow, leakage and seepage into adjacent surface and ground waters.
- 3.4.2** The disposal of produced formation water and oily wastewaters **or sludges** is prohibited on land, public drain, sewer, and water bodies used for human consumption.
- 3.4.3** The concrete or liners along the sides and bottoms of the retention pits in accordance with article **3.4.1** (iv) shall have the equivalent of 1 (one) continuous meter of re compacted or natural clay having a hydraulic conductivity no greater than 1×10^{-7} cm/sec. Such liners shall include but are not limited to the following:
- (i) Natural clay having a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - (ii) Soil mixed with cement, clay-type, and/or the additives to produce a barrier with a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - (iii) Manufactured liner (synthetic material) that exceeds the hydraulic conductivity requirement and that shall also satisfy the following definitions;

<u>Parameter or Tests*</u>	<u>Limitation/Standard</u>
- Thickness (average)	10mm
- Breaking strength	6.33 kg/m ²
- Bursting strength	9.85 kg/m ²
- Tearing Strength	1.76 kg/m ²
- Seam Strength	3.52 kg/m ²

***Testing is to be performed according to ASTM.-D751, latest edition or EPA Method 9100.**

- 3.4.3.1** Liquid levels in such pits shall not be permitted to rise within 60 cm of top of the pit walls/levees.
- 3.5** At the discretion of the Director of Petroleum Resources, and/or the operator, any production operations, which is likely to cause significant and adverse environmental effects and impacts (including oil and hazardous materials spillages), shall be subjected to the preparation of Environmental Evaluation (Post-impact) Report – (See PART VIII-A).

3.6 TREATMENT AND DISPOSAL OF WASTES FROM PRODUCTION OPERATIONS

3.6.1 Wastes from Production Operations - produced formation water, sand/sludge, oily waste waters, sanitary wastes, **LSA/NORM, hazardous chemicals**, etc. shall be treated to the satisfaction of the Director of Petroleum Resources before any disposal.

3.6.2 Disposal Of Produced Formation Water.

(a) Inland/Nearshore Area.

Produced formation/oily waters shall not be discharged into inland and nearshore areas. The disposal options are injection into disposal wells or re-injection to reservoir (sub-surface stratum or strata) approved for the purpose. (APPENDIX VIII - C).

(b) Offshore/Deepwaters.

Produced formation/oily waters may be discharged into offshore and deepwater areas provided the following conditions are satisfied;

- (i) An Oily water treatment system, designed to maintain the treatment efficiency during load variations and to operate with minimum chemical addition, shall be installed;
- (ii) The oil shall be separated from the produced/oily water;
- (iii) As a minimum, the concentration of the dispersed oil in the water to be discharged, shall not exceed 40mg/l (monthly average, otherwise the produced formation/oily waters shall be re-injected).

3.6.3 Disposal of Oily Waste Waters (INLAND/NEARSHORE).

3.6.3.1 Disposal of oily waste water shall be permitted in Inland/Nearshore areas, if treated to meet the limitations as on TABLE III - 1.

3.6.4 Disposal of Produced Sand and Oily Sludges

3.6.4.1 The produced sand, oily sludges/solid wastes shall be disposed of by methods that shall not endanger human life and living organisms and cause significant pollution to ground and surface waters. Such approved methods are recycling (resource recovery), incineration, solidification, land farming and land filling. Any other method(s) acceptable to the Director of Petroleum Resources can be used after an approval has been sought for and given.

- i) Resources recovery (Recycling).As much as possible the crude oil/hydrocarbon components of oily sludges/produced sand **shall** be recovered by using the best practicable technology currently available.
- ii) Land farming. All the conditions and requirements in PART II, E.3.5.7.1 shall be conformed to.
- iii) Land filling. All the conditions and requirements in PART II, E.3.5.7.2 shall be conformed to.
- iv) Incineration. All the conditions and requirements in PART II, E. 3.5.7.6 shall be conformed with.
- v) Solidification. All the conditions and requirements in PART II, E.3.5.7.4 shall be conformed to.

3.6.4.2 Disposal of Produced well Sands, which include well solids, containing LSA/NORM.

- a) **Licencees/operators shall report or alert the Director, Petroleum Resources within 24 hours of the presence of LSA/NORM during vessel/tank and pipeline cleaning, desludging and change out activities etc when LSA/NORM is present at levels of 50 micro rems/hr above background concentrations or 30pci/gm.**
- b) **The radiation detection instrument should measure gamma radiation and shall be capable of measuring 1 micro-roentgen per hour, and shall be calibrated at intervals not to exceed 12 months.**

- c) **The disposal/discharge of LSA/NORM is prohibited on land and overboard into inland and nearshore waters, unless treated to the satisfaction of the Director of Petroleum Resources. (APPENDIX VIII– C3).**
 - i) **An application to dispose of LSA/NORM shall be submitted by the operator and an appropriate approval granted by the Director of Petroleum Resources.**
 - ii) **The treatment and disposal methods are encapsulation, injection into appropriate formations and any other methodology that may be approved by the Director, Petroleum Resources.**
- d) **Handlers of LSA/NORM shall be trained in the handling of LSA/NORM and licenced by appropriate licensing authority and registered by the Department of Petroleum Resources.**

3.6.4.3 If any material/waste is identified as hazardous, then all the conditions as stipulated in PART VIII-C shall be conformed with.

3.6.5 Disposal of Domestic and Sanitary Wastes.

- (a) **Domestic wastes/rubbish shall be recycled, incinerated and/or land filled in accordance with the provisions of Part VIII – C.**
- (b) **Sanitary wastewater shall be discharged into inland, nearshore and offshore areas after appropriate treatment. (See Limitations in Part II, Table II-6)**
 - (i) **Cakes/sludges from septic tanks shall be disposed of at sites approved for such purposes by the Director of Petroleum Resources. Such wastes shall be backfilled, land filled and/or incinerated (See Part VIII – C).**

3.6.6 Disposal of Contaminated Metal/ Plastic Chemical Containers

3.6.6.1 Contaminated empty/plastic chemical storage containers shall be treated to the satisfaction of the Director, Petroleum Resources and recycled

3.7. Re-Usable Materials.

3.7.1. The conditions shall comply with the provisions of PART II, Article E.3.5.8.

3.8 EFFLUENT LIMITATION

3.8.1 The quality of the oily waste waters from production operations shall **be treated to** satisfy the following limitations as in TABLE III-1 before the permitted disposal/discharge into inland/nearshore water bodies.

3.8.2 The quality of produced formation/oily waters from offshore production operations shall satisfy an oil and grease content of less than 40mg/l monthly average before disposal/discharge into offshore water bodies.

3.8.2.1 The licensee/operator shall also evaluate and consider the achievement of lower limits based on the following criteria:

- (i) **Proximity to the coast or other sensitive areas;**
- (ii) **Total load from the field.**

3.8.2.2 A monthly average limitation is the highest allowable average of daily discharge(s) over a calendar month divided by the number of daily discharges measured during that month.

TABLE III-1 EFFLUENT LIMITATIONS FOR INLAND/NEARSHORE OIL AND GAS INSTALLATIONS FOR OILY WASTE WATER

POLLUTANTS OR CHARACTERISTICS <input type="checkbox"/>	COMPLIANCE LIMITS: MAXIMUM FOR ANY	
	CONSERVATIVE	30 DAY PERIOD <input type="checkbox"/>
<input type="checkbox"/>	INLAND	NEAR SHORE
pH	6.5 - 8.5	6.5 - 8.5
Temperature, °C	25	30
Total Hydrocarbon Content, mg/l	10	20
Salinity as Cl; mg/l	600	2,000
Turbidity, NTU	Less than 15 (Of Receiving Medium)	
Total Dissolved Solids (TDS), mg/l	2,000	5,000
Total Suspended Solids (TSS), mg/l	LESS THAN 50 (Of Receiving Medium)	
COD, mg/l		
BOD ₅ , mg/l		
Pb ⁺⁵ , mg/l	10	125
Total Iron (Fe), mg/l	10	125
Cu ⁺² , mg/l	0.05	No Limit
Cr ⁺⁶ (total) mg/l	1.0	No Limit
Zn ⁺² , mg/l	1.5	- do -
	0.03	0.5
	1.0	5

3.8.3 Sampling and analysis on these limitations in Table III-1, shall be taken once a week and reported each calendar month. **However, the Director Of Petroleum Resources, shall be alerted weekly, on significant non-compliance.**

3.8.3.1 On a random basis, the samples so collected shall be accompanied by a certificate of sampling, duly issued by a competent officer of the Department of Petroleum Resources.

3.8.4 The total hydrocarbon content of the permitted discharges of oily waste waters into inland and nearshore waters, shall not exceed on an average in any one calendar month 10 mg/l and 20 mg/l respectively. Such limits are to be based on measurements made not less than once each week and reported each calendar month.

3.8.5. Sanitary Waste Water

3.8.5.1 The discharge limitations as set in Part II, Table II-6 shall apply.

3.8.6 Limitation on the Quality of Offshore Recipient Water Bodies for Permitted Discharges

3.8.6.1 Limitations are hereby set on the relationship of the characteristics of the recipient water from the point of discharge of permitted formation water/oily water. The recipient samples to satisfy these restrictions shall be collected every month plus seven days, at approximately mid-depth in the main channel, approximately 500 meters from the point of discharge and promptly analysing them. The restrictions are hereby placed on certain parameters of a notional mixture, defined, as the mean volume over three (3) calendar months (measurement taken twice a month) of the daily discharge of formation water added to the volume of undisturbed sea water contained between Mean Sea Level and the sea-bed within a radius of 100 meters of the point of discharge:

$$\text{Sample; Mean Discharge} = 1,000\text{m}^3/\text{day}$$

$$\begin{aligned}
\text{Mean Water Depth (d)} &= 10\text{m} \\
\text{Radius(r)} &= 100\text{m} \\
\text{Volume of Diluting Sea Water} &= \pi r^2 \times 10 \\
&= 10 \times \pi(100)^2 \\
&= 314286\text{m}^3
\end{aligned}$$

Notional mixture consists of 1 volume of formation water and 314 volumes of seawater. The quantity of the undisturbed sea water shall be that published by a recognised authority of South Atlantic sea-water, or measurements made on a sample of sea-water taken within a period of six (6) months embracing the 3 month average period, from a point approximately one (1) meter below the surface and between 3 and 5 kilometres from the point of discharge.

i) Limitation on the Notional Mixture as Defined in Article 3.8.6.1

- a) The calculated oil content of the mixture shall not exceed that of the undisturbed seawater by more than one unit above or below.
- b) The calculated pH of the mixture shall not differ from that of the undisturbed seawater by more than one unit above or below.
- c) The calculated sum of the concentrations of the ions HCO_3^- , Cl^- and SO_4^{2-} in the mixture shall not differ from the sum of the concentrations of same ions in the undisturbed sea -water by more 20% of the latter, above or below.
- d) The calculated sum of the concentrations of the ions NO_3^- and NH_4^+ in the mixture shall not exceed 25 mg/l.
- e) The calculated temperature of the mixture shall not differ by more than 5°C from that of the undisturbed sea-water.
- f) When the dissolved oxygen content of the undisturbed sea-water is assumed to be 7 mg/l, the calculated dissolved oxygen content of the mixture shall not be less than 4mg/l.

3.8.6.2 Limitations On The Quality Of Storm Water Drainages

3.8.6.2.1 Limits are hereby set for all storm water drainages from production facilities discharged into adjacent medium without treatment:

- a) The pH of the discharged storm water shall be within 6.5 to 8.5 and/or shall not be more than the pH of the receiving water body by 1 pH units.
- b) The electrical conductivity of the storm water draining into fresh waters shall not exceed 900mhos/cm.
- c) The salinity as chloride shall in any case not be under 10% nor 10% greater than the normal levels in tidal running waters.
- d) The oil and grease content in the storm water, shall be less than 5mg/l for inland areas and 10mg/l for nearshore areas.
- e) The odour of the discharge shall be unobjectionable
- f) The turbidity of the discharge shall not be more by 10% of the receiving medium.

3.8.6.2.2 Storm water drainage networks shall have series of sluice gates and/or oil traps constructed to the satisfaction of the Director of Petroleum Resources.

3.8.6.3 Limitations On The Discharges Of Storm Water At The Upstream Of Water Bodies Used For Human Consumption.

3.8.6.3.1 Where water downstream from the point of discharge is used for human consumption samples of the storm water taken and analysed in accordance with approved/recommended methods shall not exceed the WHO Limits for Substances and characteristics affecting the Acceptability of Water for Domestic Use, (See APPENDIX V-1.

3.8.7 Certificate Of Sampling

3.8.7.1 On a random basis, samples collected to satisfy these and other limitations shall be accompanied by Certificate of Sampling, duly issued by a competent officer of the Department of Petroleum Resources.

3.8.8 GAS FLARING

3.8.8.1 Gas flaring is prohibited. However, should the licensee/operator be constrained to flare gas, the following conditions shall be met:

- i) An appropriate waiver and a permit to flare the gas shall be issued by the Director of Petroleum Resources.
- ii) The flared gas shall attract **appropriate fine for every standard cubic meter flared, in accordance with existing laws.**
- iii) **Pre-treated** 'clean' gas shall be burnt and the flare shall be luminous and bright (i.e. show complete smokeless combustion at operating gas flow rate). The relative density of emitted smoke shall not exceed two Ringelmann Number which is related to 40% of smoke density and 60% of light transmission through smoke - observed over a period of one (1) hour.
- iv) The allowable heat radiation at ground level is 6.31 kw/m^2 during maximum flaring at a distance of 60m **from** the base of the flare.
- v) A maximum sterilised approach distance of 60 meters radius, measured from the base of the stack shall be maintained. No other equipment except that related to the flare itself shall be located within this area.
- vi) The noise levels for unprotected ears **at 60m radius from the flare stack** shall be well within the threshold of pain (80-100dBA).
- vii) **Systems that can reduce carry over due to over pressure shall be considered (e.g. High Integrity Pressure Protection System – HIPPS, Over Pressure Protection System – OPSS, and quick closing valves.**
- viii) **Purging of the flare headers shall be designed to minimise emissions to air, by considering e.g.**

- A closed loop hydrocarbon purge gas system
 - Use of nitrogen gas as purge gas.
- ix) Relief valves, blow down valves and control valves to flare shall be closed during service and leakages minimized.

4.0 MONITORING

4.1 Monitoring of Wastes

4.1.1 Licencees/leasees, shall carry out:

- a) Complete chemical assay/analysis of the constituents of produced formation water from production platforms, flowstations and terminals and;
- b) 96-hr LC₅₀ toxicity testing, for produced formation water, as may be specified.

4.1.2. Monitoring requirements for produced formation water, oily waste waters, produced sand/oil sludges, sanitary waters and LSA/NORM from production operations are as shown in TABLE 111 - 2.

TABLE 111 - 2. MONITORING REQUIREMENTS FOR PRODUCTION OPERATIONS.

DISCHARGE	MONITORING REQUIREMENT			
TYPE	MONITORED PARAMETER	SAMPLE TYPE/METHOD	MEASURING FREQUENCY	RECORDED VALUES
1. Produced Formation Water	i) Volume/discharge Rate	Estimate	Once/day during discharge	Maximum daily rate
	ii) Oil and Grease	Grab	Once/day	Daily Maximum/ Monthly Average Mg/l
	iii) Free Oil	Visual Sheen	Once/day during discharge	Number of days Sheen is observed
1. Oily Waste Waters	i) Volume/Discharge Rate	Estimate	Once/week	Maximum weekly rate.

	ii) Physico-Chemical <ph </ph Temperature THC Chloride Turbidity TDS TSS COD BOD ₅ Pb ⁺² Fe (total) Cu ⁺² Cr ⁺⁶ (total) Zn ⁺²	Grab	Once/week	Monthly Average in mg/l, NTU and °C as appropriate
2. Produced Sand/Oil Sludges	i) Quantity/Weight	Estimate	During tank/vessel Clean-up, pissing and desludging Operations	Tons and/or kg

	ii) Total Hydrocarbon Content (THC)	Composite Grab	"	Mg/l
	iii) Metals: Hg Cadmium Iron ⁺³ Vanadium Nickel Chromium (total) Lead Copper Barium	Composite Grab	"	Mg/l

4. Sanitary Sewages (Continuously manned by 10 or more persons)	Same as TABLE II-8 (PART II)	Same as TABLE II-8 (PART II)	Same as TABLE II-8 (PART II)	Same as TABLE II-8 (PART II)
5. LSA/NORM	i) Volume/weight	Estimate	During Vessel Tank/pipeline/ Tubings clean-out, de-sludging and change-out; scale, carbonates sand sludges production.	Liters/kg/tons
	ii) Radiation (Background, average of lowest and highest readings)	Gamma Radiation detector	"	Exposure Rate - Specific activity in Bq/gm and Pci/L and dose limit in milirems/year or mSv/a

4.1.3 Waste Release Inventory

4.1.3.1 The provisions of PART II, E 3.8.1.3.1.1 shall apply.

4.2 Monitoring Of Recipient Water Bodies

4.2.1 Recipient water bodies for all the facilities that discharge produced formation/oily water **offshore and oily waste water (Inland/nearshore)** shall be monitored (sampling and analysis) once every month for the following parameters.

- * pH
- *Temperature
- *Electrical Conductivity
- *Salinity as Chloride
- * Total Petroleum Hydrocarbon
- *Total Hydrocarbon Content
- *Total Organic Carbon
- *Dissolved Oxygen
- *Biochemical Oxygen Demand (BOD5)
- *Chemical Oxygen Demand
- *Total Dissolved Solids
- *Turbidity
- *Phenols
- *Cyanide
- *Nutrients(Ammonium, Nitrate, Total nitrogen, orthophosphate, total phosphorus)
- *Heavy and trace metals. (Arsenic, lead, copper, zinc, chromium Nickel and vanadium)
- *E. coli & Enterococci organisms
- *Radio-active substances

4.2.2 The objectives of monitoring the recipient water bodies shall be as follows:

- i) To describe the occurrence and the spatial distribution of a broad array of water quality constituents, as listed in Article 4.2.1 above;
- ii) To describe the seasonal variations and the frequency of occurrence of selected water quality constituents;
- iii) To estimate loads of selected water quality constituents near and some distance (minimum of three (3) kilometers) away from the facility;
- iv) To define long-term trends in the concentrations and loads of selected constituents and;
- v) To identify, describe and explain the factor that affect observed conditions and trends in the surface water quality.

4.2.3 The frequency of sampling will depend on the type of the sampling approach fixed station or synoptic) and the operational area. For synoptic stations it shall be once per month for the recipient media for production platforms, tankfarms, terminal and flowstations: for fixed stations, it shall be at least once a week.

4.2.3.1 Long-term sampling may be instituted for selected stream/river reaches to provide an improved understanding of the sources, distribution and fate of particular constituent in the selected stream/river reaches for inland and nearshore locations.

4.2.4. Except otherwise specified, the results and reports of the monitoring programme shall be submitted to the Director of Petroleum Resources at the end of every month. Also, the report and results of monitoring programmes that require long-term sampling shall be submitted at the end of every year, with a monthly progress report.

4.3 BIOLOGICAL MONITORING

4.3.1 Biological monitoring of recipient media (soil/sediment/water) shall be instituted by the operators to:

- i) Assess the state or condition of the ecological/biological health of the recipient medium;
- ii) Relevant study parameters include:
 - a. Species richness, bio-diversity and abundance.
 - b. Carrying capacity
 - c. Relationship between the physical and chemical characteristics of the recipient medium as influenced by the effluent, on the functional or structural aspects of the biological community.

4.3.2 Biological monitoring for environmental changes shall be carried out by the operator during wet and dry seasons once every two years or as otherwise determined by the Director of Petroleum Resources. (See PART VIII – E.)

4.4 GASEOUS POINT SOURCE EMISSION/RAIN WATER MONITORING:

4.4.1 Licencees/leases shall:

- (a) Estimate the potential emissions of any point source air pollutant;
- (b) Register all point source emissions points and obtain the appropriate permits from the Director of Petroleum Resources.
- (c) Install appropriate facility or device, approved by the Director of Petroleum Resources that shall remove, alter, dispose, store or prevent the creation of emission of air pollutant.
- (d) Execute point source emissions and ambient monitoring programmes approved by the Director of Petroleum Resources. The monitoring programme shall assist to determine the efficiency of control equipment/technology and the control of ambient concentrations of emissions.

4.4.2 Gaseous point sources emission monitoring shall be accomplished by:

- (a) Developing emission inventory;
- (b) Installing appropriate sampling points-
 - i) Within the flue gas pipe prior to the tip (generators, boilers, etc)
 - ii) Between the flare scrubber and the flare tip (flare) and;
 - iii) At distances of 200 meters intervals away from the installation along the direction of the prevailing wind and;
- c) Sampling and laboratory analyses for the following parameters -

- i) Emission rates/factor
- ii) Flare temperature
- iii) Volume discharged
- iv) Combustion products - e.g. oxides of sulphur, nitrogen, carbon, e.t.c.
- v) Particulates
- vi) Mass Balance of combustion products
- vii) Hydrogen sulphide
- viii) Ozone
- ix) THC/VOCS.
- x) Heavy and trace metals.

4.4.3. The rain water monitoring programme, which is complementary to the gaseous point source emission monitoring shall involve:

- a) Appropriate choice of sampling point at and from the vicinity of the location and fixed distances along the prevailing wind direction; control points shall also be considered.
- b) Measurement of some meteorological parameters. These should include but not limited to:
 - i) Wind velocity
 - ii) Wind direction
 - iii) Air temperature (ambient)
 - iv) Pressure and Relative humidity
 - v) Precipitation
 - vi) Wind turbulence
 - vii) Sun radiation
- c) Sampling and Analysis of the rainwater, shall include but not limited to

the following parameters:

- pH
- Conductivity
- SO_x (Sulphate, Sulphide)
- NO_x (Nitrate, nitrite)
- HCO₃
- Total Hydrocarbons (THC)/Volatile Organic Carbon (VOC)
- Heavy and Trace Metals

4.4.4 The Mandatory frequency of sampling for the gaseous point source emission monitoring shall be weekly and shall also satisfy the averaging times for the ambient air quality standards in TABLE III - 3. However, where appropriate, a continuous emission monitoring system, approved by the Director of Petroleum Resources, shall be utilised.

4.4.4.1 Reports on the Gaseous Point Source Emission and rain water monitoring programme shall be submitted to the Director of Petroleum Resources at the end of each year.

4.4.5 **Ambient Air Quality Guidelines**

i) In the interim, the National Air Quality Guidelines as specified in TABLE III-3 shall be adopted.

TABLE III-3: NATIONAL AIR QUALITY GUIDELINES FOR MAXIMUM EXPOSURE

POLLUTANT	1-Hour	8-Hour	Daily Average/	Annual
	Mean (µg/m3)	Mean (µg/m3)	Mean (µg/m3)	Mean (µg/m3)
Suspended Particulate Matter (SPM):				
Black Smoke				40 - 60
Total SPM	150 - 230			60 - 90
Carbon Monoxide*	30			10
Sulphur Dioxide	350			100 - 150
Nitrogen Dioxide*	400			150
Lead				0.5 - 1.0 -----

*Not to be exceeded.

- (ii) Gas turbine's shall be equipped with low NOx burners and be prepared for retrofitting. Also, the turbine control unit shall be designed to allow recording of the parameters required to calculate NOx emissions.
- (iii) Chlorofluorocarbons (CFC) and Halons shall not be used. If viable alternatives exist, Hydrochlorofluorocarbons (HCFCs) and Hydrofluorocarbons (HFCs) shall also be avoided.

4.5 Monitoring of Radio-active Substances

4.5.1 Low Specific Activity (LSA) or Naturally Occurring Radio-active Material (NORM) shall be monitored in production tubing, vessels, pumps, valves, Sulphate and Carbonate Scales, Sands and Sludges.

4.5.1.1.If the presence of NORM/LSA is indicated at levels of 50micro rems/hr above background concentrations or 30pci/gm:

- (i) A survey of its extent shall be made by the identification of the radionuclides and the determination of specific/surface activities.
- (ii) A radiological risk assessment shall be made.
- (iv) Appropriate precautions shall be defined and taken to minimize potential exposure to individuals.
- (iv) Attention should be paid to cleaning and disposal methods.

4.5.2 Radiation protection against NORM/LSA shall be aimed at the minimization of external irradiation and the prevention of internal contamination.

**4.5.2.1. The limit for specific activity shall be 1 Bq/gm or 27pci/gm.
(1 Bq (becquerel) = 1 nuclear disintegration per second).**

4.5.2.2. The dose limit on the exposure to NORM/LSA radiation shall not exceed 50 mSv/a (milli – Sievert per annum).

4.5.3 Appropriate cleaning, decontamination procedures and disposal practices for these wastes shall be approved by the Director of Department of Petroleum Resources. (See Sections 3.0 – 3.5.2 of APPENDIX VIII – C3).

5.0. Methods Of Sampling And Analysis

5.1 The methods employed in the sampling and measurement in connection with the limitations and monitoring of production operation shall be those approved and issued by the Department of Petroleum Resources as in PART VIII-D.

6.0 Environmental Audits/Reviews

6.1 Licencees/operators shall conduct Environmental audits to facilitate the management control of environmental practices and assessing compliance with the management system and regulatory requirements. (See Part VIII-I)

7.0 SPILL PREVENTION AND COUNTER MEASURES PLAN.

7.1 Production operations shall have comprehensive spill prevention and counter measures plans, approved by the Director, Department of Petroleum Resources. See PART VIII-B.

7.1.1 All spillages of crude oil/chemical/oil products shall be reported to the Director of Petroleum Resources, in accordance with the Oil Spillage/Notification Reporting Formats, 'A', 'B' and 'C'. See APPENDIX VIII-B2.

7.1.1.1 In addition, a Joint Spillage Investigation (JSI) team, comprising of the Licencee/Operator/Spiller, Community and DPR shall be constituted, within 24 hours, of spillage notification to investigate the spillage.

7.1.2 Crude Oil/Chemical Spillage and Contamination Clean-up Certification

7.1.2.1 Clean-up efforts for all inland and nearshore spillages of crude Oil, Products and Chemicals, shall be subjected to Clean-up Certification, as provided for in the Oil/Chemical Spill/Contamination Clean-up Certification Forms, PARTS 'A' and 'B' (See APPENDIX VIII-B3).

7.1.2.2 The Director of Petroleum Resources for any remediation/rehabilitation method shall grant appropriate approval. (See PART VIII-F Remediation of Contaminated Land).

7.1.2.3 Licencees/operators shall keep a register of Potentially Polluted Site(s) (PPS) or Past Impacted Site(s) (PIS). Such sites are to be cleaned up, remediated and certified accordingly by the Director, Petroleum Resources.

8.0 USE OF ABRASIVE AGENTS IN BLASTING ACTIVITIES

8.1 The use of sand as an abrasive agent in blasting activities for cleaning of steel structures - tanks, pipelines, etc., shall be controlled by the Department of Petroleum Resources. Abrasive agents of less than 1% free silica, which also conform with ISO.11126/N/CS/G, are recommended.

9.0 SANCTIONS

9.1 The sanctions shall conform with the provisions of PART IX.

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PART IV TERMINAL OPERATIONS

A. BACKGROUND

- 1.0 Crude oils produced in the country are stored, dehydrated, fiscalised and piped or exported to and/or from tankfarms/terminals. These activities require the installations of major facilities - storage tanks, pumping equipment, dehydration equipment, water treatment equipment, loading systems, etc. which must be operated efficiently and according to accepted standards. The major consequence of inefficiency or malfunctioning of operations is the discharge of oil and oily wastes thereby polluting land, waterways, marine and offshore environments. It is for the intention of controlling this and other forms of associated environmental pollution that these criteria **for Standards** and Guidelines are set.
- 2.0 Relevant Applicable Petroleum Statutes include: (a) Petroleum Decree No.51, 1969 (b) Petroleum (Drilling and Production) Regulations, 1969. (c) Oil in Navigable Waters Regulations 1968. (d) Oil Pipelines Ordinance (CAP 145 of 1956) as amended by the Oil Pipelines Act 1965.
- 3.0 **The primary objective of the foregoing Guidelines and Standards shall be to regulate the environmental management practices from terminal operations in the Federal Republic of Nigeria.**

B. DESCRIPTIONS OF OPERATIONS

1.0 STORAGE/PUMPING

- 1.1 Storage of crude oil is carried out using cylindrical steel tanks. The tanks are either fixed or floating roof. The capacity of a storage tank in Nigeria is as much as 600,000 barrels.
- 1.2 Also available are the main loading pumps driven by diesel/gas turbines and gas combustion engines (booster pumps) with connecting pipeline networks on land, swamp and offshore. The offshore pipeline network usually terminates at a platform (BOP). From the platform the lines continue to underwater manifolds (PLEM). Submarine hoses then link the manifolds to SPMS/SBMS, where tankers of up to 320,000 tonnes can load.

2.0 DEHYDRATION

- 2.1 Crude oil required for export or processing/refining must be dry. It therefore must undergo dehydration processes where produced formation water must be knocked out as much as possible from the crude oil by the use of efficient oil/water separating devices and processes. Total water drainage capacity per tankfarm/terminal can be as high as 150,000 barrels/ day.

3.0 ACCOMMODATION

- 3.1 There are also chalets, canteen and recreational facilities that produce domestic waste management problems.

C. SOURCES AND CHARACTERISTICS OF WASTES

1.0 OILY SUBSTANCES/LIQUID WASTES

- 1.1 The various sources of oily water (substances) from terminal operations include:
- (i) **Oil** spills e.g. leakages from pipe/hose bursts, malfunctioning/**faulty** equipment, corrosion, **maintenance operations** etc.
 - (ii) discharges from treatment facilities of oily brine formation water.
 - (iii) Storm water runoff.
 - (iv) discharges from transporting vessels of ballast, bilge and cleaning waters.
 - (v) storm water runoff discharge of refined products from service vessels.
 - (vi) **sanitary wastes.**
- 1.2 These substances can be characterized by the following parameters:
- (i) **Total Hydrocarbon Content (THC)**

- (ii) **Total Petroleum Hydrocarbons (TPH)**
- (iii) Hydrocarbons (benzene, toluene, xylene, ethylbenzene) (BTEX)
- (iv) PAHCS (Poly aromatic Hydrocarbons)
- (v) Total Dissolved/Suspended Solids
- (vi) Salinity as Chloride (Cl)
- (vii) Heavy Metals - Ni, Cr⁺⁶, Pb, Cu, Zn, V, Fe⁺³, Cd, Hg
- (viii) Temperature
- (ix) H₂S as Sulphide
- (x) pH
- (xi) Turbidity
- (xii) COD
- (xiii) BOD₅
- (xiv) **E. coli and Enterococci organisms**

2.0 GASEOUS EMISSIONS

2.1 Air emission problems are usually associated with combustion wastes from the gas turbines/combustion engine, and the hydrocarbon emissions from **tank vents**.

2.2 These emissions can be characterized by the following parameters:

- (i) Particulate/Smoke
- (ii) NO_x
- (iii) CO
- (iv) Hydrocarbons
- (v) SO_x

3.0 SOLID WASTE

3.1 Significant solid wastes produced at the terminal include oily sludges from cleaned-up tanks and heater treaters, spent oil, garbage, grits, dirt etc.

4.0 CHEMICAL/HAZARDOUS WASTES

4.1 **Various chemicals are stored and used in the terminal operations. Some of these chemical are health hazards, explosive, unstable, corrosive, e.t.c.**

4.2 **Low Specific Activity (LSA) or Naturally Occurring Radio-active Materials (NORM), have been associated with production tubings, vessels, pumps, sulphate and carbonate scales, sands and sludges. (See PART III, Section C. 6.0 and 7.0).**

D. TREATMENT AND CONTROL OF WASTES

1.0 GASEOUS EMISSION CONTROL

1.1 The treatment and control methods for the identified gaseous parameters are similar to the methods examined for **Production Operations (PART III, Section D 3.0)**.

2.0 OILY SLUDGES AND SOLID WASTES

2.1 The volume of solids generated can be small but significant. They are either incinerated or landfilled **after appropriate treatment**.

3.0 SEPARATION OF OIL,/WATER MIXTURES

3.1 Treatment of oily waste waters presupposes the understanding of:

- (i) the sources of the oily waste waters,
- (ii) the specific nature of the oil/water separation problem,
- (iii) the various forms/concentrations/chemical interactions of the non-aqueous/ aqueous phases when oil contaminates water.

These phases or states include free oil, dispersed oil (emulsion), chemically emulsified oil, molecularly dissolved oil, solubilized oil, and oil coated suspended solids. Each state has a certain degree of difficulty associated with oil removal.

3.2 The potentials of separation techniques to separate various oil/water states are given in Table IV- 1. A modern oil waste water treatment train may include an API gravity separator and dissolved air flotation for removing free oil, oil coated suspended solids and emulsified primary dispersions; a coalescer with a prefilter for removing neutrally buoyant oil-coated solids and remaining unemulsified primary and secondary dispersions, reverse osmosis for removing emulsified, solubilized and dissolved oil, and; carbon absorption for removing the last traces of dissolved oil. A combination of other separation methods can be used, (-See Table IV-1) although the trend is gross separation followed by finer separation and finally a polishing state.

TABLE IV-1 POTENTIAL OF SEPARATION TECHNIQUES TO SEPARATE
VARIOUS OIL/WATER SYSTEM PHASES.

Technique	Free oil	Oil-coated solids	Unstalized dispersions	Stabilized dispersion	Solulized Oil	
Molecular						
dissolved oil	Settable	Neutrally buoyant	Primary	Secondary	Chemically Charge	Surface
A. Absorption XXX	XXX		XXX		XXX	XXX
B. Carbon						
C. <u>Electric and Magnetic</u>						
D. Electrophoretic				X		XX
E. Magnetic				XX		
F. <u>Thermal</u>			xx	x		
G. <u>Coanda Effect</u>	X					
H. <u>Viscosity Actused</u>	X					
I. <u>Chromatography</u> XXX						XXX
J. <u>Some & Ultrasonic</u>		X	X		X	

Legend: X poor separation; xxx – excellent separation.

4.0 OIL LEAKAGES

4.1 Leakages from terminal facilities can be controlled by regular inspections, testing, preventive maintenance and efficient operations.

5.0 CHEMICAL/HAZARDOUS WASTES/LSA OR NORM

5.1 Chemicals/hazardous waste shall be treated and disposed of in accordance with the provisions of PART VIII – C. The preferred treatment and disposal methods for LSA/NORM, are encapsulation in abandoned well bores and injection into depleted reservoirs and **controlled incineration**, on a case by case basis.

6.0 SANITARY WASTES

6.1 Sanitary wastes shall be treated biologically, preferably by a standard Sewage Waste Water Treatment Plant (WWTP).

E. ENVIRONMENTAL MANAGEMENT

1.0 Environmental Management System

1.1 Licencees/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are contained and brought to an acceptable minimum.

1.2 Roles, responsibilities and authorities shall be defined, documented and communicated in order to facilitate effective environmental management.

2.0 Environmental Management Manual.

2.1 The provisions as stipulated in PART III, Section E. 2.1 to 2.1.2, shall apply.

3.0 EFFLUENT LIMITATIONS AND STANDARDS

3.1 SCOPE

3.1.1 These effluent limitations and standards shall regulate and control the quality and mode of disposal of produced formation water and other oily discharges **and the protection of ambient environment, for terminal operations.**

3.2 CONTROL OF EXISTING/NEW SOURCES

3.2.1 All existing point sources of produced formation water/oily waste water, **chemical/hazardous substances** and solid effluents must be registered with the Director Department of Petroleum Resources and permit for **discharges obtained**, (See PART IX.)

3.2.2 Construction of new Treatment Systems or modification of existing ones of produced formation water or oily waste, **solid waste and chemical/hazardous substances** shall be approved by the **of** Director of Petroleum Resources **from** design to commissioning stages. **Environmental Impact Assessment and/or Evaluation (post-impact) Report as appropriate shall accompany the application for Environmental permit to construct or modify.**

3.2.2.1 The holder of a Permit Approval shall not make or cause to make any change in any operation or process carried out at the premises, which **causes a change**, or is intended or is likely to cause a material increase/decrease in the quantities and quality of effluent or both, discharged from the premises, unless prior written approval of the Director of Petroleum Resources has been obtained for the change. Such changes may include:

- (i) Any change in the construction, structure, arrangement, alignment, direction or condition of any channelling device, system or facility serving the premises and;
- (ii) Any change of, to, or in any plant, machine or equipment used or installed at the premises for the purpose of treatment of produced formation water and other associated wastes

3.3 **PERFORMANCE OF EXISTING SOURCES/TREATMENT TECHNOLOGY**

- 3.3.1 Performance of all registered existing sources/treatment technology shall be determined by:
- (i) Compliance limitations based on the approved control technology and as provided in TABLE III - 1 and Articles 3.6 – 3.8;
 - (ii) Information supplied to the Director of Petroleum Resources on: the estimates of quantities, concentrations and loading rates into the environment of the waste streams and the condition or state of the recipient medium – (water, atmosphere or land).
- 3.3.2 At the discretion of the Director of Petroleum Resources, the operator shall analyse samples of the produced water, produced sand, etc., to determine whether and to what extent they contain toxic and hazardous substances as the Director of Petroleum Resources may specify.

3.4 **Control of Points of Discharges**

- 3.4.1 Except when otherwise specifically permitted by the Director of Petroleum Resources, **produced formation water**, produced sand/sludge, **sewage**, **solid waste**. and oily wastes shall not be discharged directly or indirectly into:
- i) any inland waters (fresh, brackish tidal or non-tidal or reservoir);
 - ii) Swamp, Coastal or offshore waters ;
 - iii) any well other than a well drilled or converted specifically to receive a discharge of formation water and oily water and to channel the waters into subsurface stratum or strata approved for the purpose. **(See the requirements for such disposal well(s) in APPENDIX VIII –C3);**
 - iv) any pits on land other than temporary holding retention pit(s), so designed and utilized that there shall be no overflow, leakage and seepage into adjacent surface and groundwaters.
- 3.4.2 The disposal of produced formation water and oily waste waters, or sludge is prohibited on land, public drain or sewer.
- 3.4.3 The concrete or liners along the sides and bottoms of the retention pits in accordance with article 3.4.1 (iv) shall have the equivalent of 1 (one) continuous meter of re-compacted or natural clay having a hydraulic conductivity no greater than 1×10^{-7} cm/sec. Such liners include but are not limited to the following:
- (i) Natural clay having a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - (ii) Soil mixed with cement, clay-type, and/or other additives to produce a barrier with a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - (iii) Manufactured liner (synthetic material) that exceeds the hydraulic conductivity requirement and that shall also satisfy the following definitions;

<u>Parameter or Tests¹</u>	<u>Standard</u>
• Thickness (average)	>10 mm
• Breaking Strength	6.33 Kg/m ²
• Bursting Strength	9.85kg/m ²
• Tearing Strength	1.76 Kg/m ²
• Seam Strength	3.52 Kg/m ²

***Testing is to be performed according to ASTM-D 721, latest edition or EPA Method 9100**

- 3.4.4 The following conditions shall be the ground on which an exemption to discharge shall be granted; that scientific investigations support beyond all reasonable doubt the fact that the quality and quantity of the discharge shall not:
- i) Cause hazards to human health
 - ii) harm living organisms (fauna and flora)
 - iii) impair the quality to use adjacent land, surface and ground waters.
- 3.4.5 **At the discretion of the Director of Petroleum Resources, and/or the operator, terminal operations observed to cause significant and adverse environmental effects and impacts (including oil and**

hazardous materials spillages), shall be required to prepare an Environmental Evaluation (post - impact) Report - See PART VIII-A.

2.5 TREATMENT AND DISPOSAL OF WASTES FROM TERMINAL OPERATION

3.5.1 Wastes from terminal operations - produce formation water, sludge from storage tanks/vessels bottoms, oiled debris, oily waste waters, sanitary sewages, etc. shall be treated to the satisfaction of the Director of Petroleum Resources, before disposal.

3.5.2 Disposal Of Produced Formation Water

3.5.2.1 Where appropriate, produced formation water shall be re-injected into disposal wells (sub-surface stratum or strata) approved for the purpose (APPENDIX VIII –C3). Other disposal methods shall be in accordance with the Department of Petroleum Resources recommended procedures. An Environmental Permit shall be issued, to dispose of such waters.

3.5.3 Disposal of Oily Sludges, Produced Sand and Solid Wastes

3.5.3.1 The oily sludges, produced sand and solid wastes shall be disposed of by methods that shall not endanger human life and living organisms and cause significant pollution to ground and surface waters. Such approved methods are recycling (resource recovery), incineration, land farming and landfill. Any other methods acceptable to the Director of Petroleum Resources can be used after an approval has been sought for and given. In the case of :

- i) Resources Recovery (Recycling):
As much as possible the crude oil/hydrocarbon components of oily sludges/produced sand shall be recovered by using the best practicable technology currently available.
- ii) Landfarming: All the conditions and requirements in PART 11, E 3.5-7.1 shall be conformed with
- iii) Landfilling: All the conditions and requirements in PART 11, E 3.5 –7.2 shall be conformed with.
- iv) Incineration: All the conditions and requirements in PART 11, E 3.5.7.6 shall be conformed with

3.5.3.2 If any material is identified as hazardous, including LSA/NORM, then all the conditions as stipulated in PART VIII-C (Hazardous Waste Management) and PART III, E. 3.6.3.2 shall be conformed with.

3.5.3.3 Disposal of Domestic and Sanitary Wastes.

3.5.3.3.1 The provisions as provided in PART II, Section E. 3.5.6.1 (h) shall be conformed with.

3.6 EFFLUENT LIMITATION

3.6.1 The qualities of oily waste waters and produced formation water shall be as follows:

- (i) The quality of oily waste waters to be discharged into inland and nearshore areas, shall be as specified for Production Operations in TABLE III-1;
- (ii) Permitted discharges into offshore waters, shall be as specified in PART III, Section E, 3.8.2.

3.6.1.1 If the waters (oily/produced formation waters) are to be re-injected, the conditions in APPENDIX VIII-C3 shall apply.

3.6.2 Limitation on the Quality of Offshore Recipient Water Bodies For Permitted Discharges:

3.6.2.1 The conditions are as specified for Production Operations in PART III, Article E. 3.8 6.

3.6.3 Limitations on The Quality of Storm Water Drainages

- 3.6.3.1** Limits on discharges are hereby set for all storm water drainages that are discharged into adjacent/ receiving waters, without treatment.
- i) The pH of the discharge storm water shall be within 6.5 to 8.5 and/or must not be more than the pH of the receiving water body by 2 pH units.
 - ii) The conductivity of the storm water drainages into fresh waters shall not exceed 900 mhos/ cm. The salinity as chloride shall in any case not be under one-hundredth nor one-hundred times greater than the normal levels in tidal running recipient waters.
 - iii) The oil and grease **content in the storm water, shall be less than 5mg/l for inland areas and 10mg/l for nearshore areas.**
 - iv) The odour of the discharge shall be unobjectionable.
 - v) The turbidity of the discharge shall not be more by 10% of the receiving medium.

3.6.3.2 Storm water drainage networks shall have series of sluice gates designed and constructed in a manner satisfactory to the Director, Petroleum Resources.

3.6.4 Limitations On The Discharges Upstream Of Water Bodies Used For Human Consumption.

3.6.4.1 If recipient water is fresh water used for domestic purposes, the quality of samples of the storm drainage water taken **that does not satisfy the limits in TABLE III – 1** and analysed in accordance with approved/recommended methods, shall not exceed the WHO limits for Substances and Characteristics Affecting the Acceptability of Water for Domestic Use, as in APPENDIXV-1.

3.6.5 Limitations On Treated Sanitary Waste Water.

3.6.5.1 The discharge limitations, as set in **PART II, Section E 3.5.6.1. (h)**, shall apply.

3.7 Certificate of Sampling

3.7.1 On a random basis, samples collected to satisfy the compliance limitations shall be accompanied by certificate of sampling duly issued by a competent officer of the Department of Petroleum Resources.

3.8 GAS FLARING

3.8.1 The conditions are as provided for Production Operations in **PART III, Section E.3.8.8**

4.0 MONITORING

4.1 Produced Formation/Oily Waste Waters, Produced Sands and Sanitary Waste Waters.

4.1.1 The mandatory monitoring requirements for produced formation water, oily waste waters, oily sludges/ produced sand, sanitary sewages, are as provided for Production Operations in **PART III, Section E. 4.1 and TABLE III-2.**

4.1.2 Except otherwise specified, the results of the mandatory monitoring programmes as specified in Article **4.1.1** shall be submitted to the Director of Petroleum Resources at the end of every month.

4.1.3 Monitoring of Recipient Water Bodies

4.1.3.1 Recipient water bodies for all facilities that **discharge produced formation waters (Offshore)** shall be monitored (sampling and analysis) **in accordance with the provisions as described in Production Operations, PART III, Section E.4.2.**

4.2 Biological Monitoring

4.2.1 Biological monitoring shall be in accordance with the provisions as described in **PART III, Sections E. 4.3.**

4.4 Gaseous Point Source Emission/Rain Water (Acid Rain) Monitoring

4.4.1 The conditions for gaseous point source emission monitoring programme are as specified on PART III, **Section E.4.4**

4.4.1.1 Ambient Air Quality Guidelines

The interim ambient air quality guideline values, are as specified in PART III, TABLE III-3.

4.5 Monitoring of Radio-active Substances.

4.5.1 The conditions of the monitoring of radio-active substance, such as low specific Activity (LSA) or Naturally Occurring Radio-active Material (NORM) shall be as specified on PART III, Sections E.4.5.

5.0 METHODS OF SAMPLING AND MEASUREMENT.

5.1 The methods employed in the sampling and measurement in connection with the limitations and monitoring of terminal operations shall be those approved and issued by the Department of Petroleum Resources, as in PART VIII-D.

6.0 Environmental Audits/Reviews

6.1 The essential elements, types, competence of auditors, frequency of audits, the access of audit report to the Director of Petroleum Resources and Environmental Review provision, are as provided in PART III, Section E. 6.0

7.0 SPILL PREVENTION AND COUNTER MEASURE PLAN

7.1 Terminal Operations shall have comprehensive spill prevention and Counter measures plans, approved by the Director of Petroleum Resources as in PART VII-B.

7.1.1 The provisions for the reporting and clean-up certifications are as provided in PART III, Sections E.7.1.1 to E 7.1.2

8.0 USE OF ABRASIVE AGENTS IN BLASTING ACTIVITIES.

8.1 Use of Sand as an abrasive agent in blasting activities for cleaning of steel structures - tanks, pipelines, etc., shall be controlled by the Department of Petroleum Resources. Abrasive agents of less than 1% free silica which also conforms with ISO 11126/N/CS/G are recommended.

F. B I B L I O G R A P H Y

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3. WORLD BANK Environmental Guidelines, Office of Environmental Affairs, July, 1984.
4. 1987. WHO. Air Quality Guidelines For The European Region. Copenhagen. WHO Regional Office For Europe.
5. ISO. ISO/DIS 14001 Environmental Management Systems-Specification With Guideline for Use. (1996).
6. UNEP/IEO Industry And Environment Review. Vol. II No. 4 (1988)
7. UNEP/IEO Industry And Environment Review. Environmental Auditing (1990). Technical Report Series No.2.

PART V HYDROCARBON PROCESSING OPERATIONS

A. PETROLEUM REFINING

1.0 BACKGROUND

- 1.1 The Petroleum Refining processes consist of a complex combination of interdependent operations concerned with separation of crude molecular constituents, molecular cracking, molecular rebuilding and solvent finishing. In the processes of these operations a complex array of gaseous, liquid and solid effluents are discharged. The discharges however must be carried out under controlled conditions to avoid environmental damages.
- 1.2 The relevant regulations on petroleum refining operations are provided under:
- Regulation 8:1b(iii) of the Petroleum Decree No.51 of 1969.
 - Regulations (7); (24:1, 2c), (27); (35:1); (38:1 & 2); (43:1,3,4) of the Petroleum Refining Regulations, 1974.
- 1.3 The major objective of these Guidelines, Criteria and Standards is to regulate and control the quality of effluent and the mode of effluent disposal from petroleum refining plants in Nigeria.

2.0 DESCRIPTION OF OPERATIONS

- 2.1 Petroleum Refineries can be classified into the five basic categories:
- topping refinery
 - fuel oil refinery
 - gasoline refinery
 - lube oil refinery and
 - petrochemical refinery
- 2.2 Presently in Nigeria there are four operating fuel/gasoline oil refineries. One of the four fuel/gasoline oil refineries is also integrated with lube oil refining.

TABLE V-1: REFINERIES IN NIGERIA

REFINERY	REFINING DAILY CAPACITY	CATEGORY
1. PORT HARCOURT (OLD)	60,000 bbls per Stream day	Fuel oil/Gasoline
2. PORT HARCOURT (NEW)	150,000 bbls per stream day	Fuel oil/Gasoline
3. WARRI (EKPAN)	125,000 bbls per stream day	Fuel oil/Gasoline
4. KADUNA	110,000 bbls per stream day	Fuel oil/Gasoline and Lube oil with wax moulding, Tin/Drum Manufacturing and sulphur making units.

- 2.3 The fuel/gasoline refineries utilize a processing sequence established to promote the yield of product fuel oil/gasoline with greater emphasis on gasoline production. Major process units involve crude desalting, topping or skimming (atmospheric pressure distillation), and crude distillation unit to separate the feed into straight run fractions. Other units include light end treating and recovery, hydrotreaters for the crude distillation cuts, naphtha upgrading processes, thermal cracking or coking units for the heavy residue, and sulphur recovery. The crude oil, products and some chemicals are stored in storage tanks.
- 2.4 The lube oil refinery operations involve vacuum distillation of raw lube oil fractions at the vacuum distillation tower of the crude distillation unit, solvent (propane) deasphalting unit which produces an asphalt and heavy lube oil known as 'brightstock, lube stock treating unit which treats the deasphalted oil to improve the viscosity characteristics, colour and carbon residue content. The treating process involves furfural treating and dewaxing to remove the wax in order to improve the pour point by mixing the oil with a solvent, cooling the mixture and filtering out the precipitated wax and separating the oil from the solvent (MEK-methyl-ethylketone). Other processes include finishing/blending/ compounding. During these processes, oil from the dewaxing unit goes to finishing for colour improvement and oxidation stability. Oil is finished by hydrotreating which involves hydrotreating the lube in order to remove organic nitrogen and oxygen compounds. The finished lube oil stocks are blended in various proportions to produce the finished lube oil products.

- 2.5 Petrochemical refinery in Nigeria consists of four (4) operating plants; the linear Alkyl Benzene (LAB) plant in Kaduna, the Carbon Black (CB), HF Alkylation and Polypropylene (PP) plants at Ekpan – Warri and an Olefin plant at Eleme.
- 2.5.1 The 30,000 mt per year Linear Alkyl Benzene Plant is designed based on the UOP process technology involving purification of straight run kerosene by desulfurization and denitrification, extraction of normal paraffin, and dehydrogenation of the normal paraffin into Linear Olefins. The Olefins are further alkylated with benzene in the presence of a catalyst to an alkylate, which will be used for detergent production.
- 2.5.2 The 18,000 mt per year carbon black plant is designed on the basis of the Phillip’s Petroleum Oil furnace technology. The decant oil from the fluid catalytic cracking unit is used as feed to produce grades of hard carbon black.
- 2.5.3 The HF Alkylation process (licensed by Phillips) uses catalytic alkylation of Iso-butane, with butane in the presence of HF acid, as catalyst, to produce alkylate.
- 2.5.4 Polypropylene (copolymers and homo-polymers) will be produced by catalytic polymerization of purified propylene feed utilizing the EL Paso process.
- 2.6 Other refining operations include the Gas Conversion and Processing Plant, Ethylene Processing Plant, e.t.c.**

3.0 SOURCES AND CHARACTERISTICS OF WASTES

3.1 Fuel Oil/Gasoline Refinery

3.1.1 Air Emissions

3.1.1.1 The major air pollutants have been identified as:

- (i) Particulates
- (ii) **SO_x**
- (iii) CO
- (iv) **NO_x**
- (v) Hydrocarbons

3.1.1.2 **The** major sources of particulates, SO_x CO and NO_x are the **flare tower**, process heaters and boilers (which are fired by refinery fuel gas). The major source of hydrocarbon emissions is general fugitive emissions throughout the refinery - storage tanks, FCCU, boilers and process heaters, blow-down system, process drains, vacuum jets **pump leakages** and cooling towers. Other primary pollution sources are the tail gas from the acid gas treating plant and the sludge incinerator.

3.1.2 Water Effluents

3.1.2.1 The sources of contaminated water within the fuel oil/gasoline refinery include:

- (i) Sour water stripper condensate
- (ii) Contaminated process water
- (iii) Cooling tower blowdown
- (iv) Caustic wash water
- (v) Desalter water
- (vi) Oily process area storm water
- (vii) Oily cleaning water
- (viii) Oily water from ship’s ballasts
- (ix) Sanitary/Sewage water.**
- (x) Spent/expired Chemicals.**

3.1.2.2 **Run off** water is also generated within the refinery. This water is handled separately from the contaminated water by a segregated waste water system. The less contaminated water along with treated process water is retained in a holding pond for a period of time before final discharge to the local environment.

3.1.2.3 The following parameters have been identified to characterise waste **water**

Streams:

- (i) pH
- (ii) Temperature
- (iii) Electrical Conductivity
- (iv) Salinity (as Cl)
- (v) **Total Hydrocarbon Contents (THC)**
- (vi) BTEX & PAHCS**
- (vii) Total Suspended Solids
- (viii) Total Dissolved Solids
- (ix) Chemical Oxygen Demand
- (x) Biochemical Oxygen Demand
- (xi) Dissolved Oxygen
- (xii) Phenols
- (xiii) Cyanide
- (xiv.) Sulphide (as **H₂S**)
- (xv) Mercaptans
- (xvi) Sulphur (as **SO₂⁻**)
- (xvii) Ammonia (as **NH₄⁺**)
- (xviii) Total Phosphorus (as **PO₄⁻**)
- (xix) Nitrate (as **NO₃⁻**)
- (xx) Surfactants
- (xxi) Total Coliform Bacteria
- (xxii) Heavy Metals - Ni, **Cr⁺⁶**, Pb, Cu, Zn, V, Cr, Ti, Cd, Fe³⁺, Hg.

3.1.3 Solid Wastes

3.1.3.1 Sources of solid wastes within the fuel oil gasoline refinery include:

- (i) Entrained solids in the crude/product as sludge.
- (ii) Silt from surface drainage
- (iii) Corrosion products from process units and sewer systems
- (iv) Solids from maintenance and cleaning operations.
- (v) Sludge from water treatment facilities (or ash from the sludge incinerator);and
- (vi) Spent catalyst.
- (vii) **Refuse**
- (viii) Sludge from storage tanks (crude oil and products)
- (ix) Empty metal/plastic chemical storage containers/scrap.**

3.1.3.2 The following pollution parameters have been identified to characterise the solid wastes:

- (i) Oil content of oily sludge
- (ii) Heavy metals, constituents of oily and organic sludge, residue, rust or similar matter and, spent catalyst.
- (iii) Organic constituents of organic sludge, and residue.

3.2 Lube Oil Refinery

3.2.1 Air Emissions

3.2.1.1 The air pollutants and the sources are as identified for the fuel oil/gasoline refinery (See Article 3.1.1).

3.2.2 Water Effluents

3.2.2.1 The water problems involved with the Lube Oil Refinery are the same as the fuel oil/gasoline refinery. (See Article 3.1.2).

3.2.3 Solid Waste

3.2.3.1 The solid wastes generated and characterised are the same as for fuel oil/gasoline refinery. (See Article 3.1.3).

3.3 Petrochemical Refinery

3.3.1 Air Emissions

3.3.1.1 The identified pollutants are common to the petrochemical plants. They include:

- (i) Particulates
- (ii) Carbon Black Dusts/pellets (CB Plant)
- (iii) SO_x
- (iv) NO_x
- (v) CO_x
- (vi) Hydrocarbons (**BTEX & VOCS and PAHs**)
- (vii) Polypropylene dust (PP Plant)
- (viii) Chlorinated Hydrocarbon

3.3.1.2 The major sources include Carbon Black reactor/bag filter, dryer and bagging units; raw propylene condensation; light separation, drying, storage and purification units; combustion reactions (gas turbines/steam boilers).

3.3.2 Water Effluents

3.3.2.1 Sources of contaminated water within the petrochemical refinery include:

- (i) Sour Water
- (ii) Contaminated Process Water
- (iii) Cooling Water Blowdown
- (iv) Chemical (Organic/Inorganic) Spillages, Leakages and Washings
- (v) Sanitary Waste Water
- (vi) Storm Water Run-off
- (vii) Oily Cleaning Water

3.3.2.2 Parameters that characterise these water effluents are as given for fuel oil Gasoline refinery, (See Article 3.1.2.3)

3.3.3 Solids Wastes

3.3.3.1 The identified solid wastes within the petrochemical refinery are as follows;

- (i) Spent Catalyst
- (ii) Offspec Products
- (iii) Carbon Black (CB Plant)
- (iv) PP Chunks/Overs (PP Plant)
- (v) Heavy metals/Organic constituents of Organic Sludge/Residue.
- (vi) Refuse**
- (vii) Empty metal/plastic chemical storage containers/scrap**

3.3.3.2 The major sources include:

- (i) Carbon Black Reactor, Dryer, Bag Filter and Bagging Units
- (ii) Waster Water Sludge/Ash
- (iii) Homocopolymer Reactor Extrusion.

4.0 TREATMENT AND CONTROL OF WASTES

4.1 This section examines emission/pollution control techniques for the air, water and solids discharges, resulting from the refinery processes. **Currently** available control methods and potential control techniques are considered.

4.2 Air Emission Control

4.2.1 Particulates

4.2.1.1 Control method/treatment technology involves the use of venturi/impingement scrubbers. Alternatives include Bag or Fabric Filters (that will give removal efficiency of more than 99%), electrostatic precipitators, granular bed filters, etc.

4.2.2 Oxides of Sulphur (SO_x)

4.2.2.1 Control of sulphur oxide emissions can be accomplished in the following ways:

- (i) design of processes to conserve energy
- (ii) Use of low sulphur fuels
- (iii) Fuel desulphurization which involves treating with an absorption process involving aqueous regenerative sorbent e.g. amine-based (DEA - Diethanolamine), hot carbonate solutions and various organic liquids such as N-methyl pyrrolidone and dimethyl ether or polyethylene glycol. Other methods include absorption processes by use of molecular sieves.
- (iv) Flue gas treatment which involves wet scrubbing with limestone/lime, etc.

4.2.3 Oxides of Nitrogen (NO_x)

4.2.3.1 Nitrogen oxide and dioxide can potentially be controlled by various process, techniques or modifications. The four general categories are as follows:

- (i) Combustion modifications to alleviate conditions favourable to NO_x, formation which involves reducing the excess air used in firing the heater; two stage combustion; reducing the load on the heater thereby reducing the fire box temperature in the heater, and flue gas recirculation;
- (ii) Fuel modifications by denitrification through use of additives or the substitution of low NO_x forming fuels;
- (iii) Design modifications of burners, proper burner location and spacing; Treatment of flue gases for NO_x, removal by catalytic decomposition, non-selective and selective catalytic reduction, adsorption/absorption reactions by solids and liquids, respectively.

4.2.4 Carbon Monoxide (CO)

4.2.4.1 Carbon monoxide emissions can be controlled by;

- (i) Complete combustion through good practice which includes proper design, application, installation, or operation and maintenance of process heaters, burners and auxiliary systems;
- (ii) Energy conservation by techniques such as preheating the furnace air and process side material;
- (iii) Energy source substitution of fuel oil by natural gas, hydroelectric and nuclear energies;
- (iv) Gas cleaning with shift converters on the hydrogen plant and the CO boiler in the FCC unit. The resultant CO₂ produced is removed by absorption with monoethanolamine (MEA). Other CO₂ removal processes available include GiammarcoVetrocoke, Benfield, Catacarb and Sulfinol.

4.2.5 Hydrocarbon

4.2.5.1 Hydrocarbon emissions can be controlled by:

- (i) Routing the off-gas to a boiler or process heater to combust the hydrocarbons;
- (ii) Partially flashing off-gas from the rich absorbent solution and recycling this gas back through the absorber;
- (iii) Proper design of storage tanks;
- (iv) Integrated hydrocarbon vapour recovery systems
- (v) Maintaining wet scrubbers or condensers on the vents of fixed roof tanks.
- (vi) **Use of activated carbon as an adsorbent;**

4.3 Waste Water Treatment

4.3.1 In the Petroleum refining operations, reduction of waste waters is accomplished by

the reduction of water usage to the barest minimum, incorporating segregated waste collection systems and providing treatment, prior to disposal.

4.3.2 Pretreatment of waste water involves stripping of sour water. The stripped water is sent to the waste water treatment facilities for further treatment. Specifically, the sour water from the FCC unit containing the impurities - hydrocarbons, ammonia, hydrogen sulphide, phenol and cyanide, is separately stripped of acid gases which are routed to the sulphur recovery unit while, the stripped water is sent to the waste water treatment unit (WWT). The spent caustic soda in the sour water stripper area is neutralised with the process oily waste water. All process water containing significant quantities of oil are skimmed at the local oily separators before discharging to the treating unit through the oil waste sewer.

4.3.3 After having completed all reductions and pretreatments, the final process waste water and other liquid effluents must be further treated in a waste water treatment plant which usually involves pretreatment, primary, secondary and tertiary treatments depending on the quality of effluents desired.

4.3.3 A typical sequence and/or alternatives for the treatment of waste water is as follows:-

- (i) Pretreatment
 - (a) Aeration and grit removal
 - (b) Neutralization
 - (c) Corrugated plate interceptors
 - (d) Coagulation and flocculation
 - (e) API separator
- (ii) Suspended Solids Removal
 - (a) Sedimentation and Skimming
 - (b) Floatation and Skimming
 - (c) Screening and Filtration
- (iii) Secondary Dissolved Solids Removal
 - (a) Activated Sludge
 - (b) Trickling filter
 - (c) Aerated Lagoon
 - (d) Anaerobic Treatment
- (iv) Tertiary Dissolved Solids Removal
 - (a) Chlorination or disinfection
 - (b) Ion Exchange
 - (c) Membrane separation process
 - (d) Activated carbon
 - (e) Filtration
 - (f) Coagulation and flocculation
- (v) Liquids Disposal **through Controlled Discharges.**
 - (a) Lagooning
 - (b) Receiving Waters
 - (c) **Re – injection**
 - (d) Evaporation
 - (e) Ocean Disposal
- (vi) Heat Removal
 - (a) Cooling tower (oxidation)
 - (b) Spray ponds
 - (c) Air Stripping
 - (d) Autoxidation
- (vii) Sludge Concentration
 - (a) Mechanical thickening
 - (b) Dissolved Air floatation
- (viii) Sludge Digestion

- (a) Aerobic digestion
- (b) Anaerobic digestion
- (c) Sludge lagoons

- (ix) Sludge Conditioning
 - (a) Chemical Conditioning
 - (b) Heat Treatment

- (x) Sludge Dewatering and Drying
 - (a) Drying beds
 - (b) Vacuum filtration
 - (c) Centrifugation
 - (d) Pressure filtration
 - (e) Heat Drying

- (xi) Sludge Combustion
 - (a) Incineration
 - (b) Wet Oxidation

- (xii) Sludge and Ash Disposal
 - (a) Fertilizer and soil conditioner
 - (b) Dumping
 - (c) Lagooning
 - (d) Landfill
 - (e) Spread on Soil (land farming)
 - (f) Chemfix Process

4.4 Solid Waste Management

- 4.4.1 Solid wastes from a petroleum refinery consist of dirt, grit, oily/organic/chemical sludges, spent catalyst, offspec products - carbon black, PP Chunks, metal/plastic chemical storage containers etc.
- 4.4.2 Solid wastes disposal techniques include sanitary landfilling, chemfix process, incineration, recycling, etc.

5.0 ENVIRONMENTAL MANAGEMENT

5.1 **Environmental Management System.**

- (i) **Licencees/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are brought to an acceptable minimum.**
- (ii) **Specific roles, responsibilities and authorities shall be defined, documented and communicated in order to facilitate effective environmental management.**

5.1.1 **Environmental Management System Manuals.**

5.1.1.1 The provisions as stipulated in PART II, Sections 2.1 to 2.1.1 and PART VIII-H shall apply.

5.2 EFFLUENT LIMITATIONS STANDARDS AND MONITORING

5.2.1 SCOPE

5.2.1.1 These effluent limitations, standards and monitoring guidelines shall regulate and control point source discharges and the ambient environment for petroleum refining operations.

5.3 CONTROL OF EXISTING/NEW SOURCES

- 5.3.1** All existing point sources of waste water effluents, solid wastes and gaseous emissions in the petroleum refining industry shall be registered with the Director of Petroleum Resources and permits issued as in PART IX.
- 5.3.2** Construction of new treatment systems or modification of existing ones of petroleum refining wastes shall be approved by the Director of Petroleum Resources from design to commissioning stages and appropriate permits issued to such operator.
- 5.3.3** The holder of the permit shall not make or cause to make, any change in any operation or process carried on at the premises, which changes or is intended or is likely to cause a material increase/decrease in the quantity and quality of effluent or both, discharged **from** the premises, unless prior written approval of the Director of Petroleum Resources has been **sought and** obtained for the change.
- 5.3.3.1** For the purposes of Article **5.3.3** above, changes to permitted operation or process include:
- i) Any change in the construction, structure, arrangement, alignment, direction or condition of any channelling device, system or facility serving the premises, and
 - ii) Any change of, to, or in any plant, machine, or equipment used or installed at the premises for the purposes of treatment of process water, oily waters, sanitary water, storm water runoff, air emission oily/organic sludge, spent catalyst, offspec products, solid wastes etc.
- 5.3.4** Preparation of an Environmental Impact Assessment (EIA) shall be mandatory prior to the construction of any hydrocarbon processing plant (see PART VIII-A)
- 5.3.5** A Certificate of Approval for operation shall be issued.

5.3.6 Performance of Existing Point Sources/Treatment Technology

- 5.3.6.1** The performances of all registered point sources/treatment technology shall be determined by:
- (i) Compliance limits based on the approved control technologies and as provided in TABLES V-2, V-3, and V-4.
 - (ii) Information supplied to the Director of Petroleum Resources on: the estimates of quantities, concentrations and loading rate into the environment of the waste streams, and the condition or state of the recipient medium - water, atmosphere or land.
- 5.3.7.** The operator shall analyse samples of any liquid effluents, oily/organic sludge, spent catalyst, offspec products, solid wastes, etc., to determine whether and to what extent they contain toxic and hazardous substances.

5.4 CONTROL OF POINTS OF DISCHARGES

- 5.4.1** Waste waters from the petroleum refining processes comprising of processed water, storm water, cooling water, sanitary water, spent catalyst, etc. and solid waste comprising of sludges (organic/oily products tank bottom), residues, polypropylene (powder, overs, unders, chunks and slurry), metallic and glass objects, general refuse, etc. shall not be disposed of directly or indirectly into;
- (i) any inland waters (fresh **water** or reservoirs)
 - (ii) any swamp, coastal **and/or** onshore waters
 - (iii) any flood planes and upland valleys
 - (iv) any pit or land other than a temporary holding/retention lined or concreted pit basin or steel tank so designed and utilised that there shall be no overflows, leakages and seepages into adjacent surface and ground waters.
- 5.4.1.1** The lined or concreted pit basin shall have 1 (one) continuous meter of recompacted or natural clay having a hydraulic conductivity not greater than 1×10^{-7} cm/sec at the side and bottom. The liners include but are not limited to the following:
- (i) Natural clay having a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - (ii) Soil mixed with cement, clay type, and/or other additives to produce a barrier with a hydraulic conductivity of less than 1×10^{-7} cm/sec
 - (iii) Manufactured liner (synthetic material) that exceeds the hydraulic conductivity requirement and that shall also satisfy the following definitions;

<u>Parameter or Test</u> ¹	<u>Standard</u>
• Thickness (average)	≥10 mm
• Breaking Strength	6.33 Kg/m ²
• Bursting Strength	9.85 kg/m ²
• Tearing Strength	1.76 Kg/m ²
• Seam Strength.	3.52 Kg/m²

***Testing is to be performed according to ASTM method, D 751, latest edition or EPA Method 9100.**

5.4.2 The disposal of petroleum refining wastes is prohibited into unsecured land, public drain and sewers.

5.4.3 The following conditions shall be the grounds on which an **exemption** to discharge the waste waters/solids wastes may be granted; that **there is enough** scientific support beyond all reasonable doubts that the quality and quantity of the discharge shall not:

- (i) Cause hazards to human health
- (ii) harm living organism (fauna and flora)
- (iii) impair the quality to use adjacent land and water

5.4.4 Gaseous contaminants from the petroleum refining processes comprising of particulate matter/dust, hydrocarbons, carbon monoxide, nitrogen and sulphuroxides, lead, some organics etc. shall not be emitted directly or indirectly into the atmosphere.

5.4.4.1 The following conditions shall be grounds on which an exemption to discharge may be granted:

- (i) that the quality of the discharge/rate of the discharge or the total quantity to be discharged, or a meaningful combination of these, render the discharge acceptable;
- (ii) that the net benefits, from consideration of ecological, social and economic factors, of allowing the exemption to discharge outweighs that of refusing it.

5.5 An operator whose refining operations have been observed to cause significant and adverse environmental effects **or** impacts (including oil and hazardous materials spillages) shall be required to prepare an Environmental Evaluation (post-impact) Report – (See PART VIII-A).

5.6 TREATMENT AND DISPOSAL OF WASTES FROM PETROLEUM REFINING OPERATIONS.

5.6.1 Wastes from petroleum refining operations - process water, oily water, storm water, sanitary **waste**, cooling water, spent catalyst, sludges (organic, oil and product tank bottom), residues, rust, ash, offspec product, general refuse, air emission contaminants etc. - shall be treated to the satisfaction of the Director of Petroleum Resources before disposal.

5.6.2 Effluent Limitation

5.6.2.1 Fuel oil/Gasoline/Lube oil refinery

- (i) The following effluent limitations (TABLE V-2) are hereby set for the treated waste water for existing fuel oil/gasoline Lube oil refinery category.

TABLE V-2 DISCHARGE LIMITATIONS FOR **TREATED** PETROLEUM REFINERY (FUEL OIL/GASOLINE/LUBE OIL CATEGORY) **WASTE WATER.**

□ EFFLUENT CHARACTERISTICS □	COMPLIANCE LIMITS: MAXIMUM FOR ANY 1 (ONE) DAY PERIOD □
BOD ₅ , mg/l	10
COD, mg/l	40
Total Dissolved Solids (TDS), mg/l	<2000
Total Suspended Solids (TSS), mg/l	30
Total Hydrocarbon Content (THC) mg/l	10
pH	6.5-8.5
Temperature, °C	30
Sulphide as H ₂ S (mg/l)	0.2
Ammonia (NH ₄ ⁺), mg/l	0.2
Phenols (Total), mg/l	0.5
Cyanide, mg/l as CN	0.05
Chromium Cr ⁺⁶ , mg/l	0.03
Total Chromium mg/l	0.3
Pb ⁺² , mg/l	0.05
Total Iron (Fe), mg/l	1.0
Cu ⁺² , mg/l	1.5
Zn ⁺² , mg/l	1.0
Hg	
Cd	
Odour	Unobjectionable

5.6.2.2 Petrochemical - Refinery/Carbon Black and Polypropylene Plants

- (i) The following effluent limitations (TABLE V-3) are hereby set for the treated waste water from the carbon black and polypropylene.

TABLE V-3 DISCHARGE LIMITATIONS FOR **TREATED** PETROCHEMICAL REFINERY WASTE WATER (CARBON BLACK AND POLYPROPYLENE **WASTE WATER**)

□ EFFLUENT CHARACTERISTICS □	COMPLIANCE LIMITS: MAXIMUM FOR ANY 1 (ONE) DAY PERIOD □
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BOD ₅ , mg/l	10
COD, mg/l	40
Total Dissolved Solids (TDS), mg/l	<2000
Total Suspended Solids (TSS), mg/l	30
THC, mg/l	10
pH	6.5-8.5
Temperature, °C	30
Sulphide as H ₂ S	0.2
Ammonia (NH ₄ ⁺), mg/l	0.2
Phenols (Total), mg/l	0.5
Chromium Cr ⁺⁶ , mg/l	0.03
Chromium (Total) mg/l	0.3
Pb ⁺² , mg/l as Pb	0.05
Total Iron (Fe), mg/l	1.0
Cyanide, mg/l as CN	0.05
Cu ⁺² , mg/l	1.5
Zn ⁺² , mg/l	1.0
Hg	
Cd	
Odour	Unobjectionable

5.6.2.3 Petrochemical Refinery - Linear Alkyl Benzene Plants Alkyl Benzene Plant

- i) The following effluent limitations (TABLE V-4) are hereby set for the Linear Alkyl Benzene hydrocarbon processing petrochemical plant

TABLE V-4 EFFLUENT LIMITATIONS FOR **TREATED** PETROCHEMICAL (LINEAR ALKYL BENZENE(LAB) WASTE WATER)

<input type="checkbox"/> EFFLUENT CHARACTERISTICS	COMPLIANCE LIMITS: MAXIMUM FOR ANY 1 (ONE) DAY PERIOD
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BOD ₅ , mg/l	10
COD, mg/l	40
Hydrocarbons (total) mg/l	10
Total Dissolved Solids (TDS), mg/l	<2000
Total Suspended Solids (TSS), mg/l	10
pH	7.0-8.5
Temperature, O _c	30
Ammonia (NH ₄ ⁺), mg/l	0.2
Sulphide as H ₂ S	0.2
Phenols (Total), mg/l	0.1
Sulphate (SO₄⁻), mg/l	200
Cyanide, mg/l as CN	0.05
Pb ⁺² , mg/l as Pb	0.05
Chromium (Hexa), mg/l	0.03
Chromium (Total), mg/l	0.3
Mercury, mg/l	0.1
Fe ⁺² , mg/l	0.3
Total Iron (Fe), mg/l	1.0
Cu ⁺² , mg/l	1.5
Zn ⁺² , mg/l	1.0
Cd	
Hg	
Odour	Unobjectionable

5.6.2.4 Limits on smoke: The relative density of emitted smoke shall not exceed 2 Ringelmann Number which is related to 40% of smoke density and 60% of light transmission through smoke - observed over a period of 1 (one) hour. A calibrated smoke indicator and a light transmission meter shall be installed located at the Source Stack for the use of the actual determination of the related Ringelmann emission readings. The relationship between Ringelmann Number, Percent Light Transmission through smoke and Smoke Density is given in Table V-5.

TABLE V-5 RELATIONSHIP BETWEEN RINGELMANN NUMBER/PERCENT LIGHT TRANSMISSION AND SMOKE DENSITY

RINGELMANN	% LIGHT TRANSMISSION THROUGH SMOKE	SMOKE DENSITY PERCENT
0	100	0
1	80	20
2	60	40
3	40	60
4	20	80
5	0	100

5.6.2.5 Ambient Air Quality Guidelines

5.6.2.5.1 The conditions as stipulated in PART III Section E, 4.4.5 shall be complied with.

5.6.2.6 Sanitary Waste Water.

5.6.2.6.1 When a separate Waste Water Treatment Plant is provided to treat Sanitary waste water, the limitations as provided in PART II, Section E 3.5.6.1 (h) and Part II, Table II-6 shall apply.

5.6.3 On a random basis, samples collected to satisfy the compliance limitations (TABLE V2, V3 and V-4) shall be accompanied by a certificate of sampling duly issued by competent officer of the Department of Petroleum Resources.

5.6.4 The sampling and analysis to satisfy these limitations (TABLES V-2, V-3 and V-4) shall be done once a week and reported each calendar month.

5.6.5 Limits on discharge are hereby set for all storm waters and other surface drainages that are discharged into adjacent/receiving waters, without treatment from any operating petroleum refining plant:

- (i) The pH of the storm water/surfaces drainages shall be within 6.5 to 8.5 and/or must not be more than the pH of the receiving water body by one unit.
- (ii) The conductivity of the storm water/drainages into fresh waters shall not exceed 900mhos/cm.
- (iii) The salinity (as chloride) shall in any case not be **1% less than nor 1% greater** than the normal levels in tidal running recipient waters.
- (iv) There shall be no visible oil sheen.
- (v) The turbidity of the discharge shall not be more by 10% of the receiving medium.

5.6.6 It is mandatory that all storm water networks shall have series of sluice gates, designed and constructed to the satisfaction of the Director of Petroleum Resources.

5.6.7 The operator shall occasionally sample and chemically analyse storm water/drainages as to identify and quantify toxic and hazardous materials that may be discharged from be specified

5.6.8 If recipient water is freshwater, used for human consumption, then samples of the storm water/drainages taken and analysed in accordance with recommended standard methods, must not exceed the limits for the Standards and Characteristics Affecting the Acceptability of Water for Domestic Use (WHO Standards) published by the World Health Organisation (See Appendix V-1).

5.6.9 Solid Waste Disposal for Petroleum Refining Operations

5.6.9.1 All sludges (oil and product tank bottom, treated organic, residues, spent catalyst), rust, off-spec waste carbon blacks, propylene, chunks/slurry and other solid wastes from petroleum refining operations shall be disposed of by methods that shall not endanger human life and living organisms and cause significant pollution to ground and surface waters. If the waste is identified as hazardous material, then all the conditions as stipulated in PART VIII-C shall be complied with.

5.6.9.2 The approved methods of disposal are resource recovery (**recycling**), burial/landfilling, incineration, solidification and **encapsulation**. Any other method(s) acceptable to the Director of Petroleum Resources may be used after an approval has been sought for and given. A waste disposal permit shall be issued by the Director of Petroleum Resources (see PART IX). In the case of:

- 1) Resource Recovery (Recycling): As much as possible the crude oil/ hydrocarbon and other re-usable component of the wastes shall be recovered by using the best practicable technology currently available.
- 2) Incineration: The waste may be incinerated by the best practicable technology currently available. Ash when produced may be landfarmed in accordance with PART 11 E **3.5.7.1 if the leachate testing (TCLP) characteristic do not exceed the regulatory levels.**
- 3) Burial/Landfilling: The following conditions shall be satisfied;
 - i) Approval is obtained for the selected site.
 - ii) Feasibility is conducted by the operator to determine that the area/site proves favourable for burial/Landfill. The following information/characteristics shall be made available to the Director of Petroleum Resources.
 - a) Detailed description of site with relation to the following:
 - Past and present land use.
 - Geology/soil properties/hydrogeology
 - Hydrologic balance, and
 - Highest seasonal groundwater level.
 - b) Detailed description of the facility design including maps and drawings and a discussion of the following:
 - Site layout
 - Proposed waste application technique
 - Drainage control, and
 - Proposed Waste loading rate.

- c) Detailed information concerning:
- i. Sampling and testing of incoming waste
 - ii. Complete physical and chemical properties of waste, which should include;
 - pH
 - Total metals contents for arsenic, barium, cadmium, chromium, lead, mercury, silver, zinc, vanadium, nickel
 - Oil and grease content (% dry weight), **BTEX & PAH**
 - Soluble salts and cationic distributions -
 - Electrical conductivity - EC in mhos/cm
 - Exchangeable sodium percentage - ESP(%)
 - Cation exchange capacity - CEC (milli-equivalents/100 gm soil)
 - Samples are to be analysed using standard soil testing procedures.
 - iii) Bottom of the buried cell of the landfill must be at least **1.5** meters above the seasonal high water table.
 - iv) The bottom and sides of the landfill are lined or concreted with suitable materials to prevent seepages and leakages into surface water and subsoil:
 - a) The liner or concrete along the sides and bottoms of the landfill shall have equivalent of 1 (one) continuous meter of recompacted or natural clay having a hydraulic conductivity not greater than 1×10^{-7} cm/sec. Such liners include, but are not limited to the following:
 - (1) Natural clay having a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - (2) Soil mixed with cement, clay type, and/or other additives to produce a barrier with a hydraulic conductivity of less than 1×10^{-7} cm/sec
 - (3) Manufactured linear (synthetic material) that exceeds the hydraulic conductivity requirement and that shall also satisfy the following definitions;

<u>Parameter or Test</u> ¹	<u>Standard Thickness (average)</u>
• Tickness (average)	≥ 10 mm
• Breaking Strength	6.33 Kg/m ²
• Bursting Strength	9.85 Kg/m ²
• Tearing Strength	1.76 Kg/m ²
• Seam Strength	3.52 Kg/m ²

(Testing is to be performed according to ASTM method 751 or EPA Method 9100).
 - v) The waste shall be mixed with soil and the mixture of waste/soil shall comply with the following limitation:
 - a) The oil and grease content of the waste/soil mixture is less than 3% dry weight.
 - b) pH of the waste/soil mixture is 6 - 9.
 - c) The total metals content of the waste shall not exceed that of the native soil condition by 10%
 - d) The moisture content of the waste/soil mixture is less than 50% by weight.
 - vi) Adequate provision are to be made by the operator of sampling points for surface runoffs and leachate.
 - vii) There is continuous weekly sampling and analysis by the operator of the surface runoffs and leachate for two years and/or as requested by the Director of Petroleum Resources. All records shall be sent to the Director on a monthly basis.
 - viii) That operator shall decontaminate the site if so requested by the Director of Petroleum Resources. The operator is liable for any outcome of the waste disposal option.

- ix) At the discretion of the Director of Petroleum Resources, the operator shall analyse samples of the waste to determine whether and to what extent they contain such substances as the director may specify.
- x) The Director of Petroleum Resources or his accredited representative shall, at all reasonable times, enter, inspect, take samples and/or analyse such samples using the operators equipment, to ascertain whether these conditions have been complied with.

5.6.9.3 Solidification: The requirements as stipulated in Part II, E **3.5.7.4 – 3.5.7.5** shall be complied with.

5.6.9.4 Encapsulation./Fixation/Stabilization

5.6.9.4.1 Encapsulation, Fixation and Stabilization processes are used to treat hazardous waste sludges and residues to produce materials of better physical handling, leachability and landfilling characteristics than the wastes from which they are derived. (Also see Part II, E3.5.7.4 – 3.5.7.5)

5.6.9.5 All existing dumping grounds for the existing petroleum refining plants are to be registered with the Department of Petroleum Resources.

5.6.5.1 Operators shall redesign and reconstruct such dumping grounds to the satisfaction of the Director, Petroleum Resources

5.6.9.6 Article 5.6.9.5 shall become effective, six (6) months after the promulgation of these guidelines and standards.

5.7 Monitoring

5.7.1 Monitoring of Wastes

5.7.1.1 There shall be mandatory monitoring requirements for liquid and solid discharges from petroleum refining processes as shown on TABLE V-6.

TABLE V-6 MONITORING REQUIREMENTS FOR PETROLEUM REFINING PROCESSES EFFLUENT DISCHARGE

DISCHARGE TYPE	MONITORING REQUIREMENTS		
	PARAMETER/EFFLUENT	MONITORING	COMMENTS

Storm water	pH Conductivity Salinity Total Hydrocarbon Contents Turbidity	Once per week “ “ “ “	
3. Oil/Product Tank Sludges; Oily Sludges	Quantity/Weight pH Total Hydrocarbon Content Heavy Metals e.g. Ni, Cr ⁺⁶ , Cd, Hg, Pb, Cu, Zn, V, Fe ⁺³ , and Ti, LSA/NORM	During Tank Clean-out/de-sludging and other activities	
4. Sanitary Wastes Water	Discharge Rate, Residual Chlorine Total Coliform Bacteria BOD₅ Dissolved Oxygen Total Suspended Solids	Daily During discharge	

5.7.1.2 Except otherwise specified, the results of the parameters monitored in Article 5.6.1 shall be submitted to the Director of Petroleum Resources at the end of every month.

5.7.1.3 Operators shall analyse liquid and solid wastes from petroleum refining operations to determine whether and to what extent they contain toxic and hazardous substances.

5.7.1.3.1 On weekly basis operators shall be required to conduct BTEX watch.

5.7.2 MONITORING OF RECIPIENT WATER BODIES

5.7.2.1 The monitoring requirements as stipulated in PART III, Section E 4.2.1 shall apply.

5.7.2.2 Biological Evaluation of Effluent Toxicity

5.7.2.2.1 All petroleum refineries shall institute a biological evaluation of effluent toxicity based on the following: Bioassays shall be conducted to determine the lethal and sublethal chronic toxicity effects of their treated effluents against approved species (fish/shrimps) in laboratory and controlled field experiments carried out in artificial ponds once every 3 months. Only effluents with demonstrated low risk of lethal and sublethal toxicity action against sensitive biological species shall be permitted for release into the recipient body of water.

5.7.2.3 BIOLOGICAL MONITORING OF RECIPIENT MEDIUM

5.7.2.3.1 An operator shall carry out biomonitoring of any recipient medium by conducting an ecological survey of pelagic and benthic flora and fauna to assess and record changes in biodiversity, abundance (population density), frequency of occurrence amongst biologically important species and bioconcentration of selected persistent effluent constituents in selected benthos along a 5 – 10 km gradient and carrying capacity. Monitoring shall be carried out during wet and dry season, once every 2 years.

5.7.3 GASEOUS POINT SOURCE EMISSION ACID RAIN WATER MONITORING

5.7.3.1 The monitoring requirements as stipulated in PART III, Section 4.4 shall be complied with.

5.7.4. ENVIRONMENTAL AUDITS/REVIEWS.

5.7.4.1 Environmental Audits/review shall be in accordance with the provisions of PART VIII-I.

6.0 METHODS OF SAMPLING AND MEASUREMENT

6.1 The methods of sampling and measurement employed in connection with these standards shall be in accordance with the methods recommended by the Department of Petroleum Resources (see PART VIII-D)

7.0 USE OF ABRASIVE AGENTS IN BLASTING ACTIVITIES

7.1 The use of sand as an abrasive agent for blasting activities for cleaning of steel structures, tanks, pipelines, etc. shall be **controlled by the DPR**. Abrasive agents of less than 1% free silica **which also conforms with ISO11126/N/CS/G are recommended**.

8.0 SPILL PREVENTION AND COUNTER MEASURES PLAN FOR THE PETROLEUM REFINING OPERATIONS

8.1 The petroleum refining industry shall have spill prevention and counter measures plan, approved by the Director of Petroleum Resources, for specific chemicals and materials, such as ethylene, tetraethyl lead, benzene, aluminium alkyl, crude oil/products, chlorine, hydrofluoric acid (HF) etc. (See PART VIII-B & C).

8.2 The Department of Petroleum Resources will take necessary and appropriate action to safeguard human health and welfare when a disaster or emergency develops from the spillage of any of these chemicals/materials which is likely to affect and/or impact third party, if the response by the licensee is inadequate. All expenses reasonably incurred shall be recovered from the licensee.

9.0 SANCTIONS

9.1 **The penalty clause and fines for any contravention of an offence in any part of the Environmental Guidelines and Standards shall be dealt with as provided in PART IX.**

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HYDROCARBON PROCESSING OPERATIONS

B. LPG/NATURAL GAS/LNG/GAS CONVERSION & PROCESSING PLANTS

1.0 BACKGROUND

- 1.1 Liquefied Petroleum Gas (LPG) consists primarily of hydrocarbon gas components of butane and/or propane obtained from petroleum refining processes and from natural gas extraction processes. Natural gas which can be Liquefied Natural Gas (LNG), consists primarily of methane and other hydrocarbon which exist in the gaseous state at ambient temperature and atmospheric pressure and may be produced in association with crude oil or in its own right (non-associated). The LPG and natural gas must both be treated before they are used as efficient fuel sources. During these processes, an array of gaseous, liquid and solid wastes are emitted/discharged. The discharges of these wastes must be controlled, if environmental pollution/degradation must be minimised.
- 1.2 Regulations that are relevant to prevention of pollution by LPG, natural gas and Liquefied Natural Gas Plants are as follows:
- (i) Petroleum Decree No. 51 1960; Regulations 7(a)-(c); 8(b) (iii), 8(C). 8(e);
 - (ii) Petroleum Refining Regulations 1974, 7; 38

2.0 DESCRIPTION OF OPERATION

2.1 Natural Gas and Liquefied Natural Gas (LNG)

- 2.1.1 Natural Gas from bore-hole and wells can be associated with crude oil and/or non-associated. However, for the gas to serve as an efficient fuel source and/or other uses e.g. (secondary recovery) the gas must be treated.
- 2.1.2 The typical natural gas, liquefied natural gas treatment processes include; conditioning and purification. This process involves normal acid gas removal, dehydration, removal of heavier hydrocarbons and (if required) removal of mercury. The incoming stream is treated to remove impurities (e.g. CO₂, H₂O, sulphur compounds such as H₂S and mercaptans). Sulphur compounds removal depends on the quality of the feed. Two basic methods are employed to remove these impurities:
- i. The dry system which employ absorbents such as molecular sieves and;
 - ii. The wet system which employs either reversible chemical reaction between the acid (impurities) and solvents e.g. alkanolamines (monoethanolamine (MEA)), diethanolamines (DEA), diglycolamine (DGA), di-isopropanolamine (ADIP), triethanolamine (TEA) or absorption between the acid and the solvent. The acid gases are absorbed at near ambient temperature and released by heating. Heavy hydrocarbons are stripped off the natural gas by molecular sieve and solid adsorbent. Sulphur compounds and other impurities are stripped off the solid adsorbent. Elemental sulphur may be recovered by Klaus -Charles process.
- 2.1.3 After the removal of the acid impurities, the natural gas is still wet with water vapour which must be dried. Dehydration is accomplished by passing the gas to a glycol unit which is followed by a small molecular sieve system or in one-step by passing through a large molecular sieve system.
- 2.1.4 The natural gas which contains mainly methane, is liquefied in process units which

could employ various **types** of cooling **systems** or combination thereof i.e. cascade cycles, mixed refrigerant cycles or vapour/liquid expansion.

2.1.5 LNG can be contained onshore in three basic types of storage facilities: the above-ground double-walled metal tanks, stress concrete tanks and in-ground or cavern spaces.

2.1.6 Also associated with the LNG plant are other necessary components:

- (i) Connecting pipelines with pressure regulators, measuring equipment, odourizers, etc. which connect the terminal with the existing gas systems.
- (ii) Suitable harbour for handling the LNG tankers.
- (iii) Other auxiliary operations e.g. power generation, waste water treatment plant etc.

2.2 Liquefied Petroleum Gas (LPG)/Gas Conversion & Processing (GC&P)

2.2.1 Various major refining processes e.g. Crude distillation, fluid catalytic cracking, hydrotreating (naphtha, gas oil, mid-distillates, de-asphalted oil), hydrocracker etc. produce sour light ends which are routed to a gas treating plant.

2.2.2 The sour light ends are contacted with amine solution at the gas treating plant for removal of H₂S. The sweetened light ends go to a light ends recovery unit for separation into specific product streams - fuel gas, ethane and ethylene, propane and propylene, isobutane and mixed butanes.

2.3 Gas Conversion & Processing (GC&P)

3.0 SOURCES AND CHARACTERISTICS OF WASTES

3.1 Air Emissions

3.1.1 Air emissions are common to Natural Gas/LNG/LPG/GC&P plants. They consist of the following:

- (i) NO_x
- (ii) SO_x
- (iii) CO
- (iv) Particulates
- (v) Hydrocarbons
- (vi) Possibly CO₂ and H₂S.

3.1.2 The sources may include boiler, gas turbines gas process heater, regasifier (LNG), process leaks/other leaks at pump seals, vent from compressor seals, pressure reliefs (i.e. flares and vents) and storage facilities.

3.2 Water Effluents

3.2.1 The sources of contaminated water at the Natural Gas/LNG/GC&P plants may include:

- (i) Cooling water blowdown: and regeneration water from demineralized water and drinking water preparation Unit;
- (ii) Water from process area cleaning which may be accidentally contaminated with oil;

- (iii) Continuously oil-contaminated water;
- (iv) Process water from the treatment of sour gases.
- (v) **Sanitary Wastes Water.**

3.2.2 The following parameters will characterise the effluent water from e.g.

- (i) cooling water blowdown: pH, Temperature, free residual chlorine, total suspended solids, total oil contents.
- (ii) Regeneration water from demineralized water and the drinking water preparation units: pH, TDs, Conductivity.
- (iii) Water accidentally or continuously contaminated with oil: pH, TDs, total oil content, BOD,, COD, Ammonia, Total Phosphorous (PO₄, HPO₄ and H₂PO₄)
- (iv) **Sanitary Waste Water: BOD₅, DO, Total Coliform bacteria, Fecal streptocci, residual chlorine.**
- (v) **Process Water from treatment of sour gases: Sulphide as H₂S, Oil and Grease content, BOD₅, COD.**

3.3 Solid Waste

3.3.1 The LNG/LPG/**GC&P** plant do not necessarily generate solid wastes by any of the processes as to cause a solid waste handling problem however sludges can be generated during cleaning of oil water separators and during primary waste water treatment. When applied the mercury recovery process **sometime** generate a batch of waste carbon adsorbent contaminated with mercury which requires special handling and dispatch to a remote mercury recovery plant.

3.3.2 **Spent catalysts are generated from GC&P plants.**

4.0 TREATMENT AND CONTROL OF WASTES

4.1 Air Emission Control

The treatment and control method for the identified parameters – NO_x, **SO_x**, CO, hydrocarbons are similar to the methods examined for the Petroleum Refining plants in **PART V-A, Article 4.2.**

4.2 Waste Water Treatment

The Natural Gas and LNG Plants have small waste streams. The oily waste water is processed by any of the oily water separation techniques (see TABLE IV-1). The effluent from the separators can be treated in a primary waste water treatment plant with a small coagulation, sedimentation or filtrating system. The final effluent can be disposed in a properly constructed evaporation pond or observation basin prior to discharge into public waters.

4.3 Solid Waste

4.3.1 Solid wastes from the natural gas/LNG plants normally consist of dirt,. dust and soil particles contaminated with hydrocarbons.

4.3.2 Sludge handling includes thickening/dewatering. Disposal routes are by landfarming, landfilling and incineration.

5.0 ENVIRONMENTAL MANAGEMENT

5.1 Environmental Management System Manuals.

- (i) Licencees/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are brought to an acceptable minimum.
- (ii) Specific roles, responsibilities and authorities shall be well defined, documented and communicated in order to facilitate effective environmental management.

5.1.1 Environmental Management Manual.

5.1.1.1 The provisions as stipulated in PART IV, Sections E. 2.1 to 2.1.1 and Part VIII-H, shall apply.

5.2 EFFLUENT LIMITATIONS, STANDARDS AND MONITORING.

5.2.1 SCOPE

5.2.1.1 These effluent limitations, standards and monitoring guidelines shall regulate and control point source discharges and the ambient environment for the Natural Gas, Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG) and **Gas Conversion and Processing (GC&P)** plants in Nigeria.

5.3 Control of Existing/New Point Sources

5.3.1 All existing point sources of waste water effluents, solid wastes and gaseous emissions in the Natural Gas, Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG) and **GC&P** plants shall be registered, , with the Director of Petroleum resources and permits issued as in PART IX.

5.3.2 Construction of new treatment systems or modification of existing ones for NG, LNG and LPG wastes shall be approved by the Director of Petroleum Resources from design to commissioning stages and appropriate permits issued to such, operator.

5.3.3 The holder of the permit shall not make or cause to make, change in any operation or process carried out at the premises, which change or is intended or is likely to cause a material increase/decrease in the quantity and quality of effluent or both, discharge from the premises, unless prior written approval of the Director of Petroleum Resources has been **sought and** obtained for the change.

5.3.3.1 For the purposes of Article 5.3.3 above, changes to permitted operation or process include:

- (i) Any change in the construction, structure, arrangement, alignment, direction or condition of any channelling device, system or facility serving the premises, and;
- (ii) Any change of, to, or in any plant, machine, or equipment used or installed at the premises for the purposes of treatment of process water, oily waste water, sanitary water, cooling water, storm runoff, air contaminants, oily/organic sludge, spent catalyst, solid wastes etc.

5.3.4 Preparation of an Environmental Impact Assessment shall be mandatory prior to the construction of any NG, LNG, LPG and **GC&P**(above 20,000 litres, (seePART VIII-A).

5.3.5 A certificate of Approval for operation shall be issued.

5.3.6 PERFORMANCE OF EXISTING SOURCES/TREATMENT TECHNOLOGY

5.3.6.1 The performance of all registered point sources/treatment technology shall be determined by:

- (i) Compliance limits based on the approved control Technologies and as provided for in TABLE V-7, and;
- (ii) Information supplied to the Director of Petroleum Resources on the estimates of quantities, concentrations and loading rate into the environment of the waste streams, and the condition or state of the recipient medium - water, atmosphere or land.

5.3.7 At the discretion of the Director of Petroleum Resources, the operator shall analyse samples of any liquid effluents, oily/organic sludge, spent catalyst, solid wastes, etc., to determine whether and to what extent they contain toxic and hazardous substances such as the Director may specify.

5.4 Control of Points of Discharges

5.4.1 Waste waters from the NG, LNG, LPG and **GC&P** plants, comprising of process/oily water, sanitary water, spent catalyst, etc. and solid wastes comprising of sludges (organic and product tank bottom), residues, rusts, metallic and glass objects, general refuse, etc. shall not be disposed of directly or indirectly into:

- (i) Any inland waters (fresh or reservoir)
- (ii) Any swamp, coastal or offshore waters
- (iii) Any floodplains and upland valleys
- (iv) Any pit on land other than a temporary holding/retention lined or concrete pit, basin or steel tank so designed and utilized that there shall be no overflows, leakages and seepages into adjacent surface and groundwaters.

5.4.1.1 The lined or concrete pit/basin shall have 1 (one) continuous meter of recompacted or natural clay having a hydraulic conductivity not greater than $1 \times 10^{-7} \text{cm/sec}$ at the sides and bottom. The liners include but not limited to the following:

- (i) Natural clay having a hydraulic conductivity of less than $1 \times 10^{-7} \text{cm/sec}$.
- (ii) Soil mixed with cement, clay-type, and/or other additives to produce a barrier with a hydraulic conductivity of less than $1 \times 10^{-7} \text{cm/sec}$.
- (iii) Manufactured liner (synthetic material) that exceeds the hydraulic conductivity requirement and that shall also satisfy the following;

<u>Parameter or Test</u> *	<u>Standard</u>
Thickness (average)	$\geq 10 \text{ mm}$
Breaking Strength	6.33 Kg/m ²
Bursting Strength	9.85 Kg/m ²
Tearing Strength	1.76 Kg/m ²
Seam Strength	3.52 Kg/m ²

***Testing is to be performed according to ASTM method D – 751, Latest Edition or EPA Method 9100.**

- 5.4.2** The disposal of NG, LNG and LPG wastes is prohibited into unsecured land, public drain and sewers.
- 5.4.3** The following conditions shall be the grounds on which an exemption to dispose of or discharge the waste waters/solid wastes may be granted, that the quality and quantity of the discharge shall not:
- (i) cause hazards to human health
 - (ii) harm living organism (fauna and flora)
 - (iii) impair the quality to use the adjacent land and water.
- 5.4.4** Gaseous contaminant emissions from the NG, LNG, LPG and **GC&P** plants, comprising of particulate matter/dust, hydrocarbons, carbon monoxide, nitrogen and sulphur oxides, mercury, some organics etc. shall not be emitted directly into the atmosphere.
- 5.4.4.1** The following conditions shall be grounds on which an exemption of discharge may be granted:
- (i) that the total quality/rate of the discharge or the total quantity to be discharged, or a meaningful combination of these, render the discharge acceptable;
 - (ii) that the net benefit, from consideration of ecological, social and economic factors, of allowing the exemption to discharge outweighs that of refusing it.
- 5.5** An operator whose NG/LNG/LPG/**GC&P** operations have been observed to cause significant and adverse environmental effects and impacts, shall be required to prepare an Environmental Evaluation (Post-impact) Report - (See PART VIII-A).
- 5.6 Treatment and Disposal of Wastes From Natural Gas, Liquefied Natural Gas, Liquefied Petroleum Gas and Gas Conversion & Processing Plants.**
- 5.6.1** Wastes from NG, LNG, LPG and **GC&P** operations, i.e process/oily water, sanitary water, storm water, spent catalyst, sludges (organic, oil and product tank bottom), residues, general refuse, air emission contaminants etc., shall be treated to the satisfaction of the Director of Petroleum Resources before disposal.
- 5.6.2 Effluent Limitation**
- 5.6.2.1** The following effluent limitations, (TABLE V-7) are hereby set for the cooling water blowdown/regeneration water and the treated (primary treatment) wastewater from LNG, NG and **GC&P** plants

TABLE V-7 EFFLUENT LIMITS FOR **TREATED WASTE WATER AND COOLING WATER BLOWDOWN/REGENERATION WATER.**

EFFLUENT CHARACTERISTICS □	COMPLIANCE LIMITS: MAXIMUM FOR ANY 1 (ONE) DAY PERIOD
pH	6.5-8.5
Temperature, °C	30 (40 for GC&P)
Total Hydrocarbon Content mg/l	10
Residual Chlorine, mg/l	1
Sulphide as H ₂ S	0.2
Total Dissolved Solids (TDS), mg/l	<2000
Total Suspended Solids (TSS), mg/l	30
Ammonia (NH ₄ ⁺), mg/l	0.2
Dissolved Oxygen, mg/l	5
BOD₅ mg/l	30
COD, mg/l	10
Hg	

5.6.2.2 Control of Gas Flaring/Smoke:

- (j) The relative density of emitted smoke shall not exceed 2 Ringelmann Number which is related to 40% of smoke density and 60% of light transmission through smoke - observed over a period of one (1) hour;
(See TABLE V-5).
- (ii) The permissible heat radiation at ground level shall not exceed 6.31KW/m² during maximum flaring at a distance of 60meters from the base of the flare;
- (iii) The minimum sterilized approach distance shall be about 60m radius measured from the base of the flare stack. No other equipment except that related to the flare itself shall be located within this area.
- (iv) Ground temperature shall not exceed 300°K (about 27°C) at the minimum sterilized distance from the flare (i.e. from about 60m radius from the flare source).
- (v) Noise levels for unprotected ears shall not exceed 90dBA for 8 hours working period.
- (vi) Flares shall be designed for and operated with no visible (smoke), except for periods not to exceed a total of 5 minutes during any 2 consecutive hours.**

5.6.2.3 **Ambient Air Quality Guidelines (see PART III, Section E, 4.4.5)**

5.6.3 On a random basis, samples collected to satisfy the effluent limitations (TABLE V-7) shall be accompanied by certificate of sampling duly issued by competent officer of the Department of Petroleum Resources.

5.6.4 The sampling and analysis to satisfy this effluent limitations shall be done once a week and reported each calendar month.

5.6.5 The following limits are hereby set for all stormwaters and other surface drainage discharges into adjacent/receiving waters:

- (i) The pH of the storm water/surface drainages shall be within 6.5 to 8.5 and/or must not be more than the pH of the receiving body by 1 unit;
- (ii) The conductivity of the stormwater discharge into fresh water shall not exceed 900 mhos/cm;
- (iii) The salinity (as chloride) shall in any case not be **10 times greater nor 10 times lower than** the normal levels in tidal running recipient waters.;
- (iv) The turbidity of the discharge shall not be more by 10% of the receiving medium;
- (v) The odour of the discharge shall be unobjectionable;
- (vi) There shall **not** be visible oil sheen.

(vii) **The temperature shall not alter the recipient medium by 1 unit.**

5.6.6 It is mandatory that all stormwater/surface drainage networks shall have series of sluice gates, designed and constructed to the satisfaction of the Director of Petroleum Resources.

5.6.7 Stormwater/drainages shall occasionally be sampled and chemically analysed by the dischargers as to identify and quantify toxic and hazardous materials.

5.6.8 If recipient water is fresh water used for human activities/consumption, then samples of the stormwater/drainages taken and analysed in accordance with recommended standard methods must not exceed the limits for the standards and characteristics affecting the acceptability of water for domestic use (WHO standards) published by the World Health Organisation (See Appendix V-1).

5.6.9 Solid Waste Disposal for NG, LNG, LPG and **GC&P** plants

5.6.9.1 All sludges from vessel/tank bottom, treated organic residues from primary oily waste water treatment **plant**, spent catalyst etc. shall be disposed off by methods that shall not endanger human life **or** living organisms, and cause significant pollution to ground and surface waters. If the waste is identified as hazardous material, then all the condition as stipulated in PART VIII-C shall apply.

5.6.9.2 Approved methods of disposal of solid wastes and other condition are as specified for petroleum refining processes (See PART V-A, Articles **5.6.9.2** through **5.6.9.4**).

5.6.10 Sanitary Waste Water Disposal/Discharge Limitation.

5.6.10.1 **The provisions for treatment and disposal are as provided in PART III, Section E. 3.6.5.**

5.6.10.1.1 **The provisions for discharge limitations are as provided in PART II, Section E. 3.5.6.1 (h).**

5.7 **MONITORING**

5.7.1 Monitoring of Wastes

5.7.1.1 There shall be mandatory monitoring requirements for liquid and solid discharges from NG, LNG, LPG and **GC&P** plants. The discharge, type, parameter and monitoring frequencies are as provided in TABLE V-6 for Petroleum Refining processes.

5.7.1.2 Except otherwise specified, the results of the monitoring programme as specified in Article 5.7.1.1 shall be submitted to the Director of Petroleum Resources at the end of every month.

5.7.1.3 Licencees/operators shall analyse liquid and solid wastes from NG, LNG, LPG and **GC&P** operations to determine whether and to what extent they contain toxic and hazardous substances as the Director may specify.

5.7.1.3.1 On a weekly basis operators shall be required to conduct **BTEX** monitoring and alert for liquid and solid wastes.

5.7.2 Monitoring of Recipient Water Bodies

5.7.2.1 The monitoring requirements as stipulated in PART III, Section E. 4.2.1. shall apply.

5.7.2.2 The frequencies and reporting format, are as provided in PART III, Section E 4.2.2 and E 4.2.3

5.7.3 Biological Monitoring

5.7.3.1 All NG, LNG, LPG and GC&P plants shall institute a biological evaluation of effluent toxicity based on the following; Bioassays shall be conducted to determine the lethal and sublethal chronic toxicity effects of their treated effluents against approved species (fish/shrimps) in laboratory and controlled field experiments carried out in artificial ponds once every 3 months. Only effluents with demonstrated low risk of lethal and sublethal toxicity action against sensitive species shall be permitted for release into the recipient body of water.

5.7.3.2 An operator shall carry out biomonitoring of any recipient medium by conducting an ecological survey of pelagic and benthic flora and fauna to assess and record changes in biodiversity, abundance (population density), frequency of occurrence amongst biologically important species and bioconcentration of selected persistent effluent constituents in selected benthics along a 5 – 10 km gradient. Monitoring shall be carried out during wet and dry season, once every 2 years.

5.7.4 Gaseous Point Source Emission and Rainwater Monitoring Programme-

5.7.4.1 All the conditions as stipulated for Petroleum Refining Processes, PART V-A, Article 5.7.4 shall apply.

5.7.5 Environmental Audit/Reviews

The conditions as stipulated for Petroleum Refining Processes PART V – A , Article 5.7.5.1. shall apply.

6.0 METHODS-OF SAMPLING AND MEASUREMENT

6.1 The methods of sampling and measurement employed in connection with these standards shall be in accordance with the methods recommended by the Director Petroleum Resources (see PART VIII-D)

7.0 USE OF ABRASIVE AGENTS IN BLASTING ACTIVITIES

7.1 The use of sand as an abrasive agent **for** blasting activities for cleaning of steel structures - tanks, pipelines, etc. shall be **controlled by the Department Petroleum Resources. Abrasive agents of 10% free silica, which also conform with 150 11126/N/CS/G, are recommended.**

8.0 SPILL PREVENTION AND COUNTER MEASURES PLAN

8.1 **This requires that the operator** shall conform with PART VIII-B, and C. Materials/chemicals identified include liquefied gas, amine solvents, catalysts, chlorine and condensates, etc.

8.2 The Department of Petroleum Resources will take necessary and appropriate action to safeguard human health and welfare when a disaster or emergency develops from the spillage of any of these chemicals/materials which is likely to affect and/or impact third party, if the response by the licensee is inadequate. All expenses reasonably incurred shall be recovered from the licensee.

9.0 SANCTIONS

9.1 **The penalty clause and fines for any contravention or violations is as provided for in PART IX under Sanctions**

10.0 BIBLIOGRAPHY

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HYDROCARBON PROCESSING OPERATIONS

C. BLENDING PLANTS

1.0 BACKGROUND

- 1.1 Finished petroleum products such as petrol engine oil, diesel engine oil, hydraulic oil etc. are necessities in the modern day automobile transportation industries. However, the processes of manufacturing them are not devoid of environmental pollution which must be controlled and managed.
- 1.2 Relevant regulations and prevention of pollution by blending plants are as follows::
- (i) Petroleum Decree No. 51 1969; Regulation 7(a) - (C);
 - (ii) Petroleum Refining Regulations 1974, 23; 24; 38; 43.

2.0 DESCRIPTION OF OPERATIONS

- 2.1 The feedstock of a typical lubricant blending plant include;
- (i) Base oil of different categories (e.g. 15ON, 50ON, BS, etc..) which are the finished products of a Lube oil processing refinery and;
 - (ii) Additives, which give specific characteristics of the finished product (e.g. corrosion inhibition, antioxidants stabilisation, viscosity index improvement etc.).
- 2.2 The operational/manufacturing processes involve:
- (i) Storage of base stocks in storage tanks,
 - (ii) Blending (mixing) of base oil and additives to produce the finished product usually petrol engine oil, diesel engine oil, transmission/gear oil and hydraulic oil.
 - (iii) Storage and packaging of finished product through tanks, drums, cans and bulk loading.

3.0 SOURCES AND CHARACTERISTICS OF WASTES

3.1 Air Emissions

- 3.1.1 Air emission problem may not be very pronounced as a result of these processes. However, flue gasses and smoke can be generated from the boilers/generators and hydrocarbons emissions from leaks and vents.
- 3.1.2 Such emissions can be characterised by:
- (i) Particulates
 - (ii) NO_x
 - (iii) CO
 - (iv) SO_x
 - (v) Hydrocarbons

3.2 Liquid Wastes

- 3.2.1 The sources of liquid wastes are as follows:

- (i) Inplant sources include runoff at filling points and spillages of finished products due to equipment failures such as leaks and corrosion, etc.. The pollutants that originate from these sources can be characterised as follows:

- (a) **THC (Total Hydrocarbon)**
 - (b) Polymetacrylates
 - (c) Polyolefin
 - (d) Polystyrene
 - (e) Poly Chlorinated Biphenyl (PCB)
 - (f) Sulphide as HS
 - (g) **Spent caustic soda.**
 - (h) **Waste arising from test Chemicals from inplant laboratories.**
- (ii) Process and Storm Water. The pollutants from these sources can be characterised by:
- (a) Phenol
 - (b) Chloride as **Chlorine**
 - (c) **THC**
 - (d) PCB
 - (e) Heavy metals - Ni, Cr⁺⁶, Total Pb, Cu, Zn, V, Fe⁺³, Ti, Cd, Hg
 - (f) pH
 - (g) Temperature
 - (h) Total Dissolved/Suspended Solids
 - (i) Sulphide as H₂S
 - (j) Surfactants

3.3 Solid Wastes

- 3.3.3** The sources of solid wastes at the blending plant include the base oil **storage tank, metallic/glass/plastic and paper containers, sanitary wastes** oil/water separator etc. The wastes can be characterised by:
- (i) **THC** content of the sludge;
 - (ii) Sulphide as (H₂S)
 - (iii) Heavy metals as in Article 3.2.(ii) (e).
 - (v) **Total coliform**
 - (vi) **Chemical additives.**

4.0 TREATMENT AND CONTROL OF WASTES

4.1 Air Emission Control

- 4.1.1 The treatment and control method for the identified parameters (particulates, smoke, NO_x, SO_x, CO and Hydrocarbons are similar to the methods examined in **Part VA, Section 4.2.**

4.2 **Liquid Effluents**

- 4.2.1 The liquid effluents are processed by any of the oily water separation techniques (see TABLE IV-1). The effluent from the separators is discharged or drained while the oily waste is recovered and recycled.

4.3 **Sanitary Waste**

- 4.3.1 **Sanitary Waste water may be discharged into inland and nearshore waters after the appropriate biological treatment (See Part II, Table II-6)**

4.4 Solid Waste

4.4.1 Solid wastes generated by this **plant shall be recycled**, incinerated or landfilled, **and/or disposed of as may be approved by the Director of Petroleum Resources.**

5.0 ENVIRONMENTAL MANAGEMENT

5.1 Environmental Management System.

- (i) Licencees/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental problems are brought to an acceptable minimum.
- (ii) Specific roles, responsibilities and authorities shall be defined, documented and communicated in order to facilitate effective environmental management.

5.1.1 Environmental Management System Manuals.

5.1.1.1 The provisions as stipulated in PART V, Section E. 5.1.1 – 5.1.1.1.1, shall apply.

5.2 EFFLUENT LIMITATIONS, STANDARDS AND MONITORING.

5.2.1 SCOPE

5.2.1.1 These effluent limitations, standards and monitoring guidelines shall regulate and control point source discharges and the ambient environment of the blending plants.

5.3 Control of Existing,/New Point Sources

5.3.1 All existing point sources of waste water effluents, solid wastes and gaseous emissions in the blending plants shall be registered with the Director of Petroleum Resources and permits issued as in PART IX.

5.3.2 Construction of waste water treatment systems or modification of existing ones for petroleum blending plants wastes shall be approved by the Director of Petroleum Resources from design to commissioning stages and appropriate permits issued to such operator.

5.3.3 The holder of the permit shall not make or cause to make, in any operation or process carried out at the premises, any change which is intended or is likely to cause a material increase/decrease in the quantity and quality of effluent or both, discharged from the premises, unless prior written approval of the Director of Petroleum Resources has been obtained for the change.

5.3.3.1 For the purposes of Article 5.3.3 above, changes to permitted operation or process include:

- (i) Any change in the construction, structure, arrangement, alignment, direction or condition of any channelling device, system or facility serving the premises, and;
- (ii) Any change of, to, or in any plant, machine, or equipment used or installed at the premises for the purposes of treatment of runoffs (product/storm/water), oily waters, sanitary water, process/cooling water, air emission, oily, organic sludge, spent catalyst, solid wastes etc..

5.3.4 Preparation of an Environmental Impact Assessment Report shall be mandatory prior to the construction of any hydrocarbon. blending plants (see PART VIII-A).

5.3.5 A certificate of Approval for operation shall be issued.

5.3.6 PERFORMANCE OF EXISTING SOURCES/TREATMENT TECHNOLOGY.

5.3.6.1 The performance of all registered point sources/treatment technology shall be determined by:

- (i) Compliance limits based on the approved control Technologies and as provided in TABLE V-8, and;
- (ii) Information supplied to the Director of Petroleum Resources on the estimates of quantities, concentrations and loading rate into the environment of the waste streams, and the condition or state of the recipient medium - water, atmosphere or land.

5.3.7 The operator shall analyse samples of any liquid effluents, oily/organic sludge, spent catalyst, solid wastes, etc., to determine whether and to what extent they contain toxic and hazardous substances.

5.4 Control of Points of Discharges

5.4.1 Waste waters from the blending plant processes that may comprise of process water, storm water, cooling water, sanitary water, spent catalyst, etc. and solid waste comprising of sludges (organic/oily products tank bottom), residues, rusts, ash, metallic and glass objects, general refuse, etc. shall not be disposed of directly or indirectly into;

- (i) any inland waters (fresh or reservoir)
- (ii) any swamp, coastal or offshore waters
- (iii) any floodplain and upland valleys
- (iv) any pit or land other than a temporary holding/retention lined or concreted pit, basin or steel tank so designed and utilised that there shall be no overflows, leakages and seepages into adjacent surface and groundwaters.

5.4.1.1 The lined or concreted pit **shall have the equivalent** of 1 (one) continuous meter of recompacted or natural clay having a hydraulic conductivity not greater than 1×10^{-7} cm/sec at the side and bottom. The liners shall include but are not limited to the following:

- (i) Natural clay having a hydraulic conductivity of less than 1×10^{-7} cm/sec.
- (ii) Soil mixed with cement, clay type, and/or other additives to produce a barrier with a hydraulic conductivity of less than 1×10^{-7} cm/sec
- (iii) Manufactured liners (synthetic material) that **exceed** the hydraulic conductivity requirement shall also satisfy the following definitions;

<u>Parameter or Test</u> *	<u>Standard</u>
Thickness (average)	≥ 10 mm
Breaking Strength	6.33 kg/m ²

Bursting Strength	9.85 kg/m ²
Tearing Strength	1.76 kg/m ²
Seam Strength	3.52 kg/m ²

* **Testing is to be performed according to ASTM method D-751, latest revision. or EPA Method 9100.**

5.4.2 The disposal of petroleum refining wastes is prohibited on unsecured land, (**non-engineered sanitary land fill**), public drain and sewers.

5.4.3 The following conditions shall be the grounds on which an exemption to discharge waste waters/solid wastes may be granted; that **there is** scientific support beyond all reasonable doubts that the quality and quantity of the discharge shall not:

- (i) Cause hazards to human health
- (ii) harm living organism (fauna and flora)
- (iii) impair the quality to use adjacent land and water

5.4.4 Gaseous contaminant emissions from the blending plant, comprising of particulate matter/dust, hydrocarbons, carbon monoxide, nitrogen and sulphur oxides, mercury, some organics etc. shall not be emitted directly into the atmosphere.

5.4.4.1 The following conditions shall be grounds on which an exemption of discharge may be granted:

- (i) that the total quality/rate of the discharge or the total quantity to be discharged, or a meaningful combination of these, render the discharge acceptable;
- (ii) that the net benefit, from consideration of ecological, social and economic factors, of allowing the exemption to discharge outweighs that of refusing it.

5.5 An operator whose blending plant operations have been observed to cause significant and adverse environmental effects and impacts (including base oil and hazardous materials spillages), shall be required to prepare an Environmental Evaluation (Post-impact) Report – (See PART VIII-A).

5.6 Treatment and Disposal of Wastes From Blending Plants

5.6.1 Wastes from blending plant operations - process/oily water, cooling water, sanitary water, product/storm water runoff, spent catalyst, sludges (base oil and product tank bottom), residues, general refuse, air emission contaminants **in-plant chemicals arising from laboratory test Chemicals, e.t.c.** - shall be treated to the satisfaction of the Director of Petroleum Resources before disposal.

5.6.4 Effluent Limitation

5.6.4.1 The following effluent limitations (TABLE V-8) are hereby set for the cooling water blowdown/regeneration water and the treated waste water from blending plants.

TABLE V-8 EFFLUENT LIMITATIONS FOR TREATED WASTE WATER FOR BLENDING PLANTS

□ EFFLUENT CHARACTERISTICS □	COMPLIANCE LIMITS: MAXIMUM FOR ANY 1 (ONE) DAY PERIOD
pH Temperature, °C THC mg/l Residual Chlorine, mg/l Sulphide as H ₂ S Total Dissolved Solids (TDS), mg/l Total Suspended Solids (TSS), mg/l Dissolved Oxygen, mg/l BOD ₅ Ammonia (NH ₄ ⁺), mg/l Chromium (Cr ⁺⁶), mg/l Chromium (Total), mg/l Pb, mg/l Hg Cd	6.5-8.5 30 10 1 0.2 <2000 30 5 30 0.2 0.03 0.3 0.1

5.6.2.2 Limits on Smoke

- (i) The relative density of emitted smoke shall not exceed 2 Ringelmann Number which is related to 40% of smoke density and 60% of light transmission through smoke - observed over a period of one (1) hour; **(PART VA, Section 5.6.2.4)**

5.6.2.3 **Ambient Air Quality Guidelines**

5.6.2.3.1 **The conditions as stipulated in PART III Section E. 4.4.5 shall be complied with.**

5.6.3 On a random basis, samples collected to satisfy the effluent limitations (TABLE V-8) shall be accompanied by certificate of sampling duly issued by competent officer of the Department of Petroleum Resources.

5.6.4 The sampling and analysis to satisfy this effluent limitations shall be done once a week and reported each calendar month.

5.6.5 The following limits are hereby set for all stormwaters and other surface drainage discharges into adjacent/receiving waters:

- (i) The pH of the stormwater/surface drainages shall be within 6.5 to 8.5 and/or must not be more than the pH of the receiving body by 1 unit;
- (ii) The conductivity of the stormwater discharge into fresh water shall not exceed 900 mhos/cm;
- (iii) The salinity (as chloride) shall in any case not be **1% less than nor 1%** greater than, the normal levels in tidal running recipient waters.;
- (iv) The turbidity of the discharge shall not be more by 10% of that of the receiving medium;
- (v) The odour of the discharge shall **not be** objectionable;
- (vi) There shall be no visible oil sheen.

5.6.6 It is mandatory that all stormwater/surface drainage networks shall have series of sluice gates, designed and constructed to the satisfaction of the Director of Petroleum Resources.

5.6.7 Stormwater/drainages shall occasionally be sampled and chemically analysed by the dischargers as to identify and quantify toxic and hazardous materials.

5.6.8 If recipient water is fresh water used for human activities/consumption, then samples of the stormwater/drainages taken and analysed in accordance with recommended standard methods must not exceed the limits for the standards and characteristics affecting the acceptability of water for domestic use (WHO standards) published by the World Health Organisation (See Appendix V-1)

5.6.9 Solid Waste Disposal for Blending plants

5.6.9.1 All sludges from vessel/tank bottom, treated organic residues from primary oily waste water treatment plant, spent catalyst etc.. shall be disposed of by methods that shall not endanger life and, living organisms, and **or** cause significant pollution to ground and surface waters. If the waste is identified as hazardous material, then all the condition as stipulated in PART VIII-C shall apply.

5.6.9.2 Approved methods of disposal of solid wastes and other condition are as specified for petroleum refining processes (See PART VA, E. 5.6.9.2 through 5.6.9.4).

5.7 Monitoring

5.7.1 Monitoring of Wastes

5.7.1.1 There shall be mandatory monitoring requirements for liquid and solid discharges from blending plants.

5.7.1.1.1 **The discharge type and parameters are as provided on TABLE V-8. The frequency of monitoring shall be on weekly basis.**

5.7.1.2 **The results of the monitoring programme as specified in Article 5.7.1.1 shall be submitted to the Director of Petroleum Resources at the end of every month.**

5.7.2 Monitoring of Recipient water Bodies.

5.7.2.1 **The monitoring requirements as stipulated in PART III, Section E 4.2.1 shall be conformed with.**

5.7.2.2 **The frequencies and reporting format, are as provided in PART III, Section E 4.2.2 and E 4.2.3.**

5.7.3 Biological Monitoring

5.7.3.1 **All blending plants shall institute a bio-monitoring programme to assess the state of state of environment in the recipient medium of the effluent discharges.**

5.7.3.2 **The reports of such programme (which shall be carried out once in two years) shall be submitted to the Director, Petroleum Resources.**

5.7.4 Gaseous Point Source Emission and Rainwater Monitoring Programme.

5.7.4.1 **All the conditions as stipulated for Petroleum Refining Processes, PART VA, Section 5.7.4 shall apply.**

5.7.5 Environmental Audits/Reviews:

5.7.5.1 **Environmental audits/reviews shall conform with provisions of PART III, Section E, 6.0.**

6.0 METHODS OF SAMPLING AND MEASUREMENT

6.1 **The methods of sampling and measurement employed in connection with these standards shall be in accordance with the methods recommended by the Director of Petroleum Resources (see PART VIII-D)**

7.0 USE OF ABRASIVE AGENTS IN BLASTING ACTIVITIES

7.1 The use of sand as an abrasive agent in blasting activities for cleaning of steel structures - tanks, pipelines, etc. shall be **controlled by the Director of Petroleum Resources**. Abrasive agents of less than 1% silica **which also conforms with ISO11126/N/CS/G are recommended**.

8.0 SPILL PREVENTION AND COUNTER MEASURES PLAN

8.1 Blending plants shall have spill prevention and counter measures plan in accordance with PART VIII B & C. Materials and Chemicals identified include lube oil, waste oil, additives and other hazardous chemicals

8.2 Trapezoidal cross-sectional shaped earth bundwalls covered by steel reinforced cemented slabs or butimen cement/sand mix **shall** be built around the bulk storage tank to prevent a sudden release of oil/base oil into the environment on the event of tank collapse.

8.3 The bundwall so constructed as in Article 8.2 should be above ground, and sized to contain about 120% capacity of the largest tank within the enclosure.

8.4 The Department of Petroleum Resources will take necessary and appropriate action to safeguard human health and welfare when a disaster or emergency develops from the spillage of any of these chemicals/materials which is likely to affect and/or impact third party, if the response by the licensee is inadequate. All expenses reasonably incurred shall be recovered from the licensee.

9.0 SANCTIONS

9.1 **The penalty clause and fines for any violation, contravention, and or offence shall be dealt with as provided in PART IX.**

10.0 BIBLIOGRAPHY

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APPENDIX V-1

LIMITS FOR SUBSTANCES AND CHARACTERISTICS AFFECTING THE ACCEPTABILITY OF WATER FOR DOMESTIC USE (WHO STANDARDS)

SUBSTANCES	HIGHEST LEVEL	DESIRABLE	MAXIMUM LEVEL	PERMISSIBLE
Total Solids	500mg/l		1,500mg/l	
pH Range	7.0 to 8.5		6.5 to 9.2	
Mineral Oil	0.01mg/l		0.3mg/l	
Phenolic Compounds	0.02 mg/l		0.002mg/l	
Chloride as Cl ⁻	200mg/l		600mg/l	
Copper as Cu ⁺⁺	0.05mg/l		1.5mg/l	
Iron as Fe ⁺⁺	0.1mg/l		1.0mg/l	
Zinc as Zn ⁺⁺	5.0mg/l		15mg/l	
Sulphate as SO ₄	200mg/l		400mg/l	
Total Hardness	100mg/l		500mg/l	
(CaCO ₃)	75mg/l		200mg/l	
Calcium as Ca ⁺⁺	30mg/l		150mg/l	
Magnesium as Mg ⁺⁺	0.05mg/l		0.5mg/l	
Manganese as Mn ⁺⁺	0.2mg/l		1.0mg/l	
Anionic Detergents	5 units		50 units	
Colour	Unobjectionable		Unobjectionable	
Odour	-do-		-do-	
Taste				

PART VI OIL AND GAS TRANSPORTATION

A. BACKGROUND

- 1.0 Transportation of hydrocarbons by pipelines, barges, ships, road tankers, railwagons, etc. do cause pollution problems.

- 2.0 Reports of cases of oil spillages and pollution caused by damaged pipelines, leaking barges, ships and accidented road tankers are common. There is therefore, a need to control the practices that cause this type of pollution, so as to minimize impacts on human health, other living organisms and properties. The establishment of uniform guidelines and standards for such operation therefore becomes imperative.

- 3.0 Relevant Regulations for the control of such pollution are as follows:
 - (i) Petroleum Regulation 1967
 - (ii) Oil Pipelines Ordinance (CAP 145 of 1956) and as amended by the Oil Pipelines Act 1965.
 - (iii) Oil in Navigable waters Regulations 1968.

B. DESCRIPTION OF OPERATIONS

1.0 Pipelines

- 1.1 In Nigeria, the major Government operated pipeline which transports crude oil and petroleum products (not gas) is divided into five (5) major systems made of pipelines sizes ranging in diameters from 6 - 16 inches:
 - (i) System 2A Pipeline - Warri to Mosimi.
 - (ii) System 2B Pipeline - Atlas Cove to Ilorin
 - (iii) System 2C Pipeline - Warri to Kaduna
 - (iv) System 2D Pipeline - Kaduna Refinery to Kano Depot via Zaria pump station with a branch, to Gussau Depot. Another originates from Kaduna refinery to Maiduguri depot via Jos and Gombe depots
 - (v) System 2E Pipeline:-
 - (i) Port-Harcourt to Makurdi depot via Aba and Enugu depots.
 - (ii) **Makurdi to Yola**
 - (iii) **Enugu to Auchi to Suleija to Kaduna**
 - (iv) **Suleija to Minna to Benin**

- 1.2 Some of the major gas lines also operated by the Government joint ventures include;
 - (i) Oben/Utorugu Gas pipeline and;
 - (ii) Escravos - Lagos Gas Pipelines.
 - (iii) **ECOWAS Project (Escravos - ECOWAS Countries i.e. Benin, Togo, Ghana)**

- 1.3 There are also numerous smaller crude oil flowlines criss-crossing the oil fields and bigger trunklines operated by licencees/operators/government which deliver crude oil to storage/treatment terminals, offshore transfer/export systems and refineries. These operators are also involved in the piping of gas to industrial consumers.

- 1.4 **These** pipelines are permanent structures designed and constructed on the

basis of ultimate estimated capacity. On land and swamps, they are laid in trenches, specially prepared, according to the soil conditions, topography and other factors after the rights-of-way have been cleared. In offshore and in rivers, trenches are also made by dredging the rights-of-way, laying weighted pipes to minimize or eliminate shifting after they are set in place.

1.5 Pumping is required for transportation of the petroleum/products. Constant speed unit and/or variable speed drives are most frequently used. Pump stations are therefore installed along the pipeline. The pump design, selection and location depends on factors like viscosity of crude/product, topography, distances, pressure gradient, etc..

2.0 Barges, Ships, Tankers and FPSOs

2.1 Barges are flat bottomed, often unpowered freight boats for harbours and inland waters operations. These are usually divided into compartments which are required to be fitted with horizontal bar under each sighting port to indicate the maximum allowable contents in the tank/compartment. The compartments are piped to facilitate loading and discharging. They usually do not have facilities for ballast/bilge oily water separators.

2.2 Ships and tankers are cargo vessels constructed and adapted for the carriage in -bulk of merchandise, goods, crude oil, petroleum products and chemicals.

2.3 Tankers are compartmentalised and piped to facilitate loading and discharging. When a ship/tanker discharges its cargo it must take ballast water into tanks or into designated tanks to obtain a manoeuvrable and seaworthy condition.

2.3 Barges, Ships/Tankers receive products through jetties while crude oil is received from Terminals containing onshore and offshore berths. The jetties are linked with the Refineries and Depots by network of pipelines. The jetty heads, comprise of berthing points for ocean-going tankers and barges. Offshore, crude oil is loaded into tankers via submarine pipelines and strings of flexible hoses. In order to cater for the very Large Crude Carriers, offshore terminals are provided with Single Buoy Moorings (SBM) Berths capable of accommodating vessels of up to 320,000 tonnes dead weight. Offshore vessels load at the Single Buoy Moorings (SBMs) from the shore via floating hoses connected to ship manifold.

2.5 When such tankers are fitted with facilities for reception, storage, processing and treatment of crude oil prior to offloading/export, they become FPSOs.

3.0 Road Tankers and Rail Wagons

3.1 Road tank vehicles and railwagons are also used to carry and transport mostly petroleum products from one place to another.

3.2 While a road tanker must be constructed of fire resistant materials and compartmentalised if the capacity exceeds 5,455 litres, the railwagons must be constructed of steel and can only carry lidless cases of petroleum. The typical operation involves loading of products from, usually depots, to retail outlets. There are provisions for valves and hoses.

C. SOURCES AND CHARACTERISTICS OF WASTE

1.0 Pipelines

- 1.1 The trenching, excavating and/or dredging of land, river, and sea floors for the laying of pipelines produce sediment and dredge spoils. The construction of necessary access roads and rights-of-way also involves timber and tree fell, earth movement, etc.. All these activities not only produce substantial volume of solid waste but associated soil erosion and discharge of sediments to surface waters.
- 1.2 Leakages from pipelines, that can result from various causes e.g. corrosion, damage from external forces, operational malfunction etc., are the principal sources of pipeline pollution. Oily sludges, waste oil and oily water are also produced during pigging exercises and oily water separation, at pumpstation respectively.
- 1.3 The air pollution emission is mainly hydrocarbons from spills and flue gases, smoke from pumpstation operation.

2.0 Barges, Ships, Tankers and FPSOs

- 2.1 Crude oil and/or petroleum products are the major pollutants from barges and tanker operations. These are as a result of accidental discharges (spillages, leakages and operational malfunction). Other pollutants include oily sludges from tank cleaning and oily water from ballasting of oily tanks.
- 2.2 The air pollution emission is mainly hydrocarbons from loading racks and spills.
- 2.3 **Sanitary and general refuse wastes occur from sinks, showers, toilets and laundries resulting in oxygen consuming organic matter, faecal Coliform and garbage.**

3.0 Road Tankers and Rail Wagons

- 3.1 Spillage of petroleum products due to leakages, accidents, operational malfunction, etc is the primary source of pollution.
- 3.2 Air pollution emission is mainly hydrocarbons from loading racks and spilled products.

D. TREATMENT AND CONTROL OF WASTE

1.0 Pipeline

- 1.1 Oil pollution from pipeline operation can be controlled by various means before and during operations:

- (i) **Carry out appropriate hazard assessment prior to the laying of the pipelines**
- (ii) All materials are carefully inspected for manufacturing defects;
- (iii) All welded joints receive careful inspection and testing either by visual, X-ray, or ultrasonic methods.
- (iv) Hydrostatic test, at pressure above normal working pressures **are used** to detect wall cracks, thin holes, or other defects that might cause leakages.
- (v) Protection against external and internal corrosion **is** provided by coating with such materials as asphaltic mixtures, coal-tar enamel, epoxy compounds or cathodic

protection and addition of corrosion-inhibitors to the materials passing through the lines respectively.

- (vi) Inspections (**visual/electronic**) of long length of the pipeline with helicopters, vehicles, foot and by divers are **meant** to detect spillages and encroachment on the pipelines that might endanger them;
- (vii) Sensors and shut-off devices are installed for monitoring and controlling of pipeline operations;
- (viii) Erection of warning signs or boards where pipelines cross navigable water ways.

1.2 At pump stations, discharges of petroleum products, oily waters and spills around the location are controlled and routed into an oily water separator for treatment. The recovered oil is either returned to the system or incinerated as oily waste, while the water is drained and dumped as effluent water.

2.0 Barges Ships and Tankers

2.1 Oil contaminated water from these vessels can originate from ballast water, tank cleaning water bilge water and produced formation water.

- (i) **Ballast water:-** The water taken into cargo tanks in order to keep the vessel in a manoeuvrable sea worthy condition must be discharged before the next cargo can be loaded. The ballast water sometimes contains silt/fine solids and oily residues which remain behind in the tanks after discharge. It may also contain non-indigenous aquatic organisms.
- (ii) **Tank cleaning water:-** Prior to **loading** the next cargo, most of the time the cargo tanks need to be cleared to avoid contamination with residues of the previous cargo. Cargo tanks are also washed in order to create clean compartment for loading of clean ballast. Oily water generated during tank cleaning operations is similar to dirty ballast with sometimes additional pollutants such as additives in the form of surfactants, detergents, solids and rust scales.
- (iii) **Bilge water:-** Bilge water contains spilled cargo, lubricating oil, hydraulic fluids and water usually resulting from leakages in the engine pump rooms. Bilge water sometimes contains solids and rust scales.
- (iv) **Produced Formation Water: Fluids produced from oil reservoirs that have been separated form the hydrocarbon. They contain dissolved/suspended solids.**

2.2 Pollution from badges and tankers can be controlled by means of:

- (i)
 - a. Maintaining the construction specification upto standards;
 - b. Maintaining good operating and housekeeping standards;
 - c. Proper handling and utilization of cargo hoses.
- (ii) Using oil/water separators onboard vessel which prevent oil from being discharged overboard together with the water;
- (iii) Using segregated ballast tanks instead of cargo tanks for ballasting purposes;
- (iv) Using the LOT (Load On Top) technique when tanker are enroute to the next loadport where the vessel is to arrive with clean ballast in the cargo tanks. The tank washings are collected in a slop tank where the oil and washwater are separated;
- (v) Using the crude oil washing technique. Tankers carrying crude oil with a capacity in excess of 40,000 tons are required to have this system fitted. Crude oil washings are

- carried out during cargo discharge. The system uses high pressure jets which make it possible to remove the residue in the cargo tanks together with the cargo;
- (vi) Providing **shore** reception facilities for tankers and barges to pump the dirty ballast, bilge water, etc **ashore** instead of discharging directly into the marine environment. **Shore** reception facilities are fitted with devices which take care of the oil/water separation;
 - (vii) To avoid introduction of undesirable foreign organisms into Nigeria, use of appropriate reception facilities or chlorination or other biocidal treatment of ballast water before discharge.
 - (viii) **For the offshore line system, great care must be exercised during loading when ships valves are manipulated, to avoid pressure surges. Pressure recorders are to be fitted at the spool piece between ship manifold and tail end of the hose string to monitor pressure changes generated on board the vessel.**
 - (ix) **Whilst berthed at the SBM, a secondary watch must be kept on the fore castle head by member(s) of the ships crew throughout the hours of darkness to raise the alarm and advise the berthing master on the approach of local small crafts. The berthing master should also be advised in the event that the vessel rides up to the SBM.**

2.3 Air pollution from Barges, Tankers **and FPSOs** can be controlled by means of;

- i) Using an inert gas system on board (IGS). Tankers must have this system fitted in line with requirements as laid down in SOLAS 1974.

The Inert gas system enables a vessel to maintain non-flammable atmosphere in the cargo tanks and at the same time prevents cargo vapours to escape into the environment.

The inert gas system uses boiler flue gas from an inert gas generator which is cooled, cleaned and pumped into the cargo tanks. The system is designed to keep the oxygen levels in the cargo tanks below 8% of the volume which prevents combustion of cargo vapour.

- (ii) Hydrocarbon emissions from vessels and cargos not fitted with an inert gas system are controlled using a vapour return system during loading operations. The vapour return system leads into a vapour recovery unit or an incinerator.

3.0 Road Tankers and Rail Wagons

- (i) Standardisation of construction materials and proper operations are the major control to minimise or check accidents and leakages that will result in spillages.
- (ii) Hydrocarbon emission from loading operations are generally controlled by the use of a vapour collection device manifolded into a vapour recovery unit.
- (iii) **Regular mandatory check on tyres and batteries before loading and haulage of tanks are carried out.**

E. ENVIRONMENTAL MANAGEMENT

1.0 Environmental Management System.

- 1.1 Licencees/operators shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are contained and brought to an acceptable minimum.**
- 1.2 Specific roles, responsibilities and authorities shall be defined, documented and communicated in order to facilitate effective environmental management.**

2.0 Environmental Management System Manuals

- 2.1 The provisions as stipulated in PART III, E. 2.1 – 2.1.1 and Part VIII-H shall apply.**

3.0. EFFLUENT LIMITATIONS, STANDARDS AND MONITORING

3.1 Regulations Standards and Code of Practice

- 3.1.1 Regulations, Standards and Code of Practice to ensure proper loading/unloading operations and maintenance of pipelines, barges and ships, road tankers and rail wagons are already available and specified in the Petroleum Regulations 1967, and the Oil in Navigable Waters Decree No. 34 of 1968.**

- 3.1.2 It shall be mandatory for licencee or leasee to prepare an Environmental Impact Assessment Report for crude oil and gas delivery line, flowline and pipeline in excess of a total of 20 Kilometers in length (see PART VIII-A).**

3.2 Inspections

- 3.2.1 All pipelines and flowlines for crude and petroleum products including gas, shall be patrolled and inspected, once in every month or otherwise as approved by the Director of Petroleum Resources.**

- 3.2.2 Details of the inspection shall be recorded in a log book which shall **include** but not limited to the following:**

- (i) Licencee,s Name
- (ii) Identification of pipelines traces
- (iii) Condition of the way leave (free from grass, weeds or inflammable material)
- (iv) Irregularity along the pipelines which might endanger the line (e.g. access road construction or major excavation work at the vicinity of the line, proximity and encroachment of human habitation, usage of R.O.W. as access road by public and private transporters, conditions of river banks when intersected by the line, sea/river floor conditions affected by environmental influences, movement of bottom sediments, storm. scouring, ship anchorage etc.)
- (v) Corrosion monitoring indications and measurements
- (vi) Continuous pressure readings of all oil/product pumps involved in the transfer and receipt of products.
- (vii) Operating conditions of pumps, metering devices, valves/shut-off system, fire fighting appliances etc..
- (viii) Actions taken to remedy any unfavourable inspection report.

3.2.3 Reports of such inspections shall be submitted to the Director of Petroleum Resources, on the first week of every month.

3.3 Control of Existing Effluent Point Sources at Pumpstations

3.3.1 All point sources of existing effluent discharges - air, water and solid **shall** be registered with the Department of Petroleum Resources and the appropriate permit issued.

3.3.2 No discharges are permitted on unsecured land, where such discharges may be allowed, the land shall be lined and concreted and shall satisfy other conditions as stipulated in **E. 3.4.4 and E.3.6.2-3.6.4.**

3.4 Control of New Sources

3.4.1 All new point sources of waste water effluents, solid waste and gaseous emissions shall be registered with the Director of Petroleum Resources and shall satisfy all other conditions as specified in **E, 3.2 of PART III , E . 3.2**

3.4.2 In addition, an Environmental Impact Assessment Report shall be submitted for such projects (see PART VIII-A).

3.5. Compliance Limitations

3.5.1 Pumpstations

3.5.1.1 The following effluent limitations, (TABLE VI-1) are hereby set for pumpstations.

TABLE VI - 1 EFFLUENT LIMITATIONS FOR PUMPSTATIONS

EFFLUENT CHARACTERISTIC	COMPLIANCE LIMITS MAX FOR ANY DAY
Temperature, °C	30
PH	6.5-8.5
THC , mg/l	7.0
Total Suspended Solids, mg/l	30
Sulphide (as H ₂ S), mg/l	0.2
Lead, mg/l	0.05

3.5.1.2 On a random basis, samples collected to satisfy the effluent limitations (TABLE VI-1) shall be accompanied by certificate of sampling duly issued by competent officer of the Department of Petroleum Resources.

3.5.1.3 It is mandatory that once in every month, a pumpstation's discharge effluent water shall be sampled and chemically analysed for the following parameters in accordance with the methods recommended by the Director of Petroleum resources (see PART VIII-D):

- (i) pH
- (ii) Temperature
- (iii) Electrical Conductivity
- (iv) Total Dissolved/Suspended Solids

- (v) Salinity as Cl-
- (v) THC**
- (vi) **BTEX**
- (vii) **PAHs**
- (viii) COD
- (ix) BOD₅
- (xi) Sulphide (as H₂S)
- (xii) Ammonia (as NH₄⁺⁺)
- (xiii) Total Phosphorous (as PO₂⁴⁻)
- (xiv) Nitrates (as NO₃,)
- (xv) Heavy Metals -Ni, Cr⁺⁶, Pb, Cu, Zn, V, Ti, Cd, Fe⁺³, Hg.

3.5.1.4 All storm water and surface drainages that are not channelled to the oil/water separator shall comply with the following specifications:

- (i) The pH shall not exceed 6.5 to 8.5
- (ii) There shall be no visible oil sheen
- (iii) The conductivity of the storm water if drained into freshwaters shall not exceed 900 umhos/cm.
- (iv) The turbidity of the discharge shall not be more by 10% of that of the receiving medium if the receiving medium is water.
- (v) The odour of the discharge shall not be objectionable.
- (vi) The salinity (as chloride) shall in any case not be **10% less nor 10%** greater than the normal levels in the tidal running recipient waters.

3.5.1.5 It is mandatory that all storm water drainage networks have series of sluice gates, constructed to the satisfaction of the Director of Petroleum Resources.

3.5.1.6 If the recipient water for the treated oily water and/or storm water drainages is fresh water used for human consumption, samples of such discharges must be taken, and analysed in accordance with approved recommended methods. The results shall not exceed the standards on limits for substances and characteristics affecting the acceptability of water for domestic use *WHO Standards (see Appendix V-1).

3.6 Air emission requirements shall conform with **PART III, Section E 4.4 of the Guidelines and Standards.**

3.7 Ocean Ballast Water

3.7.1 It is mandatory for Operators, ship owners, charters and ship agents to ensure that **samples of clean ballast and treated bilge water to be disposed of meet effluent limitations for ocean ballast as in TABLE VI –2, before discharge.**

TABLE VI - 2 EFFLUENT LIMITATIONS FOR OCEAN BALLAST

EFFLUENT CHARACTERISTIC	COMPLIANCE LIMITS MAX FOR ANY ONE DISCHARGE
Temperature, °C	30

pH	6.5-8.5
THC, mg/1	40
Total Suspended Solids, mg/1	50
Total Dissolved Solid, mg/l	<2,000
Pb	0.05

3.7.2 Pollution of the sea by dirty ballast, bilge discharge or any other wastes will result in Sanctions (See PART IX).

3.8 Produced formation/Oily Waters from FPSOs

3.8.1 Effluent limitation are as stipulated in Part III, Section E.3.8.2

3.8.1.1 Limitations on the quality of offshore recipient water for permitted discharge are as provided in Part III, Section E.3.8.6

3.8.2 Monitoring of produced formation/oily waters and other wastes shall conform with Part III, Section E4.0.

3.9 Solid Waste Disposal

3.9.1 All solid waste disposal from the pump station, barges and ships, road tankers and rail wagons shall be in accordance with PART III Section E 3.6.4.

4.0 METHOD OF SAMPLING AND MEASUREMENT

4.1 The methods of sampling and measurement employed in connection with these standards shall be in accordance with methods recommended by the Director of Petroleum Resources (see PART VIII-D).

5.0 ENVIRONMENTAL AUDITS/REVIEWS

5.1 The essential elements, types, competence of auditors, frequency of audits, the access to audit reports and review provisions, are as provided in PART VIII-I

6.0 USE OF ABRASIVE AGENTS IN BLASTING ACTIVITIES

6.1 The use of sand as an abrasive agent in blasting activities for cleaning of steel structures - tanks, pipelines, etc. shall be **controlled by Director of Petroleum Resources. Abrasive agents of less than 1% free silica, which also conforms with ISO. 11126/N/CS/G, are recommended.**

7.0 SPILL PREVENTION AND COUNTER MEASURES PLAN

7.1 Pipeline licencees, operators of barges, ships and FPSOs, road tankers and rail wagons, shall **have spill prevention and countermeasures plan for crude oil and petroleum products including gas, approved by the Director of Petroleum Resources (See Part VIII - B & C).**

7.1.1 The provisions for the reporting and clean-up certifications are as provided in PART III, Sections E.7.1.1 and E.7.1.2.

8.0 SANCTIONS

8.1 The provisions are as provided in PART IX.

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PART VII MARKETING OPERATIONS

A. DEPOTS

1.0 BACKGROUND

- 1.1 Petroleum products are stored in bulk in strategic depots all over the country. These depots are linked with a network of pipelines. The facilities provided for storing large volumes of liquids and gases can be classified as closed-storage vessels or open-storage vessels. Closed-storage vessels include fixed roof tanks, pressure tanks, floating roof tanks, and conservation tanks while open-storage vessels include open tanks, reservoirs, pit and ponds. In Nigeria, the storage vessels are of the closed type and some have capacities in excess of 150,000 barrels. The bulk storage tanks are normally surrounded by a main retaining bundwall which is capable of containing the content of the largest storage tank plus 10% of the content of the remaining tanks. If there is only one tank, the bundwall shall, in the event of any emergency, be capable of containing the contents of the tank. **A crude oil carrier can be converted for bulk storage of petroleum product for export, e.g. MT TUMA B at Mouth of Bonny Estuary.**
- 1.2 The use of standard designs, materials, fabrications, coatings, corrosion control and monitoring programmes is as provided in the Mineral Oil Act, 1962, Mineral Oil **Safety Regulations, 1997** and Petroleum Regulations, 1967 **and Oil in Navigable Waters Regulation, 1968.**

2.0 DESCRIPTION OF OPERATIONS

2.1 Operations carried out at the depots include:

- (i) **Stock taking:** involving the determination of the quantity and quality of crude oil and products held in Depot tanks.
- (ii) **Fiscalization:** involving the process of determining the exact quantity and quality of crude oil and petroleum products in a tank. It is mandatory to fiscalize tanks for Daily/Monthly/Yearly stock taking as well as during custody transfer operations. The step by step fiscalization procedure is as follows:
 - (a) Tank dipping, sampling and temperature measurement.
 - (b) Laboratory analysis of samples taken
 - (c) Determining through appropriate calculation the quantity and quality of the crude oil/products.
- (iii) **Laboratory Analysis:** involving the determination of:
 - (a) Specific gravity (API Gravity) and temperature
 - (b) The Base (Bottom) Sediment and Water, (BSW):
 - For crude oil (a) and (b) above applies,
 - For petroleum products only (a) above applies.
- (iv) **Custody Transfer:** which is the change of ownership or responsibility for handling crude oil/petroleum products.

3.0 SOURCES AND CHARACTERISTICS OF WASTES

- 3.1 Pollution from bulk storage of petroleum products can be caused by tank failure, leakages, malfunctioning oil separator, and spills arising from the overfilling of tanks/leakages from loading arms. Tank failures can be caused by differential settlement, corrosion problems arising from water at the bottoms, old age and design errors.
- 3.2 Malfunctioning/inefficiency of the oil separators can lead to the discharge of effluent with high oil contents.
- 3.3 Loading arms/bays, tank vents, drains, generator exhausts, etc. are some of the major sources of gaseous pollutants (hydrocarbon emission, flue gases, etc.).
- 3.4 **Surface drainage results from precipitation run off. It may contain petroleum based oil from miscellaneous spills and leakages of oil and other chemicals used at the facility.**
- 3.5 **Domestic sanitary wastes originate from toilets, sinks, showers and laundries. The volume and concentration of sanitary wastes vary with time, facility, occupancy, and operational situation. The pollutants of concern are oxygen consuming organic matter, faecal coliform and garbage.**

4.0 ENVIRONMENTAL MANAGEMENT.

4.1 Environmental Management System.

- (i) **Licencees/operators of depot, and associated pipelines shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are contained and brought to an acceptable minimum.**
- (ii) **Specific roles, responsibilities and authorities shall be well defined, documented and communicated in order to facilitate effective environmental management.**

4.1.1 Environmental Management System Manuals

- 4.1.1.1 **The provisions as stipulated in PART III, E. 2.1 – 2.1.1 Part VIII-H shall apply.**

4.2 POLLUTION CONTROL MEASURES

- 4.2.1 The depot **shall** be fenced round preferably with masonry wall made of concrete to a height not less than two and half metres, in order to prevent access to unauthorized persons. In addition, fire break around the wall shall be provided.
- 4.2.2 A bundwall, approximately one metre high and having a trapezoidal cross-section **shall** be built around bulk storage tanks, in order to control any oil spillage.
- 4.2.2.1 A bundwall so constructed around storage tanks **shall** be such as to contain about **110%** of the capacity of the largest tank within the enclosure.
- 4.2.3 Intermediate bundwalls **shall** be constructed of half the height of the main bundwalls if the number of tanks in the bunded areas are many.

- 4.3 Tank cleaning **shall** be carried out only under the supervision of competent persons.
- 4.3.1 Tanks undergoing cleaning **shall** be thoroughly ventilated. Ventilation is normally assisted by using windmills at roof manholes, eductors or fans driver.
- 4.3.2 The period of time that personnel **shall** be permitted to remain in the tank during cleaning varies with site conditions. However, in no case **shall** the time exceed 90 minutes with a regular 30 minutes break before entering the tank again.
- 4.3.3 After draining a horizontal tank completely of its contents, the manhole covers may be removed and water used as a flushing medium. After flushing, the mixture of oil and water may be pumped into a slop tank for settlement or passed through an oil interceptor where any traces of oil may be skimmed from the surface.
- 4.3.4 Sludge **shall** be removed from the tank through a closed pumping system. The remaining contents of the tank **shall** be drained through the main drain lines.
- 4.4 Adequate provision for draining surface water **shall** be made from each installation within the depot area. A concreted drainage channel with a series of sluice gates should be constructed around the tank farm.
- 4.5 All liquid effluents **shall** be treated by appropriate oil/water separation techniques (**See Part IV, Section D.3.0 and Table IV-I**)
- 4.6 Treated effluents shall not be discharged into land except into a pit designed and constructed to the satisfaction of the **Director** of Petroleum Resources. Such effluents may also be discharged into water bodies, if they meet the effluents limitations as specified in Table VII-1.
- 4.7 The final disposal of waste **shall** be such that it does not constitute a pollution threat to inland waters, rivers and ground water **to the satisfaction of the Director of Petroleum Resources. (See Part III, Section 3.6.2)**
- 4.8 Corrosion Control - Storage Tanks
- (i) Bulk storage tanks are to be constructed from non- combustible materials (e.g. mild steel) and must be properly fabricated.
 - (ii) Storage tanks **shall** be properly coated in addition to cathodic protection.
 - (iii) Periodic checks for water/sludge in storage tanks **shall** be made.
 - (iv) Bulk storage tanks **shall** be monitored for leaks and records kept.
 - (v) Leak detectors **shall** be installed around substructures on which the tanks are placed.
- 4.9 Control of gaseous emissions (especially hydrocarbons) are as described in **PART VA, Section 4.2.5.1.**
- 4.10 **Sanitary Wastes**
- Sanitary wastes from depot in nearshore and inland facilities shall be treated by biological Waste Water Treatment System.**

4.10.2 The limitations of the effluent discharges from such treated sanitary wastes, are as provided in PART II, Section E 3.5.6.1(h).

4.11 Control of Solid waste:- Domestic waste (rubbish) shall be disposed of by methods approved by the Director, Petroleum Resources.

4.12 MONITORING, EFFLUENT LIMITATIONS AND STANDARDS.

4.12.1 Control of Existing/New Point Sources.

- (i) Compliance limits based on the approved technologies and as provided in TABLE VII-1 **shall be met and;**
- (ii) Information **shall** be supplied to the Director of Petroleum Resources on: estimates of quantities, concentration and loading rate into the environment of the waste streams the condition or the state of the recipient medium, water, air or land.

4.12.2 Control of Points of Discharges

4.12.2.1 Wastes from petroleum product depots may comprise of oily, storm and sanitary waters, leaked products and sludges (organic, oily/product tank bottom), residues, rust, ash, general refuse, etc., **The waste shall not be directly or indirectly discharge into:**

- (i) Any inland waters (fresh or reservoir)
- (ii) Any swamp, coastal or offshore waters.
- (iii) Any floodplains and upland valleys.
- (iv) Any pit on land other than a temporary holding/ retention pit or a landfill so designed and utilised that there shall be no overflows, leakages and seepages into adjacent surface and groundwaters. Such secured pit shall satisfy all the conditions as stipulated in **Part VA Section 5.4.1.1**

4.12.2.2 The following conditions shall be the grounds on which an exemption to dispose of or discharge waste materials may be granted; that scientific investigation support beyond all reasonable doubts the fact that the quality and quantity of the discharge shall not;

- i) cause hazards to human health
- ii) harm living organism (fauna and flora)
- iii) impair the quality to use adjacent land and water.

4.12.2.3 Gaseous contaminants from depots comprising of hydrocarbons, particulate matter/dust, carbon monoxide, nitrogen and sulphur oxides, **are not to be directly** or indirectly **emitted** into the atmosphere.

4.12.2.3.1 The following conditions shall be grounds on which an exemption to discharge may be granted:

- i) that the quality of the discharge/rate of the discharge or the total quantity to be discharged, or a meaningful combination of these, render the discharge acceptable;
- ii) that the net benefit, from consideration of ecological, social and economic factors, of allowing the exemption to discharge outweighs that of refusing it.

4.12.2.4 An operator whose depot operations have been observed to cause significant and adverse environmental effects (including, product and hazardous material spillages), shall be required, to prepare an Environmental Evaluation (Post-impact) Report – (See PART VIII-A)

4.12.2.5 Construction of product depot with a combined minimum capacity of 50,000 Barrels or more shall require Environmental Impact Assessment (EIA) Report, which must be approved by the Director of Petroleum Resources.

4.13 Compliance Limitations

4.13.1 The following effluent limitations (TABLE VII-1) are hereby set for the separated treated effluent discharge water from depots.

TABLE VII-I: EFFLUENT LIMITATIONS FOR DEPOTS

□EFFLUENT CHARACTERISTICS□	COMPLIANCE LIMITS: MAXIMUM FOR ANY DAY
Temperature, °C	30
PH	6.5-8.5
THC, mg/l	10
Total Suspended Solids (TSS), mg/l	30
Total Dissolved Solids (TDS), mg/l	<2000
Sulphide (as H ₂ S), mg/l	0.2
Turbidity	10
Chromium (Cr ⁺⁶), mg/l	0.03
Lead	0.05
Hg	0.1

4.13.2 On a random basis, samples collected to satisfy the effluent limitations in TABLE VII-1 shall be accompanied by certificate of sampling duly issued by competent officer of the Department of Petroleum Resources.

4.13.3 All storm water and surface drainages that are not channelled to the oil/water separator shall comply with the following specifications:

- i) The pH shall not exceed 6.5 to 8.5.
- ii) There shall be no visible oil sheen.
- iii) The conductivity of the storm water if drained into freshwaters shall not exceed 900mhos/cm.
- iv) The turbidity of the discharge shall not be more by 10% of that of the receiving medium of water.
- v) The odour of the discharge shall not be objectionable.
- vi) The salinity (as chloride) shall in any case not be **ten (10) percent less** nor **ten (10) percent** greater than the normal levels in running recipient waters.

4.13.4 If the recipient water for the treated oily water and/or storm water drainage is freshwater used for human consumption, then samples of such discharges must be taken and analysed

in accordance with approved/ recommended methods. The results shall not exceed the WHO Standards on Limits for Substances and Characteristics Affecting the Acceptability of Water for Domestic Use (WHO Standards) (See APPENDIX V-1)

4.13.5 It is mandatory that once in every month, the depots discharged effluent water shall be sampled and chemically analysed for the following parameters in accordance with the methods recommended by the Director of Petroleum Resources (See PART VIII-D). The results of the monitoring programme shall be sent to the Director, on a monthly basis.

- i) pH
- ii) Temperature
- iii) Electrical Conductivity
- iv) Total Dissolved/Suspended Solids
- v) Chloride as Cl^-
- ii) THC,
- iii) TPH
- iv) BTEX
- v) PAH
- x) COD
- xi) BOD_5
- xii) Sulphide as H_2S
- xiii) Ammonia as NH_4^+
- xiv) Total Phosphorus as PO_4^-
- xv) Nitrate as NO_3^-
- xvi) Heavy Metals - Ni^+ , Cr^{+6} , Pb, Cu, Zn, V, Ti, Cd, Fe^{+3} , Hg.

4.13.6 All solid wastes disposal from the depot operations shall conform with **Part VA, Section 5.6.9**

4.13.7 Air emissions requirements shall conform with **Part VA, Sections 5.6.2.4 - 5.6.2.5**

4.14 ENVIRONMENTAL AUDIT/REVIEW

4.14.1 The essential elements, types, competence of auditors, frequency of reports and review provisions, are as provided in **PART VIII, section E. 6.0.**

4.15 SPILL PREVENTION AND COUNTER MEASURES PLAN

4.15.1 Depot operations shall have crude oil/products spill prevention and counter measures plans, approved by the Director of Petroleum Resources (See PART VIII - B).

4.15.1.1 The provisions for the reporting and clean-up certifications are as provided in **PART III, Section E, 7.1.1 and 7.1.2.**

B. RETAIL OUTLETS

1.0 BACKGROUND

1.1 Retail outlets are the major facilities for dispensing petroleum products to the consumers for fuelling internal combustion engines. These outlets can be seen along every highway, major roads and streets throughout towns and villages of the country, and at jetties and public water sides. A retail outlet may have a mechanic workshop. The petroleum products

are usually dispensed from underground storage tanks (USTs) through pumps and dispensers. These USTs and mechanic workshops are major sources of pollution which need to be contained and controlled.

- 1.2 Accident prevention and abatement of potential hazards (Health and Safety) at the retail outlets are provided for in the Mineral Oils (Safety) Regulations **1997**, Petroleum Regulations 1967, and the Petroleum Refining Regulations 1974.

2.0 DESCRIPTION OF OPERATIONS AND SOURCES OF WASTES

- 2.1 Activities at the retail outlets include tank vehicle discharge of petroleum products, retailing of the products through pumps and dispensers, automobile service, car wash and super markets.

- 3.0 The sources of pollution that have been identified with retail outlets include:

- i) Spills arising from the sales of petroleum products as a result of overfilling of fuel tanks of automobiles and boats;
- ii) Used engine oil (automobile drain oil or waste oil) generated from automobile services;
- iii) Leaks from underground storage tanks due to corrosion, accident to the **vehicle** tanker during **product discharge**, oil **spillage** and usage of inferior construction material;
- iv) Sanitary wastes;
- v) Drainages from car wash and storm water.
- vi) **Refuse**

4.0 ENVIRONMENTAL MANAGEMENT.

- 4.1 **Licencees/operators of retail outlets shall institute planned and integrated environmental management practices, aimed at ensuring that unforeseen, identified and unidentified environmental issues are contained and brought to an acceptable minimum.**

- 4.1.1 **Specific roles, responsibilities and authorities shall be well defined, documented and communicated in order to facilitate effective environmental management.**

4.1.1.1 **Environmental Management System Manuals**

- 4.1.1.1.1 **The provisions as stipulated in PART III, E. 2.1. – 2.1.11 and PART VIII –H shall apply.**

4.2 POLLUTION CONTROL MEASURES

4.2.1 Tank Burial

- i) The excavation should be such that the tank should not be less than seventy centimetres below ground level when it is set to its final position.
- ii) Where the soil is of good quality, that is to say, non-corrosive, the tank can be set in a simple excavation and subsequently, backfilled with soil.
- iii) Where the soil may be corrosive, the tank may be similarly set on a clean shingle or sweet sand, free of extraneous matter **on a concrete floor/slab.**

- iv) Where the water table is high or there is risk of flooding, the tank should rest upon and be strapped to a concrete raft, or a combined concrete raft and cradle, which in either case must be of sufficient weight to overcome tank buoyancy and backfilled as above.
- v) At locations where any leakage from the tank may find its way into local drains, wells, or other water supplies, water ways or public sewers, the tank should be set in a chamber of waterproof concrete or chamber in the form of a concrete raft with brick or concrete walls, twenty three centimetres thick, rendered in the inner surface with neat cement (fine aggregate)
- vi) The capacity of any individual tank shall not exceed forty five thousand litres.
- vii) All fixed pipes must be of metal and be in positions where they will not be liable to damage.
- viii) The whole station **forecourt** should be concreted.
- ix) Storage tanks should not be installed in cellars or basements. Tanks not installed below ground should be suitably bunded.
- x) All pipes should be tested for leakage immediately after installation and after having carried out some maintenance work.
- x) The filling and dipping pipes should be combined except where an offset fill pipe is necessary. The pipes should be carried down within the tank to a sufficient depth in order to ensure the formation of a liquid seal
- xi) **Monitoring borehole should be installed at suitable location for early warning/detection of USTs leakages.**

4.2.1.1 Corrosion Control

- (i) All USTs shall be tested for leakage with **five pounds per square inch (p. s. i.)** air pressures applied for two hours or such longer period as the appropriate authority may specify. The pressure will be applied after the tank has been placed in position and prior to the back filling and thereafter a further similar test shall be undertaken and witnessed by a competent person when the several pipelines and fittings have been assembled ready for operation during which period there shall be no loss of pressure.
- (ii) Thereafter USTs should be pressure tested **and leak detected** after every five years until the tank is twenty' years old, and thereafter the tank should be pressure tested/**leak detected** after every two years **and report submitted to DPR.**
- (i) **All the activities listed in (i) and (ii) above shall be carried out by an independent consultant duly registered with DPR to carryout leak detection/pressure testing activities.**
- (iv) It is mandatory for owners of USTs to monitor their receptacles for leaks by instituting proper inventory control and pressure testing. All cases of leaks should be reported to the Director of Petroleum Resources, thereafter the affected tank should be repaired or replaced.
- (v) USTs installed in chloride or aggressive environments should be given primer coat of red-lead and a top coat of bitumen in addition to an appropriate cathodic protection.
- (vi) After the discharge of petroleum product into USTs the manhole cover should be replaced in order to prevent the entry of water or oxygen which will otherwise

promote corrosion. Gas ingress (e.g. H₂S, O₂, SO₂, etc.) into USTs should be prevented.

- (vii) The presence of sludge and/or electrolyte in USTs containing petroleum products should be promptly detected and evacuated before a new charge is put into the tank.
- (viii) Periodic checks for water/sludge in tanks, using water-finding-pastes, are mandatory and records kept by tank owners.
- (ix) All rust and scale shall be removed from the exterior of the tank and the tank shall then be painted on the outside with one coat of red-lead of a standard type and specification and with two coats of bituminous paint.

4.2.2 Fence

All retail outlets must be fenced with **masonry** wall made from concrete or embankment with a height not less than one and a half metres, in order to prevent access to unauthorized persons **and serve as fire breakers**.

4.2.3 Jetties.

- 4.2.3.1** Operators of jetties where sales of product are made should control the methods of sales to minimize spills by overfilling of tanks, and should where necessary install floating absorbent booms and other devices to control spill of products on water surfaces.

4.3 EFFLUENT LIMITATIONS, STANDARDS AND MONITORING

4.3.1 Control of Existing/New Sources

- 4.3.1.1** All existing discharge point sources of oily waste water, solid wastes and spent lubricants must be registered with the Director of Petroleum Resources and a permit for discharge issued.

- 4.3.1.2** Good drainage system shall be provided in the forecourt. The effluents should not be discharged directly to the highway or public sewers. These effluents shall pass through an efficiently operated oil/water separator (interceptor).

- 4.3.1.3** All such treated oily discharges and storm water drainages shall comply with the following specifications:

- (i) The pH shall not exceed 6.5 to 8.5.
- (ii) There shall be no visible oil sheen.
- (iii) The odour of the discharge shall not be objectionable.

- 4.3.1.4** If the recipient water for the treated oily water and/or storm water drainages is freshwater used for human consumption, then samples of such discharges must be taken and analysed in accordance with approved/recommended methods. The results shall not exceed the Standards on Limits for Substances and Characteristics Affecting the Acceptability of Water for Domestic Use as published by the World Health Organisation (See App.V-1)

- 4.3.1.5** Spent lubricants shall be differentially segregated from other oily effluents and channelled into a source recovery system where feasible or into a receptacle approved by

the Director of Petroleum Resources. The treatment and disposal methods for the spent lubricants shall be approved by the Director of Petroleum Resources. These treatment and disposal methods shall include but not limited to recycling, incineration, etc (**See Part VA, Section 5.6.9.2**)

4.3.1.6 Refuse containers shall be provided for the recovery of oily rags, empty oil cans, etc. and disposed in accordance with public health and sanitation procedures, satisfactory to the Director of Petroleum Resources.

4.4 Control of Leakages From USTs

4.4.1 If a leak from any UST occurs or is observed, the following conditions shall apply:

- i) The licensee shall inform the Director of Petroleum Resources within 24 hours;
- ii) The licensee shall immediately activate an Initial Remedial Action (IRA) plan, such as free product removal, when applicable, to prevent contamination migration. Such initial remedial action shall be approved by the Director of Petroleum Resources (Also see PART VIII-B).
- iii) The licensee shall assess, on site specific basis, the contamination by identifying the source, plume location and migration, and the possible receptor, within one (1) month of the occurrence. The scope of the assessment shall include the following:
 - (a) Background information - site location, history, operations and inventory of nearby portable wells.
 - (b) Site assessment - hydrogeological characteristics such as site lithology, aquifers and confining units, hydraulic conductivity, groundwater flow direction and rate for all affected bearing zones.
 - (c) Soil, groundwater and surface water quality- the concentration and chemical composition of the contamination in each medium.
- iv) The licensee shall be required to submit a report on the assessment as outlined in Article 4.4.1 (iii) and a Product Contamination Assessment Data Sheet (Table VII-2), to the Director of Petroleum Resources.
- v) The licensee shall then institute recovery, treatment and disposal actions, approved by the Director of Petroleum Resources.
- vi) The licensee shall be required to institute monitoring and rehabilitation programmes, approved by the Director of Petroleum Resources.

4.4.2 The Director of Petroleum Resources, has the option to take necessary and appropriate action to safeguard human health and welfare when such UST leakages occur and/or when the responses by the licensee are inadequate. In both cases, all expenses reasonably so incurred shall be recovered from the licensee.

4.4.3 When the source of a reported/observed contamination is not known (mystery) the Director of Petroleum Resources shall mobilize available resources to satisfy all the conditions as provided in these guidelines and standards and other legislations through funds established by the government.

4.5 ENVIRONMENTAL AUDIT/REVIEW

4.5.1 The essential elements, types, competence of auditors, frequency of reports and review provisions, are as provided in PART VIII-I, section E. 6.0.

4.6 **SPILL PREVENTION AND COUNTER MEASURES PLAN.**

4.6.1 All retail outlets shall have petroleum products/chemicals spill prevention and counter measures plan as approved by the Director, Petroleum Resources.

4.6.1.1 The provisions for the reporting and Clean-up certification are as provided in PART III, Section E, 7.1.1 - 7.1.2. (Also see TABLE VII -2)

5.0 **SANCTIONS**

5.1 The provisions are as in PART IX.

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TABLE VII - 2 CRUDE OIL/PRODUCT CONTAMINATIONS (ASSESSMENT DATA SHEET)

(1) Company:
 Source of Spill: - Date of Spill: Spill serial No:

(2) Type of Products:

Gasoline Group	Liters lost	Kerosine	others
- leaded - unleaded regular - unleaded premium - Others		- Kerosine - diesel - JP-4 jet fuel - jet A fuel - Others	

(3) Description of IRA (if any) Free product thickness: (litres)
 Soil removal: (cubic m)
 Soil incineration: (cubic m)

(4) Free product still present? (Yes/No) Maximum apparent thickness of plume: (m)

(5) Maximum groundwater Naphtalenes: Toluene Xylene Ethylobenezene

(6) Contaminant levels (Total VOA): Benzene EDE

(7) Lead: MTBE: DCE:

(8) Arsenic: Chromium: Cadmium:

(9) Brief lithological description:

(10) Areal and vertical extent of soils contamination defined? (Yes/No)

(11) Highest current soil concentration (ppm)

(12) Lower aquifer contaminated? (YES/NO) Depth of vertical contamination:

(13) Date of last complete round of groundwater List approved? (Yes/No):
 Date of last soil sampling: Date/Licence or Permit No,:

(14) Direction (e.g. NNW) of surficial groundwater flow:

(15) Average depth of groundwater: (m)

Observed range of seasonal groundwater fluctuations: (m)

Estimated rate of groundwater fluctuations: (m)

Hydraulic gradient across site: (cm/m)

(16) Aquifer characteristics: Values Unit Method
 Hydraulic conductivity
 Storage coefficient
 Aquifer thickness
 Effective soil porosity
 Transmisivity

(17) Possible receptors:

(18) Other remarks:

Explanatory Note:

VOA = Volatile Organic Aromatic
 EDE = 1,2-Dibronimoethane
 MTBE = Methyl Tert-Buthyl Ether

DCE = 1,2-Dichloroethane
IRA = Initial Remedial Action

PART VIII. STANDARDIZATION OF ENVIRONMENTAL ABATEMENT PROCEDURES

A. ENVIRONMENTAL IMPACT ASSESSMENT PROCESS.

BACKGROUND

- 1.1 The continued development of the oil industry in Nigeria, has revealed a need to plan, protect and enhance prudently the environmental resources in the areas of its operation for a better and healthier environment for man.
- 1.2 Studies in the country have indicated that subtle changes, occurring in our aquatic and terrestrial ecosystem correlate with petroleum activities and that cultural and historical resource are also affected. These need to be protected and preserved. It is therefore necessary to have a government programme that attempts to **protect**, restore and/or clean up the environment to an acceptable level. Government must also **properly plan for and monitor** new installations or projects **to prevent degradation of** the environment.
- 1.3 Two tools are to be used, namely, an Environmental Evaluation (post-impact) Report (EER) and an Environmental Impact Assessment Report (EIA).
 - 1.3.1 The Environmental Evaluation Report evaluates the already 'polluted' or 'Impacted' environment to enable the government know how 'good' or 'bad' (i.e. state of the environment) the recipient environment is, so as to decide and design strategies for protection and restoration.
 - 1.3.2 An Environmental Impact Assessment Report assesses all actions that will result in a physical, chemical, biological, cultural, social etc. modification of the environment as a result of the new project/development. The Environmental Impact Assessment Report should serve as a means of assessing the Environmental impacts of a proposed action plan, rather than as a justification for decisions already made. It should be prepared using a systematic, interdisciplinary approach and should incorporate all relevant analytical disciplines to provide meaningful and factual data, information and analyses. The presentation of data should be clear and concise, yet include all facts necessary to permit independent evaluation and appraisal of the beneficial and adverse environmental effects of alternative actions. The amount of details provided should be commensurate with the extent and expected impact of the action and the amount of information required at the particular level of decision making.
 - 1.3.2.1 An EIA shall be drafted in a manner and a style, which will assist the decision-maker to comprehend and evaluate the whole range of environmental impacts of a proposed action plan.
- 1.4 Applicable Regulations
 - 1.4.1 Oil and Gas operations are governed by the Petroleum Act 1969 and subsequent regulations made pursuant to section 8 (1) b (iii) of the Act which empowers the Minister of Petroleum Resources to make regulations for the prevention of pollution of water courses and the atmosphere.
 - 1.4.2 Licence holders for exploration, prospecting, exploitation, refining, transportation, marketing, etc. are required by legislation to take/adapt. Practical Precautions to prevent pollution or cause as little damage as possible to the surface of relevant area of operation, avoid interference with works of public utility, etc. Above all, the power of supervision over all oil industry operations is vested on the Director of Petroleum

Resources: (Regulations 25 and 36 of the Petroleum (Drilling and Production) Regulations 1969; Regulation 43 (3) of the Petroleum Refining Regulations 1974; Regulation 17(3) of the Oil Pipeline Ordinance Cap 145 of 1956 as Amended by Oil Pipeline's Act 1965).

1.4.3 Implementation Machinery

- (i) In the industry, the main tools for the enforcement of these regulatory requirements have hitherto been:
 - (a) Compliance Monitoring
 - (b) Revocation of Licences and Leases
 - (c) Sanctions (fines)
 - (d) Compensation
 - (e) Issuance of some interim guidelines on waste discharges.
- (ii) The preparation of Environmental Evaluation and Environmental Impact Assessment Reports are hereby made mandatory and shall be adopted as additional enforcement tools.

1.5 It should be noted that the issuance of this guideline in no way absolves the operator or licensee **from complying** with other legislations both operating and new.

1.6 The types of projects or activities requiring Environmental Impact Assessment (EIA) Reports are as follows:

- i) **All Seismic Operations.**
- ii) **Oil and Gas field developments onshore, nearshore, offshore and deep offshore.**
 - (a) **Development well drilling.**
 - (b) **Construction of crude oil production, tankfarm and terminal facilities including FPSOs.**
- iii) **Laying of crude oil and gas delivery line, flowline and pipeline in cumulative excess of 20Km length and/or as determined by the Director of Petroleum Resources.**
- iv) Hydrocarbon Processing Facilities:
 - a) Oil refineries and petrochemicals
 - b) Liquefied Natural Gas/Natural Gas Liquids /GC & P Plants.
 - c) Liquefied Petroleum Gas (above 20,000 litres)
 - d) Blending plants.
 - e) **Product Filling Stations (combined capacity above 20,000 litres)**
- v) Construction of product depot with combined capacity of **50,000 bbls or more.**
- vi) **Construction of waste treatment and/or disposal facilities, Viz:**
 - a. **Waste Water Treatment Plant.**
 - b. **Incineration process above 300Kg/hr.**
 - c. **Engineered sanitary landfilling.**
 - d. **Landfarming/composting/ex-situ bioremediation in excess of 1.25Km² of land take.**
- vii) **Dredging Activities of about 500m² .**

2.0 ENVIRONMENTAL EVALUATION REPORT PROCESS

2.1 The following systematic process shall be followed in preparing an EER.

- (i) An operator or licensee whose activity has been observed to cause significant and adverse environmental effects and impact (see Article 4.0) shall be required to prepare an EER. Spillages of oil or hazardous materials/wastes are under this category.
- (ii) An interdisciplinary panel of experts from the Department of Petroleum Resources and the operator or licensee shall draw up the scope of work for the preparation of the EER.
- (iii) The operator or licensee prepares/produces and submits the EER to the panel.
- (iv) The panel reviews the EER and submits its recommendations to the Director of Petroleum Resources.
- (v) The Director of Petroleum Resources based on the panel's reports, determines appropriate mitigating and ameliorating measures and instructs the operator/licensee to institute same.

2.2 The EER shall contain the following facts:

- (i) Description of the existing action namely; installation/project, operations, oil/hazardous materials/waste spillage, waste generation, characteristics of wastes, existing pollution control technology, disposal methods, etc.
- (ii) Qualitative and quantitative descriptions of the already impacted environment.
- (iii) Levels of significance for losses of environmental resources affected by the already existing installations/projects or action. These environmental resources are the elements, features, conditions and areas valued by man that can be characterised as physiographic, biological (**including bioaccumulation and chronic toxicity testing**) cultural, aesthetic, etc.
- (iv) Modification/mitigating/ameliorating plans to processes or systems to either eliminate or decrease adverse environmental impacts to the greatest extent possible.
- (v) **Environmental Management Plan (post-EER)**

2.3 The reporting format and elements of most of the descriptions/investigations shall as much as possible where related, be in accordance with the details as presented in Article 5.0.

3.0 ENVIRONMENT IMPACT ASSESSMENT REPORT PROCESS

3.1 A systematic process described below shall be followed in preparing an EIA:

3.1.1 The project or activity is **conceptualised** by an operator or licensee.

3.1.1.1 **An initial assessment/environmental screening and scoping of significant issues are carried out on the concepts, by the initiator and the DPR. An Environmental Screening Report (ESR) of all optional concepts being evaluated is produced and reviewed with the DPR.**

3.1.2 **A preliminary assessment of impacts, focused on the selected project option is carried out. The preliminary Assessment of Impacts, shall involve detailed screening (Article 6.0) by the project initiator, Department of Petroleum Resources and other stakeholders for potential significant and adverse environmental effects. The Preliminary Environmental Impact Assessment Report (PAIR) shall be approved by the DPR before an approval of the project conceptual plan is granted to the initiator.**

- 3.1.2.1 If no potentially significant impacts, following the review of the PAIR, the project/activity may proceed with appropriate mitigation measures and post EIA monitoring.
- 3.1.2.2 If the PAIR identifies potentially significant impacts;
- a The DPR and project initiator shall draw up the scope of work for the detailed EIA study;
 - b A Draft EIA is produced by the initiator and submitted to the DPR for review;
 - i. Mitigation Measures (including design mitigation) are analysed and considered;
 - ii. The Draft EIA shall form the basis of approval for the detailed Engineering design of the project.
 - c Final EIA is produced by the initiator and submitted to the Director of Petroleum Resources at the end of detailed engineering design.
 - i. Project implementation/construction approval is given by the DPR;
 - ii. The implementation of mitigation measures (constructional and operational) and environmental strategies are firmed up.
 - iii. Post – EIA monitoring and post – auditing programmes are approved and implemented.

3.1.3 EIA/PROJECT INTERFACE

The following sequence for the EIA process shall be adopted for a major development project.

(a) Environmental Screening Report (ESR)

This shall be carried out during concept selection studies. Every alternative project concept shall be environmentally screened and the outcome of the screening shall influence the decision on the choice of a concept.

(b) Preliminary Environmental Impact Assessment

This shall be prepared at the end of concept selection studies. It shall focus on the selected project option and shall be prepared and approved before an approval of conceptual plan could be granted by the DPR.

(c) Draft Environmental Impact Assessment

This shall be prepared and submitted to DPR at the end of project conceptual design and shall form the basis for approval of the detailed Engineering design by DPR.

(d) Final Environmental Impact Assessment

A final EIA shall be prepared and approval obtained at the end of detailed engineering design but prior to the commencement of any construction activities.

3.2 The initiator shall also satisfy any other conditions required by other government authorising body.

3.3 Eligibility for the Preparation of Environmental Impact Assessment Report.

3.3.1 Environmental Impact Assessment reports for the oil and gas industry shall be prepared only by persons or parties who possess the Certificate of Eligibility issued by the Department of Petroleum Resources.

3.3.2 EIA **consultants and** reviewers shall be competent and shall have attended prescribed courses in principles and practice of EIA process and Environmental Management, relating to the determination of the feasibility of projects.

4.0 SIGNIFICANT EFFECTS/IMPACTS

4.1 The Significant effects/impacts shall be determined by the following factors:

4.1.1 Actions or operations of the project that may have both beneficial and/or detrimental effects, even if, the net effect is beneficial.

4.1.2 The short and long term, primary and secondary effects of the project as a result of:

- (i) Changes in land use patterns
- (ii) Changes in energy supply and demand
- (iii) Increased developments in flood plains
- (iv) Significant changes in ambient air and water quality or noise levels.
- (v) Potential violations of air quality
- (vi) Water quality and noise standards
- (vii) Changes in surface or ground water quality or quantity.
- (viii) Encroachment on wetland, coastal zones or fish and wildlife habitat, wild and sceptic rivers.
- (ix) Changes promoting the distribution and abundance of economic pests and disease vectors.
- (x) Potential adverse effects on fish migration routes and nursery areas.
- (xi) Potential and significant socio-cultural consequence of an activity.**
- (xii) Damage to historic and anthropogenic sites.**

4.1.3 Minor actions which may set a precedent for future major actions with significant adverse impacts or a number of actions similar in execution and purpose with individually insignificant but cummulatively significant adverse impacts.

4.1.4 Action or operation of the project that would cause irreparable loss or destruction of scientific, ecological data, and endangered wildlife species.

5.0 CONTENT OF AN ENVIRONMENTAL IMPACT ASSESSMENT REPORT

5.1 Summary Sheet

5.1.1 The summary **shall** briefly describe the project, the probable significant environmental impacts, the ameliorating and mitigating measures **and the environmental management plan (Post – EIA monitoring)** to be implemented by initiator, and the significance of the residual environmental impacts following amelioration or mitigation.

5.1.2 It **shall** be written in such a manner that it can be comprehended easily.

5.2 The Project Setting

- 5.2.1 Declaration: The initiator of the action must be identified and **accept** full responsibility for all statements and judgements taken or accepted by the initiator.
- 5.2.2 The Need and Description of Proposed Action:
- (i) Evidence for demanding proposed development vis-à-vis the timing of the project should be outlined in details.
 - (ii) The relationship of the proposed action (which shall be discussed in detail) to other projects and proposals directly affected by or stemming from it shall be discussed.
 - (iii) **Cost – benefit analysis, shall be carried out.**
- 5.2.3 General Layout
- (i) Legal site description outlining the proposed development or activity in relation to geographic and environmental factors is to be prepared. Maps, photos and artists sketches shall be included.
 - (ii) The plan shall include discussions on leases/permits, road, airstrips, buildings, ports or marine terminals in the proposed area.
 - (iii) The plan should include proposed project features e.g. pipelines, well sites, plant sites, water sources, waste and sewage disposal sites, sumps, dykes and roads, etc.
 - (iv) Schematic diagrams for all facilities or activity to be installed.
- 5.2.4 Construction Detail: The following items should be described in concise terms:
- (i) The method(s) and timing of construction for each part or phase of the proposal.
 - (ii) Interruption to natural physical processes such as river flows in terms of timing and other pertinent variables.
 - (iii) Any effluents and emissions in terms of quantity and characteristics, and noise or aesthetic factors caused or attributable to construction.
 - (iv) Site preparation:
 - (a) Pile driving
 - (b) Materials transport
 - (c) Land clearing
 - (d) Land fill
 - (e) Surfacing and paring
 - (f) Drainage/escavation
 - (g) Dredging if applicable
 - (h) Spoils deposition
 - (i) Channels and river blocking
- 5.2.5 Operation and Maintenance: The following items should be described:
- (i) Timing and commissioning details of proposal;
 - (ii) Expected releases, discharges or stock pile of waste used or generated during all phases of the proposal with the identification of potential air, land or water contaminants;
 - (iii) The quantity and quality of atmospheric, liquid and solid products of the activity, their storage, disposal and ultimate fates;
 - (v) The nature, transportation, storage, use, treatment and final disposition of hazardous materials;
 - (vi) Spill prevention and counter measures Plan for identifiable substances - Oil/product/hazardous chemicals, etc. (see PART VIII-B);
 - (vii) Methods of fire prevention, detection, suppression and abandonment.

5.2.6 Abandonment Plan

5.2.6.1 Plan for abandonment shall include the following:

- (i) what Personnel, equipment and facilities, both onshore and offshore that will be removed when the project is abandoned temporarily (such as for emergencies) or permanently. How and when they will be removed the area will be reclaimed, stabilized or otherwise secured.
- (ii) Details of the release, loss, storage or ultimate disposal of any gaseous, liquid, or solid contaminant stored or otherwise contained in the areas.
- (iii) A discussion of the possibility of an early total abandonment of all production activities in addition to a phased and more orderly abandonment over the lifetime of the reserves.

5.3 Alternatives. The initiator shall develop, describe and objectively weigh feasible alternatives to any proposed action including the options of taking no action or postponing action. The description should show sufficient detail to allow for comparative evaluation of costs, benefits and environmental risks of the alternatives.

5.4 Baseline Description of the Existing Environment and Resources Used:

This section should describe the environment, as it exists prior to project development with emphasis on the environmental components that are of particular significance to the proposal. Consideration should not only be given to the immediate environment, but adjacent systems that may also be impacted.

5.4.1 Land: The following should be considered and discussed:

- (i) Climate/meteorological factors
- (ii) Terrain
- (iii) Geological and **hydrogeological character**
- (iv) Relief and topographic character
- (v) Land capability in terms of agriculture, forestry, wildlife, fisheries (land use) should be shown on a composite map.

5.4.2 Water: The following should be. considered and discussed.

- (i) Quantity/quality of surface water in the seasonal context.
- (ii) Hydrology of low-lands relative to overland flow characteristics.
- (iii) Seasonal stream characteristics relative to stream flow, channel dimensions, slope, bank and bed characteristics.
- (iv) Watershed characteristics such as subsurface drainage patterns, water table, seepage conditions
- (v) Oceanographic parameters/factors and their seasonal variability that can characterise pollution impact.

5.4.3 Flora and Fauna. The following should be considered and discussed.

- (i) The types and distribution of economically **important** organisms in all biological communities with special emphasis on the larval/forms of species important to commercial and/or juvenile or artisanal fisheries, and any social habitat and life history requirements of the species.

- (ii) The qualitative composition of various biological assemblages to seasonal and geographical influences, micro-organisms, phytoplankton, macrophytes, zooplankton, benthos, fish, mammals, birds.
- (iii) The biological descriptions through the preparation of maps depicting the distribution of ecological zones, areas of high environmental sensitivity, and /or areas of high economic concern (high productivity/nursery areas).
- (iv) The potential environmental contaminants in the physical, chemical and biological components of the environment and the capacity of ecological systems to assimilate possible pollutants resulting from the proposed development or activity.

5.4.4 Socio-Economics Aspect: The following should be considered and discussed.

- (i) Life patterns (employment opportunities, housing and social interactions)
- (ii) Mood/atmosphere (Awe-inspiration, isolation/solitude, mystery, ‘Oneness’ with nature)
- (iii) Cultures (cultural setting of the project area)
- (iv) Existing historical /scientific packages, (architecture and styles, events ecological/native land/villages/fishing camps/hunting reserves, areas of archaeological or paleontological significance, areas of religious significance.)
- (v) Areas of ecological interest (endangered species, unique ecosystems).

5.4.5 Water Use: The following should be considered and discussed.

- (i) Domestic uses (drinking, bathing, cassava-soaking etc.)
- (ii) Industrial (intake and discharge)
- (iii) Recreational
- (iv) Transportation
- (v) Agricultural (Irrigation)
- (viii) Fisheries

5.4.6 Air quality assessment

- i. **Climatology**
- ii. **Meteorology**
- iii. **Gaseous emissions and sources**

5.4.7 Waste Management

- i) **All the Industrial and non-industrial wastes and their sources shall be documented.**

5.4.8 Noise Assessment.

5.5 Hazard and Risk Assessment

- (i) **Hazard identification**
- (ii) **Quantitative hazard assessment**
- (iii) **Risk assessment**

5.5.1 All the existing and potential hazards associated with the construction, operation, maintenance and abandonment shall be assessed and mitigated (risk reduction plan provided)

5.6 Environmental Impacts

5.6.1 The positive and negative effects of the proposed action as it affects the immediate and ancillary areas should be assessed. The attention given to different environmental factors will vary according to the nature, scale and location of proposed action.

5.6.2 The EIA should be able to distinguish :

- (i) Primary impacts - those that can be attributable directly to the proposed action.
- (ii) Secondary impacts: indirect or induced changes.
- (iii) Short term, **cumulative** and long term impacts - which should describe the extent to which the proposed action involves tradeoffs between short term environmental gains at the expense of long term gains or vice-versa and the extent to which the proposed action forecloses future options. Special attention shall be given to impacts which narrow the range of future uses of land and water resources or pose long term risks to health and safety; enhance, disrupt, impair or destroy existing features, conditions or processes in the natural environment; cause enhancement of, or conflict with established, or historic land use and ways of life, or affect livelihood.

5.7 Mitigating and Ameliorating Measures

5.7.1 All environmental **and socio-economic** impacts that have been identified and which can be eliminated or minimised to an acceptable level shall be complemented by options and measures available to avoid, minimise or mitigate such harmful effects and to enhance beneficial effects. **Each mitigating measure must be accompanied by an analysis of its associated costs and benefits**

5.7.2 Also the EIA should describe the kinds and magnitude of adverse impacts which cannot be avoided should the proposal be implemented and steps to minimise harm to the environment.

5.7.3 For the two categories, the methods should include but not limited to:

- (i) Location changes
- (ii) Design changes
- (iii) Changes in the scheduling of associated activities
- (iv) Rehabilitation of impaired features
- (v) Environmental education of construction and operational staff.
- (vi) Enhancement of beneficial impacts
- (ix) Spill prevention and counter measures plan (Contingency Plans)

5.8 Environmental Management Plan (EMP)

(a) All EIA and EER reports shall contain functional chapters on EMP, with appropriate schedules of implementation.

(b) The EMP shall:

- i) **Identify and discuss the management and/or implementation of commitments to stakeholders, as identified in the report;**
- ii) **Discuss how to implement the mitigating/amelioration measures, as identified in the report;**
- iii) **Design and implement an appropriate post-EIA monitoring and;**
- iv) **Identify the action party and provide time frame for implementation of issues identified.**

- v) Have a budget for implementation of mitigative measures and monitoring;
- vi) Put in place a systematic procedure of obtaining all necessary regulatory approvals for all the aspects of the project from start-up to de-commissioning.

5.8.1 Basic Requirements of Post Environmental Impact Assessment (EIA) Monitoring.

1.0 SCOPE.

Post Environmental Impact Assessment Monitoring shall be designed and implemented to:

- a) Document the actual impacts in relationship to the predicted impacts of the project/activity/action;
- b) Forewarn the DPR and/or the proponent of unanticipated adverse impacts or sudden changes in impact trends and provide immediate warning whenever an impact indicator approaches a critical level. In the interim, the critical levels can be defined in terms of:
 - i) Carrying Capacity
 - ii) Threshold Levels
 - iii) Regulation and Enforcement Standards
- c) Potentially control and manage the timing, location and level of impacts and;
- d) Provide the cause and effect data for the empirical verification or validation of various predictive models of action/impact relationships.

2.0 APPROACH.

The development, implementation and operation of a post EIA monitoring system shall as a minimum, include the following work elements:

- a) Predict impacts/Define major impacts.
(Impacts and activity causing the impact shall be identified for each environmental parameter);
- b) Define the objective(s) of the post EIA monitoring system (see scope 1.0);
- c) Determine, review and conduct the requirements, availability and feasibility evaluation of data needs;
- d) Implement post EIA monitoring system;
- e) Evaluate impacts;
- f) Document changes and;
- g) Control and reduce impacts.

3.0 ENFORCEMENT AND CONTROL

3.1 The Department of Petroleum Resources shall be involved by the proponent(s) in the development, implementation and operation of a post EIA monitoring programme/system.

3.2 Summary report of the post EIA monitoring programme shall be submitted to the Director of Petroleum Resources, twice a year during the site preparation and construction phases and on annual basis for a minimum of five (5) years after the project/activity/action completion phase.

5.9 Annexes: The following should be included as annexes:

- (i) List of references/methodologies cited/used.
- (ii) Copies of correspondences and reports developed from studies associated with the evaluation.
- (iii) Common names for organisms (English or vernacular).
- (iv) Site photos, especially for sites, which may be the subject of eventual impact or used for monitoring.

6.0 ENVIRONMENTAL SCREENING:

6.1 Criteria For Making Screening Decisions

6.1.1 The following general criteria, shall be used when making a decision as to the Environmental effect of an activity.

- (i) Magnitude: This is defined as the probable severity of each potential impact. **It is measured by the percentage of a population or resource that may be affected by an impact.**
- (ii) Prevalence: This is defined as the extent to which the impact may eventually extend as in the cumulative effects of a number of stream crossings. Each one taken separately might represent a localised impact of small importance and magnitude but a number of such crossings could result in a widespread effect.
- (iii) Duration: **this refers to the time that is estimated for a population or a resource to recover from the impact. Duration is identified as one of the following:**
 - ✓ **Short-term – this is defined as < 1 year**
 - ✓ **Moderate term – 1 to 10 years**
 - ✓ **Long-term - > 10 years**
- (iv) Frequency: **this refers to the number of times an activity is estimated to occur in the lifetime of the project. It is categorized as follows:**
 - ✓ **Once**
 - ✓ **Intermittent**
 - ✓ **Continuous**
- (v) Risks: This is defined as the probability of serious environmental effects. The accuracy of assessing risk is dependent upon the knowledge and understanding of the activities and the potential impact areas.
- (vi) Importance: This is defined as the value that is attached to a specific area in its present status.
- (vii) Mitigation : The factor to consider is whether there are available solutions to the problems.
- (viii) Degree of reversibility: **this refers to whether or not an adverse or negative impact is reversible or irreversible over a certain period of time (5 years).**
- (ix) Scope: **The scope refers to the geographical area potentially affected by the impact.**
- (x) Direction: **This refers to the type of impact and is defined as one of the following:**
 - **Positive**
 - **Negative**
 - **Neutral**

6.2 Screening Procedure:

6.2.1 Screening procedure will involve the use of a matrix **or other tools** which relates a list of project activities with areas of potential environmental impact.

6.2.2 The matrix should identify activities which are likely to occur during the principal phases of project development, viz

- (i) Site investigation and preparation
- (ii) Construction
- (iii) Operation and maintenance (of completed project)
- (iv) Future and related activities, which are considered subsequent to project development, if any.
- (v) Abandonment**

6.2.3 The matrix should also identify:

- (i) The general areas in which environmental effects, namely physical- chemical, **biological, anthropogenic**, aesthetic and social, can be expected and;
- (ii) The relationships between activities and impact areas.

7.0 GENERAL

7.1 Choosing a Methodology:

There is a wide variety of assessment tools methodologies that make the preparation of impact assessment reports less formidable and more meaningful, since there are no universally applicable procedures. In considering the appropriateness of tools, therefore, the following criteria for methodology evaluation are suggested. It is for the initiator to pick the most appropriate methodology for the assessment preparation.

7.1.1 Impact Identification:

7.1.1.1 An impact methodology must be comprehensively specific (sub-categories of impact types), identify project impacts as distinct from future environmental changes produced by other causes, identify the timing and the duration of impacts and should require identification of the sources of data used for the impact identification./prediction.

7.1.2 Impact Measurement:

7.1.2.1 The methodology should suggest specific measurable indicators to be used to quantify impacts parameters, and provide for the measurement of impact magnitude as distinct from impact significance, emphasize objective rather than subjective impact measurement.

7.1.3 Impact Interpretation:

7.1.3.1 The methodology should require explicit assessment/assumptions of the significance of measured impacts, the assessment of the risks, uncertainly or degree of confidence in impact projections made should provide a specific method for the comparison of alternatives and may provide a mechanism for aggregating impacts into a net total or composite estimate.

7.1.4 Impact Communication/**public forum**

7.1.4.1 The methodology should require the project setting to aid evaluation/assessment report users in developing adequate overall perspective, for high lighting key issues and impacts, linking impacts to the specific affected geographical or social groups and should suggest mechanism for public involvement in the interpretation of impact significance.

7.1.4.2 **Workshops and/or public forum by experts shall be conducted by the proponent to consider the EIA report prior to obtaining an approval or environmental permit at the discretion of the Director of Petroleum Resources.**

7.1.5 Others:

7.1.5.1 In addition to the above 'content' criteria, methodological tools should be evaluated in terms of:

(i) **Resource Requirement**

- (a) **Data Requirements:** Does the methodology require data that is presently available at low retrieval costs?
- (b) **Manpower Requirements:** What special skills are required?
- (c) **Time:** How much time is required to learn to use and/or actually apply the methodology?
- (d) **Costs:** How do costs of using a methodology compare to costs using other tools?
- (e) **Technologies:** Are any specific technologies (e.g. computerisation) required to use a methodology?

(ii) **Replicability**

- (a) **Ambiguity:** What is the relative degree of ambiguity in the methodology?
- (b) **Analyst Bias:** To what degree will different impact analysts using the methodology tend to produce widely different results?

(iii) **Flexibility**

- (a) **Scale flexibility:** How applicable is the methodology to projects of widely different scale?
- (b) **Range:** For how broad a range of project or impact types is the methodology useful in its present form?
- (c) **Adaptability:** How readily can the methodology be modified to fit project situations other than those for which it was designed?

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B. CONTINGENCY PLANNING FOR THE PREVENTION, CONTROL AND COMBATIN G OF OIL AND HAZARDOUS SUBSTANCES SPILLS.

1.0 BACKGROUND .

An Oil Spill Contingency Plan is an organised and predetermined course of actions to be pursued in the event of a spill. This orderly arrangement of events to contain and control oil spill incidents shall be compiled in a document by all operators in the petroleum industry for approval by the Director of Petroleum Resources, and subsequent implementation by the operators.

1.1 Oil and Gas operations are governed by the Petroleum Act 1969 and subsequent regulations made pursuant to Section 8 (i) b (iii) of the act which empowers the Minister of Petroleum Resources to make regulations for the prevention of pollution of water courses and the atmosphere .

1.1.1 Licence holders for exploration, prospecting, exploitation, **hydrocarbon processing**, transportating, marketing etc. of Petroleum Resources are required by legislation to take/adapt Practical Precautions and/or all steps Practicable to prevent pollution.

1.1.2 Some of these regulations include Regulations 25 and 36 of the Petroleum (Drilling and Production) Regulations 1969, Regulation 43 (3) of the Petroleum Refining Regulations 1974 and Regulation 17 (3) of the Oil Pipeline Ordinance Cap 145 1956 as Amended by Oil Pipeline's Act 1965; e.t.c.

1.1.3 There are also some International Conventions that were **ratified** by Nigeria. These include the International Convention for the Prevention of Pollution of the Sea by Oil 1954 as amended in 1962 which was implemented by the Oil in Navigable Waters Act 1968, and the Convention on the Continental Shelf and High Seas (Geneva 1958).

1.2 In 1980, the Department of Petroleum Resources issued guidelines for preparing first level Contingency Planning for the Petroleum Industry. The guidelines have been updated for first and higher levels of responses. Each licensee/leasee is required to prepare and/or update its plan accordingly.

2.0 CONTENT OF THE CONTINGENCY PLAN

The Contingency Plan should include statements on the following:

2.1 Policy.

The operator's (licencee/leasee) policy on environmental conservation, oil/product/hazardous substances/chemicals/muds, oil/pollution, prevention and management as stipulated by the above referred regulations should be clearly stated.

2.2 Purpose/Objective

2.2.1 Oil Spill Contingency Plan has basically three functions:

- (i) To ensure that the environment is protected,
- (ii) To ensure that manpower, equipment and funds are available to effectively contain and clean up oil spills and,

- (iii) To ensure that good record-keeping is maintained and accurate information concerning the Spill is disseminated to the public and government,

2.2.2 The operator is required to state the objectives of the oil spill contingency plan as it affects its operations.

2.3

Description of Facilities and Area of Operations

2.3.1 Each operator or facility owner shall describe the areas of operation. The operator is to identify beforehand, all sensitive areas that should be protected in the event of a spill.

2.3.1.1 It is mandatory to locate all Potential sources of spills from the facility(ies) and thereafter:

- (i) Estimate the size of each potential spill;
- (ii) Predict movement of spills and determine potential containment sites;
- (iii) Determine the response time necessary;
- (iv) Establish the probability of more than one spill occurring at the same time and the consequences of such occurrences;
- (v) Determine the equipment and materials required to contain and **clean-up** the potential spills(See Appendix VIII-B1).
- (vi) Make an inventory of available assets which would satisfy the equipment and personnel requirements to include the maximum necessary for the anticipated concurrent spills.
- (vii) Determine the deficiencies of equipment and personnel by comparing the requirements of the plan with the available assets, and correcting such deficiencies according to the said requirements, on a continual basis.
- (viii) Select the response vehicle which will provide the control/combat response that has been determined to be required.
- (ix) Locate environmentally sensitive areas requiring priority protection. This will involve the development of an Environmental Sensitivity Index (ESI) Map of the operational areas. The guidelines for the development of ESI Maps are as in Article 2.3.2.

2.3.1.2 **Finger Printing of crude oil shall be carried out on a field by field basis.**

2.3.2 The Environmental Sensitivity Index (ESI) Mapping.:

2.3.2.1 Objectives of an E. S. I: The objectives of the E.S.I. are as follows

- (i) Identification **and mapping** of the areas sensitive to oil pollution, (**relative to**) the operational areas; **Onshore operational areas are defined as an entire OML covering operations of an oil and gas company. Offshore operational areas shall be the outer coastline defined as having a greater than 10% chance of oiling in the event of an oil spill from the specific offshore OML block, based on the results of oil spill simulations. The operational areas to be mapped for offshore operations shall also include the coast belt region and all the river mouths up to 10km landward of the outer coastline.**
- (ii) Prioritisation of the sensitive areas **in the operational areas** to effect a quick oil spill response strategy;
- (iii) Description of the ecosystem and other facilities of special socio-economic importance in the identified sensitive areas;
- (iv) Integration of physical, ecological, operational and socio-economic concerns into a comprehensive spill response document.

2.3.2.2 Scope of E. S. I. : The scope of E.S.I. is as follows:

- (i) Preparation of detailed colour-coded maps of the operational areas on a scale of no less than 1:50,000 of all environment (in the operational area) with respect to the sensitivity of each environment to oil spill pollution. **Larger scale maps (1:25000) can be used to show more detail. ESI maps shall be produced in hardcopy and in digital format (in a geographic information system environment).**
- (ii) Appropriate classification and scheme.(where applicable) of shoreline, river course, on a scale of 1-10 with 10 being the most sensitive environment;
- (iii) Classification and sensitivity ranking of the utilization of the natural vegetation areas;
- (iv) Collection of physical, geophysical, geomorphic and chemical data for the classification of shoreline and river course **coastal and inland** environments and important natural land resources according to their relative sensitivity to oil spill damages using approved procedures.
- (v) Collection of hydro-geologic data during wet and dry seasons for the determination of vulnerability of the subsoil in relation to groundwater utilization;
- (vi) Location of sensitive biological and/or agricultural assemblages domestic water supplies and artisanal gears that might require special attention in the event of an oil spill. Special symbols or other graphic effects should be used to designate such assemblages;
- (vii) Location of areas, physical and/or infrastructural facilities of special socio-economic importance. Special symbols coded or sized should be used to designate each type such as boat docks, historic sites, villages, community sacred lands, marina, etc.;
- (viii) Detailed transportation routes for example, air (Helipads), roads, water, etc to the sensitive areas should be shown on the maps;
- (ix) A short text describing strategy for protecting the areas which had been prioritised as the most sensitive areas, should be given. For example, such description may include the location for the placement of booms, skimmers, or axis along which earth dams or trenches could be constructed, etc.;
- (x) The E.S.I. mapping is a dynamic feature of oil operations which should be improved upon as more information is obtained about the operational areas.

2.4 Organization and Responsibility

2.4.1 There shall be an organization chart of the response team showing the chain of command for the spill control. Also, the responsibilities of the principal staff to be engaged in controlling the spill situation should be delineated.

2.4.2 The response to an oil spill can be accomplished either in-house or by an oil spill co-operative.

- (i) In-House: An operator or owner of a facility shall be required to develop a response unit comprising competent personnel trained in oil and hazardous substances spill control/combustion in its employ. Such personnel shall be competent in controlling/combating and removing spills from the environment type(s) in which the facility is located or operated.

- (ii) In a situation where an operator/owner has several facilities located at different locations, the response organization or team shall serve as a focal point for the control/containment and removal of a spill as well as to train all personnel involved in the day-to-day running/operation of the facility on the rudiments of a spill control/containment and removal. This implies that in addition to the specialized training of the response team, all persons involved in the operation of a facility shall be trained on the principles and requirements of a spill control/containment removal.
- iii) Oil Spill Co-operatives: Where several operators/owners of facilities are doing business they shall be required to form a co-operative for the purpose of pooling resources for the control/containment and removal of any spill of **whose** magnitude might render the resources of any one individual plan ineffective. It behoves any member of the co-operative to ensure that his needs and requirements are met by the content of the co-operative plan. It shall be the responsibility of the members of the co-operative to ensure that the co-operative plan is continually appraised to meet with contemporary technology and strategies in oil spill control and containment.

2.5 Plan Equipment Content

- 2.5.1 Each plan shall contain a minimum number of appropriate containment equipment that can effectively be used in the environment within which the facility is operated. The quantity of equipment will depend on the number of facilities from which spills can occur.
- 2.5.2 It shall be mandatory that each operator stocks and/or is capable of mobilizing a minimum quantity of containment equipment at each facility. The minimum equipment shall be such as to contain at least the quantity of the largest possible spill that can occur from the facility.
- 2.5.3 For all facilities **that** operate on waters (offshore, coastal, inland/**wetland**) an appropriate size of floating booms shall be stocked for containment.
 - (i) For ocean going vessels, it is required that at all loading **and offloading** points, an operator shall stock length of booms, enough to encircle ships that shall come into the Nigerian waters for loading.
 - (ii) For land facilities, operators shall stock equipment capable of moving earth to serve as barriers.
- 2.5.4 An operator of a facility shall be required to have in the plan appropriate equipment/capabilities for recovering and removing spills from the environment within which the operation is conducted.
- 2.5.5 It shall be required that **the OSCP shall have dedicated** transport facilities for the deployment of the containment equipment and removal of the spilled substance.

2.6 Containment Procedures and Clean-Up Of Spills

- 2.6.1 For containment on waters, it shall be required that operators respond **for** immediately **containment of** oil spill in order to prevent the spreading of the spilled product.
- 2.6.2 For containment on land, the spill may be prevented from spreading by containment ditches. Due consideration should be given to prevent groundwater contamination. This is particularly necessary in areas where groundwater table is close to the surface. In a

situation where a spill occurs adjacent to water courses and drainage systems, a high priority shall be given to containment procedures to prevent its spread into these areas.

2.6.3 Clean-up of spills **in** contaminated environments shall be conducted in such a manner as not to cause additional damages to the already impacted environment. It is therefore required that an operator adopts an approved method that would suit the environment within which the spill occurred. Clean-up shall commence within 24 hours of the occurrence of the spill.

(i) For inland waters/**wetland**, the lone option for cleaning spills shall be complete containment and mechanical/manual removal. It shall be required that these clean-up methods be adopted until there shall be no more visible sheen of oil on the water. The use of any dispensing/gelling/biological agents in **the** clean-up operations is prohibited in inland waters.

(ii) For offshore waters, clean-up methods shall be by containment and mechanical recovery. However, dispersing/sinking/gelling agents may be employed by the operator only after approval has been sought and obtained from the Director, Petroleum Resources (see Article 3.3)

2.6.4 For shoreline clean up, the choice of methods to be adopted (e.g. use of pay loaders, scrapers, etc.) shall be based on careful evaluation of socioeconomic sensitivity, behaviour of oil in the shoreline or shore area-type, etc. In addition, the threatened shoreline or shore area shall be prevented from the oil impact by using booms or any approved containment equipment. If the shoreline is impacted approved restoration methods should be adopted.

2.6.5 Mangrove/other **wetland**, Clean-ups shall be based on a study and evaluation of the socio-economic and ecological sensitivity of such swamps. Such methods to be adopted may include gentle flushing, ditch digging and manual recovery.

2.6.6 The clean up of the contained oil on land may be accomplished by mechanical and manual methods (e.g. use of sorbents, pumps, buckets, etc.). When the soil is heavily contaminated the contaminated soil can be excavated and oil washed into a properly lined pit. The oil-contaminated soil can also be disposed of **methods approved by the Director, Petroleum Resources**, sanitary landfill. In an event where groundwater gets contaminated, the operator shall take necessary steps to de-pollute the contaminated soil and groundwater: Other conditions as stipulated in Article 6.0 shall apply.

2.6.7 The duration of the cleaning up of oil spill shall be in accordance with the requirements of Oil Spill Report Forms A, B, and C (see Appendix VIII-B2).

2.7 Communication

2.7.1 It is required that any operator shall have a contemporary communication network system linking all facilities owned and operated by the same operator. The communication network system shall be linked to all the offices of operator.

2.7.2 **Specific** internal alerting procedure will be established for informing personnel within the organizational chart, beginning with the discovery of the spill incident.

2.7.3 The procedure for reporting the spill to outside bodies shall be stated. However, the procedure for the reporting of the spills to the Director of Petroleum Resources, shall be as stipulated in the 011 Spill Report Forms A, B and C (see Appendix VIII-B2).

2.8 Disposal Plan for Oil & Debris

- 2.8.1 It shall be required that the first option for dealing with oil recovered from a spill incident is reuse. If however, the oil cannot be recycled, the operator responsible for the spill, shall take adequate steps to dispose of the unwanted oil in an acceptable manner approved by the Director, Petroleum Resources. The approved methods for disposal shall be by controlled burning (in lined pits), incineration, land farming and sanitary landfill.
- 2.8.2 Before an operator embarks on land farming, an approval shall be sought and obtained from the Director, Petroleum Resources. It shall be the responsibility of the operator or owner of a facility to provide such information as:
- (i) **Geological, hydrogeological information relative to the** level of groundwater resources to ensure that groundwater shall not be contaminated;
 - (ii) Effectiveness of the land farming, by identifying whether the **indigenous** bacterial content and type of the proposed land farming is capable of handling the oil to be disposed;
 - (iii) Precautions to be adopted to prevent leaching and contamination of ground and surface water resources.
- 2.8.3 Oily solid waste for disposal shall be stored in a container that shall not allow leakage, or in a pit lined with an impervious material such as concrete or High Density Poly- Ethylene (HDPE). The available disposal method shall include but not limited to:
- (i) resource recovery system where feasible,
 - (ii) land farming,
 - (iii) controlled burning,
 - (iv) incineration,
 - (v) sanitary land filling (see PART 11, Articles E.3.1.2, E.4.6.1 and E.4.7.3)

2.9 Press Relations

- 2.9.1 An oil spill contingency plan shall have a press release procedure.

2.10 Documentation of Spill and Cost of Clean-Up

- 2.10.1 Operators or facility owners shall accurately record the history of the oil spill. A log of daily events shall be kept from the time a spill is first noticed until clean-up operations are completed.
- 2.10.2 The spiller shall submit to the Director of Petroleum Resources the cost of clean-up which shall include the clean up cost, down time man-hour loss, cost of man-hour utilization, the cost of materials and repairs and cost of unrecovered oil, etc.

2.11 Remediation/Rehabilitation of Affected Area

- 2.11.1 It shall be the responsibility of a spiller to restore to as much as possible the original state of any impacted environment. The process of restoration shall vary from one environment type to another. **(See PART VIII F).**
- 2.11.2 Any restorative process to be embarked upon shall adequately evaluate the biological sensitivities of the impacted environment. In a situation where a sensitive environment is

impacted, it shall be required that a post spill impact assessment study be conducted to determine the extent of damage and the estimated duration for complete recovery of such an environment.

2.11.3 Any operator or owner of a facility that is responsible for a spill that results to impact of the environment shall be required to monitor the impacted environment along side the restorative activities. The restorative process shall attempt to achieve acceptable minimum oil content **and other target values (quality levels ultimately aimed for) for BTEX, metals and polycyclic aromatic hydrocarbon (PAHS)** in the impacted environment .**(Also see PART VIII F).**

- (i) For all waters, there shall be no visible oil sheen **after** the first 30 days of the occurrence of the spill no matter the extent of the spill.
- (ii) For swamp areas, there shall not be any sign of oil stain within the first 60 days of occurrence of the incident.
- (iii) **For land/sediment, the quality levels ultimately aimed for (target value), is 50mg/kg, of oil content. (See PART VIII F)**

3.0 USE OF OIL SPILL CHEMICALS

3.1 All oil spill chemicals intended for use within Nigeria and its territorial waters shall be certified by the Director, Petroleum Resources.

3.2 The chemicals shall be subjected to effectiveness, toxicity and biodegradability tests under Nigerian conditions and environment by reputable laboratories so recognised and approved by the Director, Petroleum Resources. The results of such tests and the detailed technical product data (ie Material Safety Data Sheet) on the physico-chemical characteristics of the chemicals, shall be submitted to the Director, Petroleum Resources. These results shall be the basis for certification.

3.2.1 Effectiveness: The test procedure may be either of the following; the Simulated Environment Test (SET) Procedure of USEPA, the Machay Test Method (Canada) or any other test procedure that may be approved by the Director of Petroleum Resources.

3.2.2 Toxicity: The test procedure shall be accomplished in accordance with requirement specified in Appendix VIII-EI.

3.2.3 Biodegradability: The procedure shall be conducted as outlined in **PART VIII E- 5.0**.

3.3 The On-Scene-Commander for an oil spill Contingency plan of any operator shall be authorised by the Director Petroleum Resources to use any oil spill chemicals in offshore waters for controlling oil spills. The use of these chemicals is prohibited in coastal and inland waters.

3.3.1 The application for an authorization to use oil spill chemical shall be submitted to the Director of Petroleum Resources. The following information shall accompany the application.

- (i) Spill Data
 - a. Cause/circumstances (fire, grounding, collision, etc.)
 - b. Time/date of incident
 - c. Location of spill/distance from shore
 - d. Type of oil

- e. Volume of oil released
 - f. Total potential of release
 - g. Type of release (instantaneous, continuous)
- (ii) Characteristics of the spilled oil.
- a. Specific gravity .
 - b. Viscosity
 - c. Pour point
 - d. Flash point ,
 - e. Others.
- (iii) Weather and water condition/Forecast
- a. Air temperature, wind speed, direction
 - b. Tide and current information
 - c. Water temperature and salinity
 - d. Water depth
 - e. Sea state.
- (iv) Oil Trajectory information
- a. Surface oil trajectory forecast
 - b. Time to landfall
 - c. Expected area of landfall
 - d. Dispersed oil trajectory forecast
- (v) Information About Available Dispersant and Dispersing Equipment.
- a. Name of dispersant/DPR acceptance reference
 - b. Type (self mix, concentrate, etc.).
 - c. Constraints imposed by DPR acceptance letter
 - d. Proposed application methods and rates
 - e. Estimated efficiency under existing conditions
 - f. Schedule of dispersant operation.
 - g. Location of area to be treated
 - h. Surface area of the slick which can be treated in the scheduled time period.
- (vi) **Shoreline** containment and clean-up options:
- a. Shoreline protection strategies (Dispersant treated and un-treated oil).
 - b. Shoreline clean-up strategies
 - c. Containment at source
 - d. Time necessary to execute response.
- (vii) Habitats and Resources at Risk. (For both Dispersant-treated spill and untreated spill):
- (a) Shoreline Habitat type.
 - (1) Eroding Scarp
 - (2) High-Energy Eroding Peat mud.
 - (3) Fine-grained sand Beach
 - (4) Medium-to coarse Grained Sand Beach
 - (5) Mixed Sand and Gravel Beach
 - (6) Gravel Beach
 - (7) Exposed Sand Flat
 - (8) Low - Energy Peat Bank

- (9) Mud flat
- (10) Fresh water/mangrove Swamp.

(b) Resources

- (1) Villages/towns/fishing ports
- (2) Public use (Marinas, Jetties etc.)
- (3) Fish (harvesting, Spawning)
- (4) Shell fish (harvesting, Spawning)
- (5) Waterfowl use (nesting, migration)
- (6) Other Resources of Special significance.

3.3.2 Based on the information supplied, the Director, Petroleum Resources shall require the On-Scene Commander to implement one or more of the following:

- (i) Do not use dispersant
- (ii) Use dispersants on a trial basis.
- (iii) Disperse in limited or selected areas.
- (iv) Disperse to the maximum extent possible with accepted methods.

4.0 MYSTERY SPILLS (SPILLS OF UNKNOWN ORIGIN)

4.1 An operator shall be responsible for the containment and recovery of any spill discovered within his operational area, whether or not its source is known . The operator shall take prompt and adequate steps to contain, remove and dispose of the spill. Where it is proven beyond doubts that an operator has incurred costs in cleaning up a spill for which he is not responsible, the operator shall be reasonably compensated, up to the extent of recovering all expenses incurred, including reimbursement of any payments for any damage caused by the spill, through funds established by the Government or the oil industry for that purpose.

4.2 For easy identification of oil spills every operator shall carry out finger printing of its crude oil on field by field basis (see APPENDIX VIII D8 for the test protocol).

4.2.1 The results of the finger printing shall be submitted to the Director of Petroleum Resources.

5.0 TRAINING, DRILLS AND PLAN REVISION

5.1 It shall be required of any operator or owner of a facility to have in his employ, personnel that are regularly trained and dedicated to environmental planning, protection and control. A facility operator or owner shall be required to provide information on the personnel trained to handle spill technologies.

5.2 On an annual basis, an operator's plan shall be reviewed and activated.

6.0 CONTROL OF OIL SPILLAGES THAT IMPACT UNDERGROUND WATERS

6.1 When underground water is contaminated the following conditions shall apply:

- i) The licensee or operator shall inform the Director, Petroleum Resources within 24 hours.
- ii) The licensee shall immediately activate an Initial Remedial Action (IRA) Plan, such as free oil/product removal, when applicable, to prevent contaminant migration. Such initial remedial action shall be approved by the Director, Petroleum Resources.
- iii) The licensee or operator shall **assess**, on site specific basis, the contamination by identifying the source, plume location migration, and the possible receptors, within one (1) month of the occurrence. The scope of the assessment shall include the following:
 - (a) Background information - site location history, operations and inventory of nearby portable wells.
 - (b) Site assessment - hydrogeological characteristics such as site lithology, aquifers and confining units, hydraulic conductivity, groundwater flow direction and rate for all affected bearing zones.
 - (c) Soil, groundwater and surface water quality - the concentration and chemical composition of the contaminant in each medium. **.(Also see TABLE VII -2).**
- iv) The licensee or operator shall then institute recovery, treatment, monitoring and rehabilitation programmes, approved by the Director of Petroleum Resources.

6.2 The Director, Petroleum Resources has the option to take necessary and appropriate action to safeguard human health and welfare when such spillages, leakages **and contamination** occur and/or when the response by the licensee or operator is inadequate. In both cases, all expenses reasonably so incurred shall be recovered from the licensee or operator.

6.3 When the source of a reported/observed contamination is not known (mystery) the Director of Petroleum Resources shall mobilize available resources to satisfy all the conditions as provided in these guidelines and standards and other legislations, through funds established by the government and/or the oil industry for that purpose.

7.0 CONDITION FOR ENVIRONMENTAL EVALUATION STUDIES

7.1 **An operator responsible for a spill** shall be required to conduct an Environmental Evaluation (Post Impact) Study of any adversely impacted environment, in accordance with Article 2.0 of the Environmental Impact Assessment Process guidelines (see PART VIII-A).

8.0 LIABILITY, COMPENSATION AND SANCTIONS

8.1 Liability

A spiller shall be liable for the damage from a spill for which he is responsible. Where more than one spiller is responsible and liable, the liability **shall** be joint and several.

8.2 Sanctions

8.2.1 **Appropriate fines shall apply (PART IX, Section 4.0).**

8.3 Compensation

8.3.1 **Settlement for damages and compensation shall be determined by direct negotiation between operator(s) and landlord(s).**

8.3.1.1 Where direct settlement between the operator(s) and landlord(s) fails, other methods of settlement shall apply:

- (i) Arbitration (tribunal, etc.)
- (ii) Legal adjudication (court, etc.).

8.3.2 It shall be the responsibility of the Compensation Tribunal to determine the quantum of compensation payable **where arbitration is employed.**

9.0 BIBLIOGRAPHY

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APPENDIX VIII- B I

GUIDELINES FOR THE STOCKING AND LISTING OF RESPONSE EQUIPMENT AND MATERIALS

It shall be mandatory that each operator stocks a minimum quantity of functional equipment and materials at any point in time that can be used for the effective combat of minor spills (**tier 1**) or for the first line of defence for bigger spills. The stock shall consist of the following:

1. **BOOMS**

These shall be described in accordance with the following characteristics:

- Types
- Total length
- Draft/freeboard length and weight per unit
- Design or intended use (e.g. use in open sea or sheltered water operations)
- Mobilization time Means of transportation required
- Available transportation
- Personnel for handling
- Estimated procurement cost/meter
- Estimated daily rental cost/meter

2. **SKIMMERS AND OTHER PICK-UP DEVICES**

The following characteristics shall be specified.

- Types, total numbers
- Weight and size per unit
- Design or intended use
- Mobilization time
- Means of transportation required
- Available transportation
- Personnel for handling
- Estimated procurement cost
- Estimated daily Rental Cost

3. **EQUIPMENT FOR STORAGE OIL**

The following characteristics shall be specified

- Types, total numbers/capacity
- Weight and size per/unit
- Additional support equipment necessary
- Design or intended use
- Mobilization time
- Means of transportation required
- Available transportation
- Personnel for handling
- Estimated procurement cost
- Estimated daily rental cost

6 **SPECIALIZED SHORELINE CLEAN-UP EQUIPMENT (WHEN APPLICABLE)**

The following characteristics shall be specified.

- Types
- Weight and size per unit
- Additional support equipment necessary

- Design or intended use
- Mobilization time
- Means of transportation required
- Available transportation
- Personnel for handling
- Estimated procurement cost
- Estimated daily rental cost

5. VESSELS (SPECIALIZED AND OTHERS)

The following characteristics shall be specified

- Type, length, breadth, speed
- Onboard storage capacity
- Application (open sea or sheltered waters)
- Mobilization time
- Personnel for handling
- Estimated daily rental cost

6. AIRCRAFT (WHEN APPLICABLE)

The following characteristics shall be specified

- Type, -rotary/fixed wing
- Operating speed
- Load capacity
- Mobilization time
- Estimated daily rental cost

7. DISPERSANTS

The following characteristics shall be specified

- Types, total stock of each type
- System of storage
- Method of Application
- Approval Data (e.g. DPR approval reference/number)
- Toxicity, Efficiency and biodegradability data
- Means of transportation
- Available transportation
- Estimated price
- Expiration Date(s) per dispersant(s)

8. LIGHTERING EQUIPMENT

The following characteristics shall be specified

- Pumps; total stocks by type/capacity and weight including prime mover
- Hoses; length, diameter and weight/section
- Fenders; total stocks by type/size and weight 1
- Personnel for handling
- Estimated procurement cost
- Estimated daily rental cost

9. COMMUNICATIONS AND AUXILLARY EQUIPMENT

- Equipment on Board
- Portable equipment (on bond and ashore)
- Frequencies
- Types of emission

- Power source
- Signalling lamps
- Estimated Procurement Cost
- Estimated daily Rental Cost

10. **OTHERS.**

- **Lighting Equipment**
- **Emergency Safety Equipment**
- **First Aid Kits**

APPENDIX VIII-B2

FORM A OIL SPILLAGE /LEAKAGE NOTIFICATION REPORT

(to be submitted within 24 hours of Spill Incident)

The Director,
Department of Petroleum Resources,
7 Kofo Abayomi Street,
P.M.B. 12650,
Victoria Island,
LAGOS.

From: Oil spill serial No **/20...**
Company:

Address.

Ref:

Date:

Please be informed that an oil spillage/leakage has occurred.

- 1) Facility/Location:
- 2) Date/Time Observed:
- 3) Known extent of pollution:
.....
- 4) Precautionary measures taken since the spillage/leakage occurred to prevent hazards that may arise:
.....
.....
.....
- 5) Probable Cause(s):
.....
- 6) Estimated Quantity Spilled:

Additional details about the spillage/leakage must be reported within 14 days of the spill on the oil Spillage/Leakage report (FORM B). The Oil Spillage response/clean-up report must be submitted within four (4) weeks.

Reporting Officer:

Signature:

Designation:.....

cc. Operations Controller of Appropriate Department of Petroleum Resources Field Office.

Oil shall be deemed to mean both crude and refined petroleum product

FORM B

OIL SPILLAGE/LEAKAGE REPORT

(to be submitted within fourteen (14) days of Spill Incident)

The Director,
Department of Petroleum Resources,
7 Kofo Abayomi Street,
P.M.B. 12650,
Victoria Island,
LAGOS.

From: Oil spill serial No...../20...
Company:
Address:
Ref:.....
Date:

1. Date/Time of Occurrence:.....

2. Date/Time of Observation:

- 3.(a) Location:
- (i) OPL/OML No/UNIT DESCRIPTION.....
- (ii) Nearest Town:.....
- (iii) State:
- (b) Operational Area
- (i) Land
- (ii) Offshore
- (iii) Coastland
- (iv) Swamp
- (v) Inland waters

- (c) Type of Spill/leak
- (i) Crude oil
- (ii) Product (Specify)
- (iii) Drilling mud/Chemicals
- (iv) Others (Specify)

(d) Type of Operation at Spill site:

4 Cause of Leakage/Spillage

- (a) Unknown
- (b) Blowout
- (c) Equipment failure (specify)
- (d) Operator/Maintenance Error
- (e) Corrosion
- (f) Sabotage
- (g) Sand/Erosion/wave
- (h) Accident
- (i) Others (Specify)

5 Weather Conditions

- (a) Bright and Sunny
- (b) Cloudy
- (c) Rainy
- (d) Others Specify
- (e) Wind Direction
- (h) Wind speed

6. Sea Conditions

- (a) Calm
- (b) Rough
- (c) Not Applicable

- (d) Direction of current:.....
- (e) Strength of current:.....
- (f) Swell height:.....
- (g) **Tidal Condition** **High** **Low**

7. Quantity Leaked

(a) Estimated Quantity of oil/contaminant leaked

(a) Detailed Calculations: (attach additional sheets if necessary)

.....

8. Quantity of Crude Oil/Contaminant Recovered as at Time of Reporting:

.....

9. Details of Immediate pollution to Inland Waters, Beaches, Farmland etc.:

10. Steps being taken to prevent further pollution:

11. Any casualties: (a) Yes (b) No
 [] []

If Yes, Give Details:

.....

12. Other remarks:

.....

Reporting Officer:

Signature:

Designation:

cc: Operations Controller of Appropriate Department of Petroleum Resources, Field Office.

* **Oil shall be deemed to mean both crude and refined petroleum product.**

OIL SPILLAGE RESPONSE/CLEAN-UP REPORT
(To be submitted within (4) weeks of the Spill Incident)

The Director,
Department of Petroleum Resources,
7 Kofo Abayomi Street,
P.M.B. 12650,
Victoria Island,
LAGOS.

From: Oil spill serial No...../20...
Company:
Address:
Ref:.....
Date:

1. Date of Spill:

2. Time:

3. Place of Spill:

7 Steps taken to clean-up the spilled oil:
.....

5.: Clean-up

Party:

6. Equipment/Containment method

7. Chemical Dispersants

(a) Bundwalls

(a) Type:

(b) Booms

(b) Quantity:

(c) Sorbents

(c) Not applicable:.....

(d) Others (Specify):.....

8. Progress of clean-up (tick)

Not started	20%	40%	60%	80%	Completed
-------------	-----	-----	-----	-----	-----------

9. Clean-up duration:.....

10. Man Hours used: :.....

11. Amount of crude oil/contaminant recovered: :.....

12. Damage to the Environment: :.....

(a) Land/Spill media:

(b) Water Bodies:.....

(c) Air Media:

13. Rehabilitation for the Impacted area:
.....
.....

14. Cost of Spill:

- (a) Naira Loss due to oil spilled:
- (b) Clean-up cost:
- (c) Down-Time man hours lost:
- (d) Repair work:
- (e) TOTAL:

15. Compensation paid (if any):

16. Method of settlement of Damage claimed:

- (a) Arbitration (d) Direct negotiation between Landlords and Company
- (b) Court settlement (e) Not Applicable
- (c) Other Specify

17. SPECIFY ANY FOLLOW-UP STUDIES:

.....

18. Other remarks:

Reporting Officer: :.....
 Signature: :.....
 Designation: :.....

cc: Operations Controller of Appropriate Department of Petroleum Resources, Field Office.

* **Oil shall be deemed to mean both crude and refined petroleum product.**

APPENDIX VIII-B3

DEPARTMENT OF PETROLEUM RESOURCES.

OIL/CHEMICAL SPILL AND CONTAMINATION CLEAN-UP CERTIFICATION FORM

NOTE: THIS CLEAN-UP CERTIFICATION IS IN TWO PARTS.

PART "A " IS ISSUED AFTER THE CLEAN-UP HAS BEEN CERTIFIED AS SATISFACTORY BASED ON ASSESSMENT REPORT.

PART " B " IS ISSUED AFTER AN UNSATISFACTORY CLEAN - UP EXERCISE (EARLIER IDENTIFIED BY A PART "A" CERTIFICATION) AND POTENTIALLY POLLUTED SITES, HAVE BEEN SUBJECTED TO FURTHER CLEAN - UP, RISK ASSESSMENT OR ENVIRONMENTAL EVALUATION STUDIES (AS THE CASE MAY BE) AND THE IMPLEMENTATION OF APPROPRIATE RESTORATIVE MEASURES, HAVE BEEN CARRIED OUT, SATISFACTORILY.

CRUDE OIL/PRODUCT/CHEMICAL SPILL AND CONTAMINATION CLEAN-UP CERTIFICATION/

PART 'A'

1.0 DATE OF INSPECTION:-----

1.1 LOCATION: -----

1.2 HOW MANY SPILLS HAVE OCCURRED FROM THIS LOCATION IN THE

(a) CURRENT YEAR?-----

(b) PREVIOUS YEARS? -----

2. INSPECTION TEAM MEMBERS:

(i).....

(ii).....

(iii).....

(iv).....

(v).....

3. DETAILS OF SPILL:

3.1 Date Of Spill.....

3.2 Cause of Spill.....

3.3 Qty Spilled:

3.4 Qty. Recovered:

3.5 Clean-up Period: (..... TO)

3.6 Delimitation Of Impacted Areas:[Graphic]

4. FINDINGS:

4.1 VISUAL OBSERVATIONS: (TICK AS APPROPRIATE):

- i) Any Oil Sheen On Water? YES NO NA
- ii) Any Oil Stain On Vegetation? YES NO NA
- iii) Is Soil Wet With Oil? YES NO NA
- iv) Any Patches Of Oil
In Impacted Area? YES NO NA
- v) Any Oil Sheen When
Soil Sediment Is Disturbed? YES NO NA
- vi) Is Disposal Of Oil Debris
satisfactory? YES NO NA
- vii) Was Dispersant Applied YES NO NA

4.2 **RESULTS OF LABORATORY ANALYSES FOR SAMPLES
COLLECTED FROM IMPACTED MEDIUM/MEDIA**

S/N	PARAMETERS	RESULT OF IMPACTED ENVIRONMENT					
		(MEDIUM/MEDIA) SEDIMENT/SOIL		SURFACE WATER		UNDERGROUND WATER	
		Sample	Control	Sample	Control	Sample	Control
1	PH						
2	Polyaromatic Hydrocarbons -Benzene -Toluene -Ethyl- Benzene -Xylene						
3	THC						
4	Sulphide						
5	COD						
6	Lead						
7	Nickel						
8	Vanadium						
9	Chromium (Total)						

(Attached Sample Location Map)

5. COMMENTS / DISCUSSION

6. RECOMMENDATION

7. CONCLUSION (INDICATE WHETHER THE CLEAN - UP IS
CERTIFIED AS:

- i) SATISFACTORY []
- ii) NOT SATISFACTORY) []

8. SIGNATURES

OPERATOR/LICENCEE/SPILLER

CLEAN-UP SUPERVISOR

DPR REP.

**CRUDE OIL/PRODUCT/CHEMICAL SPILL AND CONTAMINATION
CLEAN-UP CERTIFICATION FORM.**

PART B.

NOTE: PART B IS ISSUED AFTER AN UNSATISFACTORY CLEAN UP EXERCISE (EARLIER IDENTIFIED BY PART "A" CERTIFICATION).AND POTENTIALLY POLLUTED SITES, HAVE BEEN SUBJECTED TO FURTHER CLEAN-UP, LABORATORY EVALUATION, RISK ASSESSMENT OR ENVIRONMENTAL EVALUATION STUDIES (AS THE CASE MAY BE) AND THE IMPLEMENTATION OF APPROPRIATE RESTORATIVE MEASURES.

1.0 DATE OF SPILL:

1.1 CAUSE OF SPILL: _____

1.2 QUANTITY SPILLED: _____

1.3 CLEAN - UP PERIOD: _____

1.4 DATE OF MOST RECENT JOINT POST CLEAN - UP INSPECTION

1.5 Location/Site/Coordinate

1.6 CONTAMINATED MEDIUM / MEDIA

- (i) * LAND**
 - * SOIL**
 - * SEDIMENT**
- (ii) WATER**
 - SURFACE WATER(IN - LAND)**
 - SURFACE WATER (BRACKISH SWAMP)**
 - SURFACE WATER (OFFSHORE)**
 - GROUND WATER**
- (iii) AIR (where applicable)**

1.6 FINDINGS, CONCLUSION AND RECOMMENDATION OF THE " A "

CERTIFICATION.

2 SUMMARY OF SITE INVESTIGATION, ENVIRONMENTAL EVALUATION AND/OR RISK ASSESSMENT STUDY REPORT (ATTACH DETAILS AS ANNEX)

3 SUMMARY OF THE RESTORATIVE / REMEDIATION METHODS EMPLOYED (TICK AS APPROPRIATE AND ATTACH DETAILS AS ANNEX). (NOTE THAT THE DPR SHALL APPROVE OF ANY OF THESE METHODS PRIOR TO APPLICATION)

i) Indicate Whether Method is: ON - SITE (IN - SITU) []
(Tick as appropriate) OFF SITE (EX-SITU) []

STABILISATION / SOLIDIFICATION.

CHEMICAL TREATMENT

BIOLOGICAL TREATMENT

LEACHING / WASHING / FISHING

ELECTRO-REMEDICATION

VITRIFICATION

VAPOUR EXTRACTION

THERMAL DESORPTION

IN-SITU OXIDATION

3.1 SUMMARY OF RESTORATIVE/REMEDICATION METHOD PERFORMANCE AND MONITORING REPORT.
(ATTACH DETAILS AS ANNEX)

4 CONCLUSION:

- ISSUE A PART " B " CERTIFICATION
- DO NOT ISSUE A PART " B " CERTIFICATION"
(PROVIDE REASONS)

5 SIGNATORY

DPR

C. HAZARDOUS WASTES MANAGEMENT:

1.0 BACKGROUND

1.1 The Petroleum Regulations state that non-hazardous and/or hazardous wastes from oil and gas exploration, exploitation, refining and other associated activities shall be handled in accordance with up-to-date instructions and with practices conforming with good-oil-field and international standards.

1.2 This management guidelines is therefore issued:

- (i) To control the identification, generation, storage, collection/ transportation, treatment, recovery, re-use and disposal of hazardous wastes.**
- (ii) To implement a management programme that will protect the environment (air, groundwater, surface water etc) from pollution from hazardous wastes, which if released, discharged or disposed off inappropriately, will present an imminent and substantial danger to public health and welfare in and around oil producing areas.**
- (iii) To encourage all operators in the oil and gas sector to reduce the amount of hazardous wastes developed and generated.**

1.3 It should be noted that the issuance of this guideline in no way absolves the operator or licensee to comply with other legislations for example, sections 20 and 21 of Federal Environmental Protection Agency Decree 1988 and the Harmful Waste (Special Criminal Provisions, etc.) Decree 1988.

1.4 A logical priority in managing hazardous waste would be to:

- 1. Reduce the amount of hazardous wastes generated in the first place.**
- 2. Stimulate “waste exchange” (One factory’s hazardous wastes can become another’s feedstock; for instance, acid and solvent wastes from some industries can be utilized by others without processing.**
- 3. Recycle metals, the energy content, and other useful resources contained in hazardous wastes.**
- 4. Detoxify and neutralize liquid hazardous waste streams by chemical and biological treatment.**
- 5. Reduce the volume of waste sludges generated in number four, above, by dewatering.**
- 6. Destroy combustible hazardous wastes in special high-temperature incinerators equipped with proper pollution-control and monitoring systems.**
- 7. Stabilize/solidify sludges and ash from numbers five and six to reduce leachability of metals.**
- 8. Dispose of remaining treated residues in specially designed landfills.**

2.0 WASTE MANAGEMENT:

2.1 Identification

2.1.1 Every Operator/Licencee/Leasee shall supply to the Director of Petroleum Resources all information necessary to identify hazardous materials and wastes. Such information shall include all or more of the following as may be determined by the Director, Petroleum Resources, **from time to time:**

- (i) Material Safety Data Sheet-Appendix VIII-C I.
- (ii) Waste Material Data Sheet (Physical and Chemical assay of materials/waste) – Appendix VIII-C2
- (iii) Chemical Tests/Analyses on the Criteria/Characteristics as identified in Article 2.1.2 for hazardous substances/**wastes**.
- (iv) **Risk Assessment (hazard identification, assessment and risk estimation/evaluation)** as associated with and wastes. This will be done by referring to standard reference sources for data and guidelines on:
 - Permissible Levels of Exposure,
 - Threshold Limit Values (TLV),
 - Explosion and Flammability Ranges (Lower and Upper Explosive Limits),
 - Immediate Dangerous to Life or Health (IDLH) Level (maximum level from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects),
 - Personnel Protection and Sanitation,
 - Route of entry/Target Organs,
 - Symptoms of Exposure,
 - First Aid and Measurement Methods.

2.1.2 Hazardous Substances shall include but not limited to any element, compound, mixture, solution which because of its quantity and/or concentration, or physical, chemical or infectious characteristics, may:

- (i) Cause or significantly contribute to an increase in mortality or an increase or incapacitating reversible illness, or;
- (ii) Pose substantial hazards to human health or the environment when improperly treated, stored, transported, or disposed off, or otherwise managed and;
- (iii) **Hazardous substances shall satisfy the following criteria/characteristics:**
 - (a) Ignitability:
 - Liquid and/or liquid waste other than an aqueous solution containing less than 24% alcohol, that has a flash point less than 60°C;
 - Waste (not a liquid), which is capable under standard temperature and pressure, of causing fire through friction, adsorption of moisture, or spontaneous chemical charge and, when ignited, burns so vigorously and persistently as to create a hazard;
 - An oxidizer;
 - An ignitable compressed gas;
 - (b) Corrosivity -
 - Aqueous **substance with a pH 2.0 or less or 12.0 or more;**
 - Liquid that corrodes steel at a rate greater than 5.00 millimeter per year;

- (c) Reactivity -
 - Forms toxic gases, vapours, fumes, or explosive mixture with water when exposed to pH conditions between 2.0 and 12.5;
 - Normally unstable and capable of explosion if subjected to a strong igniting/ heat source; and
 - Explosive capable of detonation or explosion at standard temperature and pressure.
- (d) Toxicity -
 - i) **TCLP Toxicity that the level of concentration using Toxicity Characteristic Leaching Procedure (TCLP), is above the regulatory Levels. (TABLE VIII – (1))**
 - ii) **Listed toxicity (capable through chemical action of killing, injuring or impairing an organism; fatal to human in low doses. See Priority Pollutant List, TABLE VIII-C2).**

2.1.3 Article 2.1.1 shall be deemed to have come into effect **six (6)** months after the promulgation of these guidelines and standards for such materials or wastes acquired before the date of the promulgation.

2.1.4 Within one (1) month of the acquisition of such hazardous substances **and wastes**, information as in Article 2.1.1 shall be supplied to the Director, Petroleum Resources.

2.1.5 When the Director, Petroleum Resources **and/or the licensee/leasee has/have** determined that a substance or waste is hazardous, the Licencee/Leasee shall be required to satisfy or comply with this and other relevant guidelines.

2.2 Generation

2.2.1 The generation of hazardous wastes shall be notified to the Director, Petroleum Resources in writing:

- (i) Within one month of its generation, for wastes generated after the promulgation of these guidelines and standards **and** wastes generated before the promulgation.

2.2.2. The generator of such wastes shall be responsible for:

- (i) A proper categorization/classification/description of **wastes** materials and a hazardous Waste Chemical Analysis Plan, that includes parameters to be tested, test methods, sampling methods and frequency of analysis;
- (ii) **Risk Assessment (hazard assessment, risk estimation and evaluation).**
- (iii) Waste minimization/reduction to the maximum extent practicable using the best practicable means;
- (iv) Site safety plan, which establishes policies and procedures to protect workers and the public from the potential hazards posed by the material or waste. As a minimum, the plan should contain the following information:
 - (a) Site's standard operating procedures (SOPS)
 - (b) Description of the risks associated with each operation conducted.
 - (c) Confirmation that personnel are adequately trained.
 - (d) Description of usable protective clothing and equipment.
 - (e) Description of any site-specific medical surveillance requirement.

- (e) Description of any periodic environmental monitoring - air monitoring, environmental sampling, personnel monitoring, etc.
- (g) Site control measures, which basically should establish work zones and decontamination procedures for personnel and equipment and;
- (h) Emergency Responses Procedure (hazardous substances spill control and counter measures plan), as approved by the Director of Petroleum Resources.

(v) **Resource Recovery: where the hazardous waste is re-used or recycled for other useful purposes including uses as energy sources.**

2.2.3. Generators of hazardous wastes shall ensure that wastes so generated are properly stored, treated on-site or delivered to and received at permitted or licenced premises for treatment or disposal. Such off-site premises/facilities shall satisfy **the DPR and other relevant Government Agency**.

2.3 **Transportation:**

- (i) Any transporter of hazardous material or waste must register with the Director, Petroleum Resources;
- (ii) The transporting vehicle/medium (tanks, vacuum trucks) shall be constructed in accordance with specifications as determined or provided by the manufacturer of the hazardous material with appropriate labeling and warnings;
- (iii) The primary burden on the transporter is safe delivery of the hazardous material or waste to the designated facility;
- (iv) If there is a discharge of hazardous material or waste during shipment, the generator and transporter must take immediate action to:
 - (a) Protect human health and the environment;
 - (b) Inform the Department of Petroleum Resources within 24 hours and;
 - (c) **Hazardous Spill Control Plan:**
 - i) Activate the hazardous substance spill control measures plan.
 - ii) The generator and transporter are responsible for cleaning up any discharge

2.4. Storage, Treatment and Disposal:

2.4.1. Facilities

- (i) **Facilities that store, treat and dispose on-site hazardous waste, shall be registered and appropriate permit(s) issued by the Department of Petroleum Resources.**
- (ii) Article 2.4.1. (i) shall be deemed to have come into effect **six (6)** months after the promulgation of these guidelines and standards for such wastes that are already available.
- (iii) The operator of the facility must obtain a detailed chemical and physical analysis of the material from the manufacturer/generator before he stores, treats or disposes of it.
- (iv) Security:- Such facilities must have a fence with controlled entry and shall be provided with 24 hour surveillance to insure that unauthorised entry is precluded. Signs must be posted at entries to read "DANGER UNAUTHORISED PERSONNEL KEEP OUT.

- (v) Inspections:- The facility must have an inspection schedule, which should be part of a preventive maintenance programme, for checking monitoring equipment, safety and emergency equipment, security systems and operating structural equipment. The schedule should indicate the types of problems or malfunctions to be looked for and include inspection frequencies that are commensurate with the probability of detection or malfunction. Areas where spills might occur must be inspected daily. Inspections must be recorded and sent to the Director of Petroleum Resources on the first week of each month.
- (vi) Training:- The facility must have a personnel training programme which will ensure:-
 - (a) that workers are aware of the potential hazards they may encounter;
 - (b) proper performance of their duties which provides the knowledge and skills necessary to perform the work with minimal risk to worker health and safety
 - (c) proper operation and procedure for the use of monitoring equipment, personal protective equipment, spill response equipment and fire fighting equipment, and limitations of such safety equipment;
 - (d) that workers can safely avoid or escape from emergencies;
 - (e) that workers know their rights and responsibilities
 - (f) Personnel are required to complete an initial training within six (6) months of being hired and have an annual review. Records must be carefully documented and shown to any Inspector on demand.
- (vii) Site Safety Plan and Emergency Response Procedures:
Each facility shall have site safety plan as described in Article 2.2.2.(c) and hazardous material or waste spill control and counter measures plan.

2.4.2. Storage

Tanks/containers/drums/storage areas used for the storage of hazardous wastes shall satisfy the following conditions:

- (i) tanks/containers/compressed gas cylinders shall be constructed with materials of structural integrity and compatibility with the material or waste, as recommended by the manufacturers.
- (ii) drums used to contain or store hazardous wastes should be of special drum types, - polyethylene or PVC-lined drums, Exotic metal drum, single walled drums etc. - depending on the characteristics of the waste.
- (iii) tanks/containers shall be constructed of corrosion resistant materials or coating, cathodic protection and electrical isolation devices, if external metal part of the system will be in direct contact with water and/or soil. For such system, a detection system which will discover a release and remove the accumulated liquids within 24 hours shall be provided.
- (iv) storage area must provide containment to hold the contents of the largest container and 10% of all the containers stored.
- (v) The base of the storage area must be sloped to prevent accumulations of spilled materials. Such an area should have spill detection/ recovery system.

2.4.3. Treatment/Disposal of Waste.

2.4.3.1 An application to dispose of hazardous materials or wastes shall be made to the Director, Petroleum Resources, stating among other things:

- (i) **Generator's Waste Profile (Waste generator information, waste stream information, generators certification, site safety plan, site control measures, Emergency Response Procedure).**
- (ii) Waste Consignment Note (indicating proper manifestation of the movement tracking of the wastes).
- (iii) The disposal method(s) envisaged (including feasibility studies options).
- (iv) Closure and post-closure plans.

2.4.3.2 The treatment/disposal method adapted shall be conducted on-site and shall be the most effective methods, (best practicable technology currently available) that do not cause significant pollution, endanger life or property and shall be approved by the Director of Petroleum Resources. Such methods shall include but not limited to resource recovery, **controlled incineration**, detoxification (neutralization), encapsulation, solidification, secure landfill and deep well injection. Any other method (s) acceptable to the Director, Petroleum Resources can be used after an approval has been sought for and given. **In all cases, appropriate permits shall be issued by the Director, Petroleum Resources.**

2.4.3.2.1 Resource Recovery (recycling): As much as possible all the re-useable components of the hazardous waste should be recovered by using the best practicable technology currently available.

2.4.3.2.2 Solidification: The hazardous waste after some neutralization can be solidified by an appropriate waste: cement ratio. The waste and the solidified mixture shall however undergo the following tests:

- (i) Hardness (compressive strength) test and
- (ii) Leachate testing, Toxicity Characteristic Leaching Procedure test for oil and grease and heavy metals.
- (iii) The solidified material shall meet the following criteria;
- (iv) Unconfined Compressive Strength (QU): >200 lbs/in² (psi).
- (v) Permeability: <1 x 10⁻⁶cm/sec,
- (vi) Wet/Dry durability: >10 cycles to failure.
- (vii) The total metals contents of the waste shall not exceed the TCLP regulatory levels (See Table **VIII-D1**) (**See Appendix VIII-C4 for the Toxicity Characteristic Leaching Procedure**)
- (viii) The oil and grease content of the waste is less than 1% dry weight.
- (ix) The pH of the waste is 6-9.

Testing to be conducted according to ASTM and other methods. See Appendix VIII-D6 for the EP (Extraction Procedure) Toxicity Test

2.4.3.2.3 Landfilling: The hazardous material/wastes shall be subjected to detoxification (neutralization) procedures before any landfilling. The following conditions shall be satisfied, when and if, the option adopted is landfilling.

- 1) An application for site approval shall be made to the Director, Petroleum Resources.
- 2) A feasibility study is conducted by the operator to determine the

suitability of the area/site for landfilling. The following information/characteristic shall be made available to the Director of Petroleum Resources, with the application for site approval.

- a. Detailed description of site with relation to the following: .
 - Past and present land use
 - Geology/soil properties/hydrogeology
 - Hydrologic balance, and
 - Highest seasonal groundwater level.

- b. Detailed description of the facility design including maps and drawings and a discussion of the following:
 - Site layout
 - Proposed waste application technique
 - Drainage Control, and
 - Proposed waste loading rate.

- c. Detailed information concerning;
 - sampling and testing of incoming waste
 - Complete physical and chemical properties of waste, which should include;
 - ⇒ PH
 - ⇒ Total metals contents for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Silver, Zinc, Vanadium, Nickel,
 - ⇒ Oil and Grease Content (% dry weight)
 - Soluble salts and cationic distributions:-
 - ⇒ electrical conductivity - EC in mmhos/cm
 - ⇒ sodium adsorption ration-SAR
 - ⇒ exchangeable sodium percentage ESP(%)
 - ⇒ cation exchange capacity - CEC (milliequivalents/100 gm soil)

- c) The excavated landfill shall have one (1) continuous meter of re-compacted or natural clay/cement having a hydraulic conductivity not greater than 1×10^{-7} cm/sec. at the sides and bottom. The liners include but not limited to the following:
 - i. Natural clay having a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - ii. Soil mixed with cement, clay-type, and/or other additives to produce a barrier with a hydraulic conductivity of less than 1×10^{-7} cm/sec.
 - iii. Manufactured liner (synthetic material) that exceeds the hydraulic conductivity requirement and that shall also satisfy the following definitions:

<u>Parameter or Test'</u>	<u>Standard</u>
▪ Thickness (average)	>2.6 mm
▪ Breaking Strength	6.33 Kg/m ²
▪ Bursting Strength	9.85 Kg/m ²
▪ Tearing Strength	1.76 Kg/m ²
▪ Seam Strength	3.52 Kg/m ²

¹Testing is to be performed according to ASTM Method D. 751, latest revision.

- e) Bottom of the buried cell of the landfill shall be at least 1.5 metres above the seasonal high water table, while top of the uppermost cell shall be at least 1.5 metres below ground level and then covered with 1.5 metres of native soil.
- f) Provisions by the operator of sampling points for surface runoffs and leachate.
- g) Continuous weekly sampling and analysis by the operator of surface runoffs and leachate for two years/or as requested by the Director of Petroleum Resources. All records shall be sent to the Director on monthly basis.
- h) The operator shall decontaminate the site if not requested by the Director of Petroleum Resources. The operator is liable for any outcome of the waste disposed in this manner.
- i) The operator shall analyse samples of the wastes for toxic and hazardous substances.
- j) The Director of Petroleum Resources or his accredited representative shall be allowed, at all reasonable times, to enter, inspect, take samples and/or analyse such samples using the operator's equipment, to ascertain whether these conditions have been complied with.

2.4.3.2.4 Encapsulation/Fixation/Stabilization

- a) **Encapsulation, fixation and stabilization processes are used to treat hazardous waste sludges, and residues to produce materials of better physical handling, leachability and landfilling characteristics than the wastes from which they are derived.**
- b) Offsite treatment and disposal shall satisfy the conditions as stipulated by **Director, Petroleum Resources.**

2.4.3.2.5 Incineration:

- (a) **Incineration shall be carried out for either total destruction and/or recycling (resources recovery) of the hazardous materials.**
- (b) **All incinerators shall be designed, constructed and operated to meet performance standards as follows:**
 - i) **achieve a Destruction and Removal Efficiency (DRE) of 99.99% of the Principal Organic Hazardous Constituents (POHCs) and Dangerous Combustion by-products (DCBP);**
 - ii) **destroy dangerous combustion by-products and limit emissions of HCl particulate matter and ash;**
 - iii) **total Mass Emission Rate of less than 0.01% of the total mass feed rate of POHCs fed into the incinerator;**
 - iv) **rate of Emission of HCl of less than 1.8 kg/hr or 1% of the HCl in the stack gas prior to entering any pollution control equipment (which ever is larger).**
 - v) **particulate matter that is less than 180 mg/dry Standard m³ (when corrected from oxygen in the stack).**
 - vi) **ash/slag that does not exhibit TCLP values above the regulatory levels.**

(c) Trial Burn

i) A licensee/leasee operating an incinerator shall conduct trial burn. The following, as a minimum, shall be monitored during the trial burn:

- Emissions of each POHC, Oxygen and HCl
- DRE shall be computed for each POHC
- Quantifications of particulates and carbon monoxide emissions
- Identification of fugitive emissions from the furnace or boiler
- Automatic waste feed cut-off

ii) The results of the trial shall indicate the operating conditions which shall be sufficient to demonstrate compliance with the performance standards.

2.4.3.2.6 Deep Well Injection (See Appendix VIII - C3)

2.4.3.3 Closure

2.4.3.3.1 Operators of these treatment and disposal site (on – site) shall have closure and post-closure plans, approved by the Director, Petroleum Resources.

- (i) Hazardous waste generators shall be responsible for the management of their wastes from cradle to grave.**
- (ii) The Director, Petroleum Resources shall have authority to implement the approved closure plan, in cases where such closure plans are not been effectively implemented. The registered operator shall incur all monies so expended.**

2.4.3.4 Offsite Treatment/Disposal

2.4.3.4.1 When the treatment and disposal of hazardous waste are to be conducted at commercial and third party facilities, then the conditions and specifications of the National and other available standards shall be met.

3.0 MONITORING

3.1 To preclude the contamination of groundwater by hazardous wastes in waste piles, surface impoundments, secure landfill etc., detection monitoring system for the purpose of discovering contamination of the groundwater as approved by the Director of Petroleum Resources shall be provided by the licensee or operator or disposer.

3.2 Monitoring programmes for other disposal methods when/if adopted shall be stipulated by the disposer and approved by the Director, Petroleum Resources.

3.4 When accidental spillage or hazardous material occurs, the spiller shall undertake studies to determine the impact of the spill on the environment over a period of time to be determined by the Director of Petroleum Resources.

4.0 WASTE RELEASE INVENTORY

- 4.1 All licensees/leasees, shall on an annual basis (end of the year) submit to the Director, Petroleum Resources, releases of on-site (point source) effluent discharges to:**
- **air (any fugitive or stack emission);**
 - **water (discharge to any surface water body);**
 - **land (discharge made on-site to surface impoundments, land treatment, landfills, e.t.c) and;**
 - **underground injection.**
- 4.1.1 The information or data shall be provided in the appropriate units, e.g cm³, liters, kg and tonnes.**

5.0 BIBLIOGRAPHY:

1. Department of Petroleum Resources (Compiled) Manual of Petroleum Industry Legislations.
2. USEPA: Characterisation of Hazardous Wastes Sites - A Method Manual Vol.11 EPA Publication 600/4-83-040.
3. USEPA: Guide for Handling Hazardous Materials NCS, UPS, Greenwich, CT, USA.

4. USG: Resources Conservation and Recovery Act of 1976.
5. NIOSH/OSHA/USCG/EPA: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, October 1985.
6. FGN Federal Environmental Protection Agency Decree, 1988.
7. FGN Harmful Waste (Special Criminal Provisions, etc.) Decree 1988. Government Printer, Lagos.
8. **Title 43, Part XIX. Office of Conservation - General Operations. Subpart 1. Louisiana State Order No. 29-B.**

APPENDIX VIII - C1 = FORM VIII C - 1

MATERIAL SAFETY DATA SHEET

Section 1. Identity of Material.

PRODUCT NAME (GENERIC/TRADE)

SYNONYMS

FORMULA CHEMICAL FAMILY	
SHIPPING IDENTIFICATION	SHIPPING/STORAGE; SHIPPING NAME; COUNTRY OF IMPORT
USAGE:	
COMPOSITION:	
96 Hour LC50:	

Section 2. Hazard Specifications

KNOWN HAZARDS	YES	NO		YES	NO	TLV=ppm(mg/cm ³)	
						PEL=ppm (mg/cm ³)	
COMBUSTION LIQUID			SKIN HAZARD			HAZARD SIGNAL	
FLAMMABLE MATERIAL			EYE HAZARD			HEALTH	F/AMMABILITY
						STABILITY	SPECIAL
						HAZARDOUS	
PYROPHORIC MATERIAL			TOXIC AGENT				
EXPLOSIVE MATERIAL			HIGHLY TOXIC AGENT				
UNSTABLE MATERIAL			SENSTIZER				
WATER REACTIVE MATERIAL			CARCINOGEN				
OXIDIZER			REPRODUCTIVE TOXIN				
ORGANIC PEROXIDE			BLOOD TOXIN				
CORROSIVE MATERIAL			NERVOUS SYSTEM TOXIN				
COMPRESSED GAS			LUNG TOXIN				
IRRITANT			LIVER TOXIN				
			KIDNEY TOXIN				

Section 3. Safe Usage Data

PROTECTIVE EQUIPMENT TYPES	EYES
	RESPIRATORY
	GLOVES
	OTHERS
	GENERAL CHEMICAL
	LOCAL EXHAUST
PRECAUTIONS	HANDLING & STORAGE
	OTHER

Section 4. Emergency Response Disposal Data

FIRE	EXTINGUISHABLE MEDIA
	SPECIAL PROCEDURE
	UNUSUAL HAZARDS
EXPOSURE	FIRST AID MEASURES
SPILLS	STEP TO BE TAKEN
	WASTE DISPOSAL METHOD

Section 5. Physical Hazard Data

FLAMMABILITY	LEL HEL	FLASH POINT METHOD USED
STABILITY	STABLE	
	UNSTABLE	
HAZARDOUS POLYMERIZATION	MAX OCCUR	CONDITIONS TO AVOID
	WILL NOT OCCUR	
INCOMPATIBILITY	MATERIALS TO AVOID	

Section 6. Health Hazard Data

OCCUPATIONAL EXPOSURE LIMIT (TLV) EFFECTS OF EXPOSURE HEALTH HAZARDS Inhalation: Skin: Eyes: Injection:
--

EMERGENCY TREATMENT/FIRST AID

Inhalation:

Skin:

Eyes:

Injection:

Section 7. Physical and Chemical Properties

BOILING POINTS °C	VAPOUR DENSITY	VOLATILE COMPONENTS
VAPOUR PRESSURE mmHg Psi	PH	
SOLUBILITY IN H₂O (kg/m³)	WILL DISSOLVED IN	EVAPORATION RATE
APPEARANCE		MATERIAL; PASTE POWDER SOLID, LIQUID, GAS
ODOUR	FLAMMABILITY LIMITS:	
MELTING POINT. (°C)	KINEMATIC VISCOSITY (MM²/S)	
FLASH POINT. (°C)	FLAMMABLE LIMITS (%V/V)	

Section 8. Manufacturer or Supplier Data

FIRST NAME AND MAILING ADDRESS	NAME (PRINT)
	DATE
	EMERGENCY TELEPHONE NO

APPENDIX VIII-C2

**WASTE MATERIAL DATA SHEET
COMPLETE A SEPARATE SHEET FOR EACH WASTE STREAM**

COMPANY _____

MAILING ADDRESS _____






YOUR DESCRIPTION OF MATERIAL _____

PLANT LOCATION
PLANT ID NO
COMPETENT PERSON
PHONE

TELEPHONE NO. _____

QUANTITY	.LITER	MONTH	PACKING	OTHER	SHIPPING STORAGE
OTHER	GRAM	YEAR	DRUMS	BULK	STEEL
	CUMETER	ONCE			
STAINLESS					

PROCESS REQUIRING HAZARDOUS MATERIAL _____
PROCESS PRODUCING WASTE STREAM _____
PRODUCT(S) MANUFACTURED _____

					CHECK APPROPRIATE CLOCKS OR LIST VALUES IF KNOWN
PHYSICAL STATE at 701/21..1C					
ODOUROUS	SLIGHTLY				
ODOURLESS	EXTREMELY ODOUROUS				
FLASHPOINT (C)					
<0.0	70				
32	>70				
SULFUR (WT.%)					
None	TRACE				
0.5					
other	10.3%				
TOC	_____ Mg/l	Melting Point _____			
BOD	_____ Mg/l	Boiling Point _____			
COD	_____ Mg/l	_____			
Sold	Liquid	Semiliquid			
PHASE OR LAYERS					
None	Bilayered	Multilayered			
SPECIFIC GRAVITY at 50F (5.6.C)					

0.8		1.0		2		2.1		.1.41.		1.7
VELOCITY at 70F (21.1C)										
1.500	500.1000	>1000								
HEAT VALUE (THOUSANDS OF BTU).LB										
0.8	1	1.5	5.9	9.12	12.16					
16.2	162.	21.4	.7	7	10.14					
SUSPENDED SOLIDS										
<5%	5.2%	>20%	weight	Volume						
DISOLVED SOLIDS BY WEIGHT										
<4.5%	5.2%	>20%								
IDENTIFY SOLIDS BY CHEMICAL NAME										

DOES THIS STREAM CONTAIN: SODIUM, PHOSPHOROUS, TITANLUM, OR SILICON? NO/YES: if yes, list on back with concentration SPECIAL HAZARDOUS FOR HANDLING

PRODUCTIVE EQUIPMENT Eye _____ Gloves _____ Respiratory _____
 OTHER _____

Complete the chemical composition table on the back of this sheet. Information MUST be supplied. To the best of my knowledge and ability to determine, this is a complete and accurate description of this waste material .

SIGNATURE _____ TITLE _____
 DATE _____

MATERIAL SAFETY DATA SHEET ATTACHED? (YES/NO) _____

Original copy

DIRECTOR, PETROLEUM RESOURCES



CHEMICAL COMPOSITION OF STREAM

INSTRUCTIONS: List all compounds of the stream (even trace quantities) by chemical name and percentage of stream. If exact percentage chemical composition is unknown or variable give the most accurate RANGE values possible. If additional space is needed attach additional sheets or your company analysis sheet. Specify units if they differ from the units listed on this sheet. For instance , list all heavy metals in ppm.

	CHEMICAL NAME	Molecular Structural Formula	or	% (Vol/Vol)	LD ₅₀ (mg/l)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					

IF ADDITIONAL SPACE IS NEEDED PLEASE ATTACH

DRILLING AND PRODUCTION WASTE INJECTION OPERATIONS

A. BACKGROUND

1. Waste injection is a waste management option for the disposal of cuttings, spent drilling fluids, production water, produced sand/proppants, waste production chemicals and any other waste that can be grinded, pulverized and mixed with water to form a slurry that can be pumped and injected in the subsurface formation that may pose no threat to the deepest underground sources of drinking water.
2. The objective of these guidelines is to ensure that drilling and production wastes are processed and disposed of in a sound and efficient environmental manner.

B. DESCRIPTION OF OPERATION FOR DRILL CUTTINGS

1. A typical waste injection plant consists of an augured conveyor system to move drilling cuttings from the shaker area to the first of two blenders. When cuttings reach the first blender, they are mixed at a ratio of one part cuttings to three parts water.
2. The combined water and cuttings are processed through tungster carbide centrifugal pumps where solids are mechanically dispersed located above the second blender is used to process assorted waste products into the cuttings slurry.
3. After obtaining the desired properties, the processed slurry is transferred from the blender by high pressure piping to a triplex pump for injection downhole into an annular or dedicated disposal well.

C. INJECTABLE WASTES

1.0 OIL FIELD WASTES

- 1.1 Where applicable, licencees/operators shall institute a waste injection technique to process and dispose oil field waste such as:
 - (i) Produced water/brine, except for any produced water whose intended and actual use is in drilling, workover or completion fluids or in enhanced mineral recovery operations.
 - (ii) Oil base drilling mud and cuttings
 - (iii) Water base drilling mud and cutting

- (iv) Drilling, workover and completion fluids
- (v) Production pit sludges.
- (vi) Production storage tank sludges
- (vii) Produced oily sands and solids.
- (viii) Produced formation freshwater.
- (ix) Rainwater from ring levees and pits at production and drilling facilities.
- (x) Natural gas plant processing waste which may be coming with produced formation water.
- (xi) Pipeline test water which does not meet stipulated discharge limitations, or pipeline pig water, i.e. waste fluids generated from the cleaning of a pipeline.
- (xii) Sanitary and all domestic waste generated from drilling and production platforms.
- (xiii) Materials used in oil spill clean-up operations.

2.0 TREATMENT AND DISPOSAL BY INJECTION OF OIL FIELD WASTE

2.1 Operators shall obtain approval of the Director, Petroleum Resources for the storage, treatment and sub-surface disposal of oil/field wastes generated from oil and gas development operations.

2.1.1 Prior to initiating an application for waste re-injection programmes, operators shall consult with the Department of Petroleum Resources to discuss the proposed project and to review requirements and information to be developed for the technical report of the proposed injection project which shall be submitted to the Director, Petroleum Resources as an attachment to the Application form (APPENDIX IX - B), by the licensee.

2.1.2 Operators shall submit to Director, Petroleum Resources, separate application for each intended disposal well which shall be jointly evaluated by a multi-disciplinary team comprising geologists, hydro-geologists, environmentalists, chemists and engineers.

2.2 Permit Requirements

2.2.1 Prior to injection, information on the following requirements shall be provided to the satisfaction of the Director, Petroleum Resources. The information shall form the technical report of the proposed injection programme described in Article 2.1.1.

- (i) Well designation or name, and a description of the well and map or plat of the well location.

- (ii) A case-by-case description of the origin of cutting/oil wastes (well footage drilled with oil based mud)
- (iii) Expected volume of cuttings/wastes to be injected per well (not slurry volume).
- (iv) Description of slurry procedure, including volume of cuttings per volume carrier fluid expected slurry weight/density (ppg).
- (v) Expected slurry weight/density (ppg)
- (vi) Maximum volume of cuttings to be maintained on board rig/garge at any time.
- (vii) Description of surface equipment involved (process flow schematic).
- (viii) Calculated fracture gradient at shoe of annulus.
- (ix) Expected pressure regimes in the well and other near-by wells.
- (x) Maximum expected surface pressure injection.
- (xi) Geological condition of well (geology of injection intervals, any shallow hydrocarbon zones, and any faulting that could transmit injection back to surface).
- (xii) Description of protective skirt or elbow at injection point to negate erosional effects on the casing.
- (xiii) Expected depth at which injection will occur.
- (xiv) Log description of possible injection interval(s).
- (xv) Procedure to be used to seal the injection zone when disposal is completed.
- (xvi) Anticipated time the injection zone will be sealed.
- (xvii) Beginning and ending dates the disposal will occur.
- (xviii) Contingency (control) measures for the waste injection programme.

2.2.2 Licencees shall in addition to the above conditions ensure that:

- (i) Disposal is deeper than surface casing at 1067 metres (3500feet)
- (ii) Mud and/or cuttings are followed by some type of water or completion fluid (exceeding formation pressure).
- (iii) A sign identifying products injected is placed on a tree.
- (iv) Soil hydraulic conductivity and physical properties are described and evaluated to assess potential groundwater aquifer and underground sources of drinking water impacts.
- (v) Groundwater aquifer and underground sources of drinking water contamination will not occur.
- (vi) An injection volume recorder (tamper proof meter) is installed and properly maintained on the injection line of each disposal well system. Injected volumes shall be recorded monthly and reported arrivially on the annual injection well report (FORM)

3.0 OIL FIELD WASTES CONTAINING NORM

3.1 Sources and Characteristics

3.1.1 Naturally Occurring Radioactive Materials (NORM) are produced during petroleum development operations. The radioactive elements and their daughter products, primarily radium 226 (226Ra) and radium 228 (228Ra) can be leached from geologic formations by reservoir fluids and transported to the surface with produced water, oil and gas.

3.1.2 NORM contaminated material exists on the surface in at least two forms.

- (i) a heavy, dense, cement-like mixture of barium, strontium and radium sulfates. This material is precipitated in the production tubing, the well tree and the flow lines. It also tends to settle out in low parts of the line and in the gas-liquid and the oil-water separators. Some of this hard, scale-like material is also trapped in the waste water tanks, pond and sump bottoms and in filters and in the well bore of the well that returns the produced water to the producing formation.**
- (ii) Carbonate/silicate material usually referred to as formation sand. These materials precipitate out in the process stream when there is a decrease in flow rate, change of direction and usually found in thick loosely consolidated deposits in the bottoms of tanks, separators, heater treaters, ponds and sumps.**

3.1.2.1 Both of these types of NORM contaminated materials can be found in sludge that accumulate in the bottoms of oil tanks and vessels, and in filters and other water treatment equipment used to clean up produced water prior to discharge.

3.2 TREATMENT AND DISPOSAL CRITERIA FOR NORM CONTAMINATED MATERIAL

3.2.1 Licencees and/or operators shall be required to obtain approval of the Director, Petroleum Resources for the disposal of oil field wastes containing NORM above background levels.

3.2.2 Treatment and disposal of NORM-contaminated oilfield wastes shall be by encapsulation and deep well injection and other methods satisfactory to the Director, Petroleum Resources.

3.2.3 Encapsulation Criteria

3.2.3.1 As a general rule, the Department of Petroleum Resources shall not approve applications for abandoned wells as disposal locations if any of the following conditions exit:

- (a) The top of the waste is less than 3,000 feet below the seafloor, and a fault intersects the wellbore within this zone;**
- (b) A fault intersects the wellbore and extends to the seafloor;**
- (c) The abandoned well is in an area of sediment instability such as mudflows, slumps and slides.**

3.2.3.2 All perforations open to the producing formation(s) shall be squeezed with cement.

3.2.3.3 All plugs must be pressure tested as per regulations, stipulated by the Department of Petroleum Resources.

3.2.3.4 Sufficient density fluid shall be present in the casing to exert hydrostatic pressure exceeding the greater formation pressure in the intervals between the plugs at the time of abandonment.

3.2.3.5 The top of the wastes shall be at least 1,000 feet below the mudline.

3.2.3.6 Encapsulated wastes shall be isolated below from any open annulus by placing a 200-foot-long cement plug between the waste and the open annulus.

3.2.3.7 If the top of the waste is less than, 3,000 feet below the mudline, there shall be cement covering the casing at all depths above 3,000 feet.

3.2.3.8 A cast iron bridge plug and a 200-foot-long cement plug containing a permanent dye solution shall be placed at the top of the wastes.

3.2.4 Injection criteria

3.2.4.1 The disposal reservoir shall be depleted of commercial hydrocarbons.

- 3.2.4.2** The disposal reservoir/formation shall be isolated (confined) by shale barriers above and below and not contain any producing wells.
- 3.2.4.3** The disposal reservoir/formation shall be far below the deepest underground source of drinking water.
- 3.2.4.4** The wellbore, tabular goods, and control devices shall demonstrate mechanical integrity (no tubing/assign communication).
- 3.2.4.5** Surface tubing/casing annulus pressure shall be continuously monitored with a two-pen chart recorder during injection.
- 3.2.4.6** A base-line radioactive tracer log shall be run prior to injection and a follow-up log shall be run after injection to verify proper placement of the slurry.
- 3.2.4.7** If the well is to be used for future injections, the following procedures shall be followed:
- (a)** A retrievable plug shall be set;
 - (b)** The well shall be marked, clearly indicating the well is being used for the injection of wastes and whether the wastes contain NORM.
 - (c)** The tubing and casing pressure shall be monitored daily on manned structures and weekly on unmanned structures and mechanical integrity (pressure sealing properties) shall be checked annually.

3.3 WORKER SAFETY GUIDELINES

- 3.3.1** The application shall establish to the satisfaction of the Director, Petroleum Resources the existence of producers adequacy to protect those workers responsible for disposal operations.
- 3.3.2** Any employer of persons engaged in activities involving wastes containing NORM above background levels (including transportation, storage, sampling, mixing, and disposal operations) shall comply with the provisions of the Mineral Oil (Safety) Regulations, 1997.
- 3.3.3** All onsite contractors directly involved with the handling or disposal of NORM wastes shall be trained in the handling of NORM and licensed pursuant to a programme acceptable to the Director, Petroleum Resources.

3.4 APPLICATION GUIDELINES

3.4.1 Disposal information

3.4.1.1 All applications shall be submitted to the Director, Petroleum Resources and shall address the following aspects of the disposal operation:

3.4.1.1.1 A description of the material to be disposed of including:

- (a) Whether the waste is to be formed into a slurry and a description of the medium to be used to form the slurry (e.g., barite/bentonite, saltwater with HEC viscosifier, cement);**
- (b) The number of containers to be disposed of, a description of the contents of each container (example: a half – filled container of oily produced sand), and of the container itself (a 55-gallon drum, a barrel, PVC pipe, etc);**
- (c) A description of any miscellaneous material or wastes to be disposed of;**
- (d) The area(s) and block number(s) where the materials originated;**
- (e) If the waste contains NORM above background levels;**
 - (i) the location(s), if any, where the material had been stored,**
 - (ii) the radiation exposure rate for each container and for background conditions in microrems/hr.**
- (f) A description or listing of any unusual contaminants that may be present, or of any contaminants having unusually high levels, if known, within the material to be disposed of; and**
- (g) Any document submitted to Department Petroleum Resources prior to the disposal event.**

3.4.1.1.2 The lease number, area, block number, and well number of the disposal well.

3.4.1.1.3. The distance in feet/metres of the disposal well from the two nearest lease lines and the latitude and longitude of the disposal well.

3.4.1.1.4 The disposal technique (i.e., injection, encapsulation, etc.).

3.4.1.1.5 A description of the procedure for injection or encapsulation (i.e., fracture procedure, plugs to be set, etc.).

3.4.1.1.6 A schematic of the wellbore prior to encapsulation/injection and the proposed

wellbore schematic after encapsulation/injection.

3.4.1.1.7 An assurance that the worker safety guidelines outlines in Section 3.3 shall be adhered to.

3.4.1.1.8 Encapsulation Information

If any or all of the oil and gas waste is to be encased in tubulars/casing, the application shall state:

- a. The size, grade, and weight per foot of the tubulars/casing;
- b. The sub-surface depth of both the top and bottom of the tubulars/casing;
- c. Whether the tubulars casing shall be free in the hole or shall be secured by cement, a bridge plug, or a cement retainer.

3.4.1.1.9 Injection Information

- a. A description of any dilution procedure to be used prior to injection.
- b. A structure map of the formation that is to receive the injected slurry.
- c. A 5-inch open hole log showing the injection zone and the shade above and below this zone. The log shall contain spontaneous potential or gamma ray and resistivity curves.
- d. The maximum anticipated surface and reservoir injection pressure.
- e. A model simulation of the fracture that will be produced during the injection procedure (i.e., length, height, and width of fracture).
- f. The predicted maximum distance from the wellbore the injected slurry shall be placed.
- g. The distance to the nearest fault from the injection zone.

3.4.2 Offshore Storage Guidelines

3.4.2.1 When wastes containing NORM above background levels are to be temporarily stored offshore, applications for storage shall be submitted to the Director of Petroleum Resources and shall contain the following information:

- (i) The lease number, area, block, and platform where storage is required.
- (ii) Whether the platform proposed for storage is a manned or unmanned platform.
- (iii) The number of containers, a description of the wastes within the containers, and a description of the containers.

- (iv) For wastes containing NORM above background levels to be stored at the platform, the radiation exposure rate (microrems/hr) for each container and for background conditions.
- (v) The length of time requested for storage (not to exceed 1 year).
- (vi) The method of securing the containers to the platform to avoid loss during severe storms or hurricanes.
- (vii) The height above sea level of the deck(s) on which the storage is to take place.
- (viii) The lease number(s), area(s), and block(s) where the material originated.
- (ix) Similar information for additional containers to be stored on the platform should be provided to the Director of Petroleum Resources prior to placement.

3.5 REPORTING AND RECORDKEEPING

3.5.1 All applications for disposal operations shall provide an endorsement by the applicant that a report shall be submitted to the Director, Petroleum Resources within 30 days of the disposal describing:

- (i) The results of the operation,
- (ii) A discussion of any problems encountered during the disposal operation,
- (iii) If the material was disposed of in containers:
 - a. The total number of containers,
 - b. A description of the wastes in each container,
 - c. A description of the containers used.
- (iv) If the material was disposed as a slurry, the wet weight of the waste slurry.
- (v) Radiation Exposure Rate Measurements:
 - a. The radiation exposure rate, reported in microrems/hr, obtained from the outside of each container of NORM waste prior to disposal and from the 1 liter sample by placing the sensing element in direct contact with the top or bottom and the four sides of the middle of the container and liter sample;
 - b. For solid materials of odd sizes, such as pipe, the radiation exposure rate readings shall be taken from at least three different accessible points with the highest reading recorded. Pipe exposure rate readings shall be taken from the middle and end of the pipe;
 - c. The average of each group of measurements for the containers, the liter samples, and/or the odd-sized materials, as well as the highest reading recorded for each group;
 - d. A recorded background reading and;

- e. The survey, calibration, and measurement shall be performed by trained personnel. The radiation detection instrument shall measure gamma radiation, shall be capable of measuring 1 microrentgen per hour through 500 microrentgens per hour, and shall be calibrated by a qualified person at intervals not to exceed 12 months.

3.5.2 NORM Storage Operations:

- (i) The operator shall maintain records indicating the beginning date of storage; the origin of the stored material and, if applicable, where the material was previously stored; the radiation exposure measurements for each container; and the total number of containers.
- (ii) The operator shall notify the Director, Petroleum Resources within 30 days when the material is no longer stored at the site.

4.0 MONITORING OF INJECTION WELLS

4.1 Annular Pressure Monitoring

- (i) Except during approved workover operations, a positive pressure of no less than 100psi shall be maintained on the well annulus at all times. In addition, an injection volume recorder (tamper proof meter) shall be installed and properly maintained on the injection line of each disposal well system. Injected volumes shall be recorded monthly and reported annually to the Director, Petroleum Resources on the annual injection well report.
- (ii) Except during approved workover operations, wells shall be equipped with pressure gauges located on the wellhead, and situated so as to monitor the pressure of the injection stream and the pressure on the wellhead, and situated so as to monitor the pressure of the injection stream and the pressure of the annular space between the casing and the injection string.
- (iii) The pressure gauges shall have half-inch fittings, be scaled in increments of not more than 10psi, and be maintained in good working order at all times.
- (iv) A daily pressure monitoring log shall be maintained by the operator of the facility and shall contain the following:
 - (a) The date,
 - (b) The operator's name and address
 - (c) The well name, number and serial number
 - (d) The monitored injection pressure
 - (e) The monitored annulus pressure
 - (f) Whether or not the well was injecting at the time the pressure were recorded

- (g) The name or initials of the person logging the information.
- (v) The pressure gauges shall be reading pressure recorded in the daily log.
- (vi) The daily log information shall be recorded on the appropriate form and submitted to the Director, Petroleum Resources within fifteen (15) days of the end of each month.
- (vii) Any discrepancies in the monitored pressures, which shall indicate a lack of mechanical integrity and constitute noncompliance with applicable sections of this order, shall be reported to the Director, Petroleum Resources within twenty-four (24) hours.
- (viii) All fluctuations below the minimum annular pressure requirements shall be thoroughly investigated for cause and timely action shall be taken to correct the anomaly.

4.2 Well Mechanical Integrity Test and Injection Reservoir Monitoring.

4.2.1 The following tests or surveys shall be performed on the waste injection wells or subsurface injection formations:

(i) Radioactive Tracer Surveys:

- (a) A Radioactive Tracer survey with time – drive supplement shall be performed on the disposal well at least once every five years. The results of the survey shall be submitted to the Director of Petroleum Resources for review and approval.
- (b) Regardless of survey frequency, Radioactive Tracer Survey with time-drive supplements shall be performed on disposal wells whenever remedial actions designed to improve or enhance the injection of the disposal wells or disposal formations are undertaken. The results of the surveys shall be submitted to the Director of Petroleum Resources for review and approval.

(ii) Temperature Falloff Testing

- (a) A temperature log shall be performed on the disposal formation well at least once every year. The results of the survey shall be submitted to the Director of Petroleum Resources for review and approval.

(iii) Pressure Falloff Testing

- (a) **Pressure falloff testing shall be performed on the subsurface disposal formation of the injection well annually. The results of the tests shall be submitted to the Director of Petroleum Resources for review and approval.**

4.3 Monitor Well Sampling and Testing

- (i) **Water samples from monitor wells shall be sampled by an independent professional consultant and analyzed by an independent testing laboratory. Samples shall be analyzed for pH, electrical conductivity (EC), Chloride (Cl), Sodium (Na), total dissolved solids (TDS), total suspended solids(TSS), oil and grease (%), phenols, benzene, toluene, ethylbenzene, xylenes (BTEX), total Petroleum hydrocarbons (TPH), trace metals – Arsenic (AS), barium (Ba), Cadimium (Cd), Chromium (Cr), Lead (Pb), Mercury (Hg), Selenium (Se), Silver (Ag), Vanadium (V), Nickel (Ni), Copper (Cu), Iron (Fe), and Zinc (Zn).**
- (ii) **Water from monitor wells shall be sampled and analyzed on a quarterly basis, with a copy of the analysis submitted to the Director of Petroleum Resources within fifteen (15) days of the end of each quarter.**

APPENDIX VIII-C4

TESTING CRITERIA FOR RE-USABLE MATERIALS

<u>Testing</u>	<u>Limitations</u>
i) Moisture Content	<50% (By Weight) or zero free moisture
ii) pH	6.5 - 9.0
iii) Electrical Conductivity(EC)	8mmhos/cm
iv) Sodium Adsorption Ratio(SAR)	12
v) Exchangeable Sodium Percentage(ESP)	15%
vi) Leachate Testing For:	
Oil & Grease	100mg/l
Chlorides	5000mg/l
Arsenic	5mg/l
Barium	100mg/l
Cadmium	1mg
Chromium	5mg/l
Lead	5mg/l
Mercury	12mg/l
Silver	5mg/l
Zinc	50mg/l

Section I

GENERATOR (Generator completes all of Section I)

a. Generator Name: _____ b. Generating Location: _____

c. Address _____ d. Address: _____

e. Phone No.: _____ f. Phone No.: _____

If owner of the generating facility differs from the generator, provide:

g. Owner's Name: _____ h. Owner's Phone No.: _____

i. ASSIGNED WASTE CODE Containers

j. Description of waste: _____ k. Quality Units No. Type

TYPE	
DM - METAL DRUM	
DP - PALSTIC DRUM	
B - BAG	
BAG or WRAP	
T - TRUCK	
O - OTHER	

GENERATOR'S CERTIFICATION: I hereby certify that the above named material has been Properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations:

UNITS	
Y - YARDS	P - POUNDS
M ³ -CUBIC METERS	
Y ³ - CUBIC YARDS	
O - OTHER	

Generator Authorized Agent Name

Signature

Shipment Date

Section II

TRANSPORTER (Generator complete a-d; Transporter I complete e-g)
Transporter II complete h-n)

a. Name: _____

b. Address: _____

c. Driver Name/Title: _____

d. Phone No.: _____ e. Truck No.: _____
PRINT/TYPE

f. Vehicle License No./State: _____
Acknowledgement of Receipt of Materials.

g. _____

Driver Signature

Shipment Date

h. Name: _____

i. Address: _____

j. Driver Name/Title: _____

k. Phone No.: _____
PRINT/TYPE

m. Vehicle License No./State: _____

n. _____

Driver Signature

Shipment Date

SECTION III

DESTINATION (Generator completes a-d, destination site completes e-f)

a. Site Name: _____

c. Phone No.: _____

b. Physical Address: _____

d. Mailing Address _____

e. Discrepancy Indication Space: _____
hereby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate

f. _____ □□□□□□

Name of Authorized Agent	Signature	Receipt Date
---------------------------------	------------------	---------------------

CERTIFICATION: I hereby declare that the contents of this consignment are fully accurately described above by proper shipping name and are classified, packaged marked, and labelled/placarded, and in all respects in proper condition for transport according to applicable section and national governmental regulations.

e. Shippers's Name & Title: _____	_____	□□□□□□
Print/Type	Shippers's Signature	Date

f. Name and Address
of Responsible Agency: _____

GENERATOR'S WASTE PROFILE SHEET

PLEASE PRINT IN INK OR TYPE

DPR'S PERMIT OBTAINED: PERMIT NUMBER: PROFILE NUMBER:

<input type="checkbox"/> Hazardous	<input type="checkbox"/> Non-Hazardous
Renewal Date:	



1. Generator Name: _____ 2. Facility Street Address: _____
 3. Phone: ____ (____) _____ 4. Facility City: _____
 5. State: _____ 6. Postal Code: _____
 7. Local Govt: _____ 8. Customer Name: _____
 9. Customer Phone: ____ (____) _____ 10. Customer Contact: _____
 11. Customer Fax: _____

Same as above

B. Waste Stream Information

1. Description
 a. Name of Waste: _____
 b. Process Generating Waste: _____

c. Color	d. Strong odor (describe):	e. Physical state @ 70°F <input type="checkbox"/> Solid <input type="checkbox"/> Liquid <input type="checkbox"/> Gas <input type="checkbox"/> Sludge <input type="checkbox"/> Other	f. Layers <input type="checkbox"/> Single Layer <input type="checkbox"/> Multi-Layer	g. Free liquid range to % h. pH: Range to %

i. Liquid Flash Point: <73°F 73-99°F 100-139°F 140-199°F ≥200°F Not applicable
 j. Chemical Composition (List all constituents (including halogenated organics, debris, and UHC's) present in any concentration and submit representative analysis):

Constituents	Concentration	Constituents	Concentration Range
--------------	---------------	--------------	---------------------

	Range			

TOTAL COMPOSITION MUST EQUAL OR EXCEED 100%

- k. Oxidizer Pyrophoric Explosive Radioactive
 Carcinogen Infectious Shock Sensitive Water Reactive

l. Does the waste represented by this profile contain any of the carcinogens?
(list in Section B.1.j)

YES NO

m. Does the waste represented by this profile contain dioxins? (list in Section B.1.j)

YES NO

n. Does the waste represented by this profile contain asbestos?

YES NO

If yes friable non-friable

o. Does the waste represented by this profile contain benzene?

YES NO

If yes, concentration _____ ppm

p. Does the waste contain <500 ppmw volatile organic (VO)?

YES NO

Volatile organic concentration _____ ppm

q. Does the waste contain any ozone-depleting substances?

YES NO

r. Does the waste contain debris? (list in Section B.1. j)

YES NO

2. Quantity of Waste

Estimated Annual Volume _____ Tons Yards Drums

Other (specify) _____

3. Shipping Information

a. Packaging:

Bulk Solid; Type/Size: _____ Bulk Liquid; Type/Size:

_____ Drum; Type; size: _____ Other:

b. Shipping Frequency: Units _____ Per: Month Quarter Year

One time Other _____

c. Is this a Hazardous Material? (If no, skip d, e, and f)
..... YES NO

d. Reportable Quantity (lbs.; kgs.): _____ e. Hazard Class/ID #: _____

f. Personal Protective Equipment Requirements:

g. Transporter/Transfer Station:

C. Generator's Certification (Please check appropriate responses, sign, and date below.)

1. Is this a DPR hazardous waste?
..... YES NO

a. If yes, identify ALL DPR listed RCI and characteristic wastes

b. If a characteristic hazardous waste, do underlying constituents (UHCs) apply? (if yes, list in Section B.1.j)

..... YES NO

c. Does this waste contain debris? (If yes, list size and type in Chemical Composition - B.1.)

..... YES NO

2. Is an Emergency Response Procedure Plan Available and Tested?
..... YES NO

3. Does the waste represented by this waste profile sheet contain radioactive material,

or is disposal regulated by the Nuclear Regulatory Agency?
..... YES NO

4. Does the waste represented by this waste profile sheet contain concentrations of

Polychlorinated Biphenyls (PCBs)? (if yes, list in Chemical Composition - B.1.j) YES NO

a. If yes, were the PCBs imported into Nigeria?
..... YES NO

5. Do the waste profile sheet and all attachments contain true and accurate descriptions

of the waste material, and has all relevant information within the possession of the

Generator regarding known or suspect hazards pertaining to the waste been

Instructions

Information on this form is used to determine if the waste may be transported, treated, store or disposed in a legal, safe and environmentally sound manner. Answers must be provided for sections A, B, and C and must be printed in ink or typed. A response of "NONE" or "NA" (not applicable) can be made if appropriate. If additional space is needed, indicate on the form that additional information is attached, and attach the information to Generator's Waste Profile Sheet.

A. Waste Generator Information

1. **Generator Name** - Enter the name of the facility where the waste is generated.
2. **Facility Street Address** - Enter the street address (not P.O.Box) of the facility where the waste is generated.
3. **Phone** - Enter Generator's area code and phone number.
4. **Facility City** - Enter the city where the waste is generated.
5. **State** - Enter the state where the waste is generated.
6. **Postal Code** - Enter the generating facility's postal code.
7. **Local Government** - Enter the local government where the waste is generated.
8. **Customer Name** - Entity that the Contractor is directly working with regarding the represented waste stream. If the same as the Generator, mark "Same as Above".
9. **Customer Phone** - Enter technical contact's area code and telephone number.
10. **Customer Contact** - Enter the name of the person who can answer technical questions about the waste.
11. **Customer Fax** - Area code and facsimile number for the customer.

B. Waste Stream Information

- 1.a. **Name of Waste** - Enter a name generally descriptive of this waste (e.g., paint sludge, fluorescent bulbs).
- 1.b. **Process Generating Waste** - Describe the process generating the waste in detail. List the specific process/operation or source that generates the waste (e.g., incineration of municipal refuse, asbestos removal, wastewater treatment, building maintenance).
- 1.c. **Colour** - Describe the colour of the waste (e.g., blue, transparent, varies)
- 1.d. **Strong odour** - **DO NOT SMELL THE WASTE!** If the waste has a known odour, then describe (e.g., acrid, pungent, solvent, sweet).
- 1.e. **Physical state @ 70°F** - If the four boxes provided do not apply, a descriptive phrase may be entered after "Other" (e.g. multi-phase).
- 1.f. **Layers** - Single Layer means the waste is homogenous. Multi-layer means the waste is comprised of two or more layers (e.g., oil/water/sludge).
- 1.g. **Free liquid range** - Range (in percent by volume) of free liquids in the waste.

- 1.h. pH Range - Indicate the pH range.
 - 1.i. Liquid Flash Point - Indicate the flash point obtained using the appropriate test method.
 - 1.j. Chemical composition - List all organic and/or inorganic components of the waste using chemicals names. If trade names are used, attach Material Safety Data Sheets or other documents that adequately describe the composition of the waste. For each component, estimate the range (in percent) in which the component is present.
 - 1.k. Check all that apply.
 - 1.l. Identify any element, chemical compound, or mixture in concentration of 0.1 percent or greater that is considered a carcinogen or potential carcinogen.
 - 1.m. Indicate if the waste contains any dioxins (list in Section B.1.j).
 - 1.n. Indicate if the waste contains asbestos. Indicate if the asbestos is friable.
 - 1.o. Indicate if the waste contains benzene, the level in ppm, and whether it is subject to the benzene NESHAP.
 - 1.p. indicate if the waste contains less than 500 ppmw Volatile Organic (VO). Indicate the VO concentration, if known, in parts per million weight.
 - 1.q. Indicate if the waste contains any ozone-depleting controlled substances.
 - 1.r. Indicate if the waste contains debris (list size and type in B.1.j).
2. Quantity of Waste - Appropriate volume in tons, yards or other (e.g., drums, gallons) that will be received by the ultimate management facility. This volume amount is not intended for use in complying with state and/or permit restrictions.
- 3.a. Packaging - Choose the appropriate option or "other" along with a description.
 - 3.b. Shipping Frequency - Choose the appropriate option or "other along with as description.
 - 3.c. Is this a hazardous material? - Choose the appropriate response: yes or no.
 - 3.d. Reportable Quantity (ibs.;kgs.) - if the answer to 3.c. is yes, enter the Reportable Quantity (RQ) Indicate the appropriate units for the RQ.
 - 3.e. Hazard Class/ID # - If the answer to 3.c. is yes, indicate the proper hazard class and identification number.
 - 3.f. Personal Protective Equipment Requirements - All personal protective equipment Necessary to safely manage the waste stream.
 - 3.g. Transporter/Transfer Station - Transporter and/or transfer station name.

C. Generator's Certification (Please check appropriate responses, sign, and date below.)

Indicate the appropriate response to questions/statements 1,2,3,4,5,6 and 7. By signing this Generator's Waste Profile Sheet, the Generator certifies the responses are true and accurate with respect to the waste stream(s) listed.

Certification Signature - Signature of an authorized employee of the Generator.
or authorized representative of the generator.

Title - Enter Employee's title.

Name - Type or Print Employee's name.

Company Name - Company employing the person certifying the Generator's Waste Profile Sheet.

ACRONYMS

- * RCI - Reactivity, Corrosivity & Ignitability
- * DPR - Department of Petroleum Resources
- * TCLP - Toxicity Characteristic Leaching Procedure

D. STANDARDIZATION OF TEST PROCEDURES FOR MONITORING PHYSICO - CHEMICAL PARAMETERS

1.0 BACKGROUND

- 1.1 The Guidelines and Standards provided herein shall cover all effluent stream sampling and analysis procedures for water, soil and sediment media, irrespective of the area of operation in the Petroleum Industry.
- 1.2 In 1980, the Department of Petroleum Resources issued out some analytical methods selected for measuring several physico-chemical parameters by the Oil Companies. Some oil companies used the recommended analytical methods to monitor both effluent discharges and recipient ecosystems, while many others used methods different from those recommended.
- 1.3 The objectives of these formulated guidelines are:
- (i) Up-date and standardize the analytical methods to include all parameters to be measured.
 - (ii) Provide the criteria necessary for the selection of the best method to measure each parameter and achieve the desired results, taking into account the sensitivity of the method, interferences present and the variations in precision and accuracy that can be tolerated.
 - (iii) Recommend one or more analytical methods for each parameter in order to facilitate data evaluation interpretation and comparison.
 - (iv) Provide general guidelines on sampling, analyses and laboratory safety for quality control and quality assurance.

2.0 STANDARD PROCEDURES FOR SAMPLING AND ANALYSES

- (i) Sampling shall involve obtaining a representative portion of the material concerned.
- (ii) The samples shall represent the conditions existing at the point taken and time of sampling.

- (iii) The samples shall be of sufficient volume and shall be taken frequently enough to permit reproducibility of testing requisites, for the desired objective, as conditioned by the method of analysis to be employed.
- (iv) The samples shall be collected, and preserved prior to analysis in a manner that safeguards against change in the particular constituents or properties to be examined.
- (v) Contact with any material other than the original container shall be avoided to prevent possible contamination or alteration of the sample.

2.1 Water Sampling

2.1.1 The goal of sampling shall be to obtain for analysis a portion of the main body of water that is truly representative. The most critical factors necessary to achieve this shall be:

- (i) Points of Sampling
- (ii) Sampling Time
- (iii) Frequency
- (iv) Maintenance of integrity of the sample prior to analysis.

2.1.2 Sampling Points: Normal sampling points shall be as listed below:

- i) Effluent at discharge point
- (ii) Effluent of Primary Tanks - This point shall be selected near the lower end of the effluent channel to allow thorough mixing of effluent.
- (iii) Influent (e.g., raw water.-) - At a convenient point prior to any treatment where representative sample can be obtained..
- (iv) Receiving Stream - At least 500 metres up-stream and downstream from entry of effluent.

2.1.3 Collection of Samples: Care shall be taken to obtain a sample that is truly representative of existing conditions and to handle it in such a way that it does not deteriorate or become contaminated before it reaches the laboratory. Before filling, the sample container shall be rinsed out two or three times with the water being collected.

2.1.4 Sample Containers:

- (i) Sample containers shall be made of materials that will not contaminate the samples and before use, shall be cleaned thoroughly to remove all extraneous surface dirt. Chemically resistant glass, rigid and collapsible plastic containers of polyethylene shall be suitable materials for the containers.
- (ii) The closures for the sample containers shall be glass stoppers that have been thoroughly washed or plastic caps with suitable liners.

2.1.5 Sample Labels

Space shall be provided for the following information on an etched area of the bottle, a gummed label or a cardboard or linen tag securely affixed to the container:

- (i) Sample Number
- (ii) Date and Time of Sampling
- (iii) Point of Sampling (Designated in sufficient detail to enable anyone to collect a second sample from the identical spot from which the first sample was taken).
- (iv) Temperature of Sample

2.1.5.1 **The following information shall be provided in a field note book.**

- (i) Results of Field Tests made on the Sample;

- (ii) Temperature and Rate of Flow of the Fluid in the Equipment from which the Sample was taken;
- (iii) Type and Quantity of preservative added;
- (iv) Name and Signature of Sampler.

2.1.6 Sample Shipping Containers

- (i) The sample shipping container shall be a case having a separate compartment for each sample container. The compartment around each container shall be lined with corrugated paper or other suitable materials, with the containers held in place with spring clips; an elastic packing material may be used.
- (ii) The stoppers closing the sample container shall be fixed in place by wire, tape, or cord to prevent leakage in transit.
- (iii) The sample containers shall be of such size that when filled with the desired amount of sample, space roughly equivalent to 1% of the volumetric capacity of the containers will be available for expansion of the liquid.

2.1.7 Shipping Label

- (i) The addresses of consignee and consignor shall be plainly printed upon two sides of the outer container, or attached firmly thereon by cards or labels.
- (ii) Warning and descriptive labels shall be attached to the outer containers, such as "Fragile", "Hazardous", "Corrosive", "Flammable", etc., where applicable.

2.1.8 Types of Sampling

- (i) Grab Sampling: This practice shall be for the collection of a grab sample of water from sources such as wells, rivers, streams, lakes, oceans, reservoirs, pipelines and conduit processing tanks and valves etc., at atmospheric or higher pressures and at a specific site representing conditions only at the time of sampling.
- (ii) Composite Sampling: This practice shall be for the collection of a composite water sample at a specific site, portions of which are collected at varied time intervals. Alternatively, the composite shall consist of portions collected at various sites or a combination of both site and time.
- (iii) Continual Sampling : This practice shall provide a continuous flowing sample, from one or more sampling sites, suitable for on-stream analysers.

2.1.9 Sample Preservation - The objectives of sample preservation shall be to:

- (i) Retard biological action;
- (ii) Retard hydrolysis of chemical compounds and complexes and;
- (iii) Reduce volatility of constituents. They are also generally limited to pH control, chemical addition, refrigeration, and freezing.

2.1.10 Recommended Sample Preservation Practices: The recommended practices shall be in accordance with the requirements specified in Tables VIII-D1 through D4.

TABLE VIII-D1 PRESERVATIVES THAT MAY BE USED TO RETARD CHANGES IN SAMPLES INTEGRITY

PRESERVATIVES	ACTION	APPLICABLE TO:
1. HgCl ₂	Bacterial inhibitor	Nitrogen forms, phosphorous forms
2. Acid (HNO ₃)	Metal solvent percents Precipitation	Metal
3. Acid (H ₂ SO ₄)	Bacterial inhibitor Salt formation with organic bases	Organic samples (COD), Oil and Grease, organic carbon, etc.) Ammonia, amines
4. Alkali (NaOH)	Salt formation with volatile compounds.	Cyanides, organic acids.
5. Refrigeration or freezing	Bacterial inhibitor	Acidity, Alkalinity, organic Material, BOD ₅ , Colour, Odour, Organic, organic N, carbon, etc., Biological organisms (Coliform, etc.)

TABLE VIII -D2 - RECOMMENDED CHOICE OF PRESERVATIVES FOR VARIOUS CONSTITUENTS

S/N	PARAMETER	REQUIRED VOL (ML)	CONTAINER	PRESERVATION	MAXIMUM HOLDING PERIOD
1	pH	35	P,G	Cool, 4 °C Det. On site	6 hours
2	Electrical Conductivity	100	P,G	Cool, 4 °C	24 hours
3	Colour	50	P,G	Cool, 4 °C	24 hours
4	Odour	200	G,only	Cool, 4 °C	24 hours
5	Turbidity	100	P,G	Cool, 4 °C	7 days
6	Total Dissolved Solids (TDS)	50	P,G	Filter on site cool 4°C	24 hours
7	Total Suspended Solid (TSS)	50	-	Filter on site	6 months
8	Total Hardness	100	P,G	Cool, 4°C HNO ₃ to pH <2	7 days
9	Acidity and Alkalinity	100	P,G	Cool, 4 °C	24 hours
10	Salinity as Cl	50	P,G	None required	7 days
11	Chemical Oxygen Demand (DD)	50	P,G	2ml H ₂ SO ₄ per litre	7 days
12	Biochemical Oxygen Demand (BODs)	1,000	P,G	Refrigeration at 4°C	6 hours
13	Surfactants as	250	P,G	Cool, 4 °C	24 hours

	(MB AS)				
14	Dissolved Oxygen (DO)	300	G, only	Det. On site	No holding
15	Ammonia	400	P,G	Cool, 4 °C H ₂ SO ₄ to pH<2	24 hours
16	Oil & Grease	1,000	G, only	Cool, 4 °C H ₂ SO ₄ or HCL to pH <2	24 hours
17	Nitrate NO ₃	100	P,G	Cool, 4 °C H ₂ SO ₄ to pH < 2	24 hours
18	Sulphate (SO ₂ /4)	50	P,G	Cool, 4 °C	7 days
19	Carbonate (CO ₃) free CO ₂ & HCO ₃	-	P,G	-	-
20	Cyanides	500	P,G	Cool 4°C NaOH to pH 12	24 hours
21	Phosphorous	-	-	40 mg, HgCl ₂ per litre 4°C	7 days
22	Phenolics	500	G, only	Cool, 4°C H ₂ PO ₄ to pH<4 1.g CuSO ₄ /Litre	24 hours
23	Chromium	100	P,G	HNO ₃ to pH <2	-
24	Arsenic	100	P,G	HNO ₃ to pH <2	6 months
25	Cadmium	100	P,G	HNO ₃ to pH <2	6 months
26	Cobalt	-	P,G	HNO ₃ to pH <2	6 months
27	Copper	-	P,G	HNO ₃ to pH <2	6 months
28	Iron	-	P,G	HNO ₃ to pH <2	6 months
29	Mercury	100	P,G	Filter, HNO ₃ to pH <2	38 days (GLASS)
30	Lead	100	P,G	HNO ₃ to pH <2	6 months
31	Nickel	100	P,G	HNO ₃ to pH <2	6 months
32	Zinc	100	P,G	HNO ₃ to pH <2	6 months
33	Vanadium	100	P,G	HNO ₃ to pH <2	6 months
34	Calcium	100	P,G	None required	7 days
35	Magnesium	100	P,G		6 months

- P = Plastic
- G = Glass

TABLE VIII-D3: RECOMMENDED PRESERVATION PRACTICE FOR GENERAL ORGANIC CONSTITUENT METHODS.

S/N	ORGANIC CONSTITUENT	METHOD ANALYSIS	OF	RECOMMENDED PRESERVATION PRACTICE
1	COD	D 1252		H ₂ SO ₄ , or Sodium Bi-sulphate and refrigeration at 4oC
2	Total Organic Carbon	D 2579 Combustion Infra-red		Refrigeration and HCL
3	Volatile Organic Matter in water	D 2908 aqueous gas		Refrigeration and H ₂ SO ₄ or Sodium Bisulphite
4	Total Organic Demand	D 3250 Combustion		Refrigeration and HCL
5	Purgeable Organic Compounds	D 3871		Hermetical Sealing and Refrigeration

TABLE VIII-D4 RECOMMENDED PRESERVATION PRACTICE FOR SPECIFIC ORGANIC CONSTITUENT METHODS

S/N	ORGANIC CONSTITUENT	METHOD ANALYSIS (ASTM)	OF	RECOMMENDED PRESERVATION PRACTICE
1	Phenolic Compounds	D 1783 - 4AAP Method		Refrigeration and H ₂ SO ₄ or Na HSO ₃ or H ₃ P ₀ ₄
2	Morpholine	D 1942		HCL
3	Cyanide (CN)	D 2036		NaOH in presence of Chlorine,Chlorine removal
4	Cyanogen Chloride	D 2036		None (analysis as soon as possible)
5	Primary and Secondary Amines	D 2327		HCl
6	Alkyl Benzyl Sulphonate	D 2330		H ₂ SO ₄ or NaHSO ₃
7	Phenolics	D 2580-Gas-Liquid Chromatography		Refrigeration and H ₂ SO ₄ or NaHSO ₃
8	Cyclohexylamine	D 2909		HCl
9	Pesticides, Organochloro	D 3086		Refrigeration
10	Ethylenediamine tetra - acetate	D 3113		Refrigeration
11	Chlorophenoxy Acid (Herbicides)	D 3478		Refrigeration and H ₂ SO ₄ or NaHSO ₃

12	Poly biphenyls	chlorinated	D 3534	Refrigeration
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2.2 Solid Sampling

2.2.1 Any scheme for the selection of a soil sample for laboratory study must recognise:

- (i) Changes in soil properties with lateral and vertical displacement.
- (ii) The variation in a soil property from point to point that may be of considerable magnitude and the rate of change, which may be gradual in some cases and abrupt in others.

2.2.2 Profile Sampling

- (i) A pit shall be dug to display the various soil layers (horizons) in vertical cross section (profile), if sampling in depth is desired at a specific point on the land surface. Care shall be exercised to avoid incorporation of soil from different horizons in the same sample.
- (ii) Care shall be taken when sampling lower horizons to prevent contamination with loose soil from upper layers.
- (iii) Transition zones between horizons shall be allowed to prevent errors.
- (iv) When a sample of the surface soil only is desired e.g. the plowed layer of a cultivated field, any surface litter of undecomposed vegetable material shall be removed, and a sample of uniform cross-section taken to the desired depth (sample Unit).

2.2.3 Area Sampling

- (i) To obtain a sample representative of a soil area, differences in soil properties from point to point on the land surface shall be recognised.
- (ii) Estimate of mean values shall be obtained from a sample composited from several sampling units, taken from a sampling area.
- (iii) The number of sampling units taken to make up the sample shall be governed by the variability of characteristics under test and the degree of accuracy of the estimate desired.
- (iv) Twenty (20) to thirty (30) sampling units for surface horizons are recommended as minimum values for some purposes. The sampling units shall be taken from sites chosen at random within the sampling area.

2.2.4 Sampling Tools: The ideal sampling tool shall be one that gives an uncontaminated, reproducible sampling unit of approximately uniform cross section to the desired depth.

2.2.5 Sample Preparation:

- (i) The soil sample shall be placed in a non-contaminated container. Closely woven cloth or sacks shall be convenient for this purpose.
- (ii) The sample shall be spread on a sheet of heavy paper in a room free of dust or chemical fumes, as soon as possible after collection for air-drying.
- (iii) Any large chips or clods shall be broken to hasten drying process.
The soil sample shall be passed through a sieve with openings of 2 mm. in diameter when dry.
- (iv) Any material that fails to pass the sieve shall be placed on a clean hard surface, and crushed with a hard wood roller or rubber type pestle.
- (vi) It shall be unnecessary and undesirable to reduce rock fragments or coarse vegetable remains to 2 mm. size but the crushing and sieving shall continue until all primary particles smaller than 2 mm. in diameter have passed through the sieve.
- (vii) The sieve sample shall be thoroughly mixed and reduced by quartering or other suitable means and the stock sample so prepared, stored in a close glass container. This shall be used directly for many different chemical determinations.

- (viii) Great care shall be taken in taking sub-samples from the stock sample for chemical analysis or for further grinding because of the tendency for soil particles of different sizes to segregate. This may result in large sub-sampling errors because of the chemical nature of the large primary particles (sand fraction) which is usually quite different from that of the silt and clay particles.

2.2.6 Sample Containers.

- (i) Container paper bags fitted with plastic (polyethylene) liners shall be used for field collection and transportation of samples to the laboratory.
- (ii) The samples shall be dried on sheets of plastic and sieved through screens of nylon or similar material.

2.2.7 Sediment Samples Preparation for Chemical Analysis

- (i) Details on preliminary treatment of field samples, preparation of analytical samples, drying procedure, moisture correction and calculation shall be in accordance with the Standard Practice for Preparation for Sediment Samples for Chemical Analysis (refer to ASTM D3976-80)
- (ii) The preparation, standardization and storage of standard solutions for chemical and analysis shall as specified in ASTM E200 - 86.

2.3 Solid wastes

2.3.1 The method and equipment used for sampling waste materials will vary with the form and consistency of the waste materials to be sampled. Standard Methods approved by the Department of Petroleum Resources are as follows:

- i) Extremely viscous liquid - ASTM D140-70
- ii) Crushed or powdered material - ASTM D346-75
- iii) Soil or rock-like material - ASTM D420 - 69
- iv) Soil like material - ASTM D 1 452-65
- v) Fly-ash-like material - ASTM D2234-76

2.4 Recommended Test Methods For Physico-Chemical Parameter Analysis:

2.4.1 The recommended standard test methods for the determination of each physico-chemical parameter shall be as provided in Appendix VIII – D1.

2.5 Method of Reporting Results

2.5.1 All analytical results on water, soil and sediment samples shall be reported in accordance with standard method of reporting (ASTM D. 596).

3.0 ANALYTICAL QUALITY CONTROL AND QUALITY ASSURANCE

3.1 In order to ensure and document, that valid data are being produced in any analysis, and that the methodology is actually measuring what is in the sample, operators shall institute appropriate quality control and laboratory analysis.

3.2 It shall be recognised , that quality control begins with the sample collection and does not end until the resulting data are reported and utilized.

3.3 Responsibilities And Duties Of The laboratory To Ensure Quality

Control And Quality Assurance

- 3.3.1 Organisation - A table of organisation shall be available that indicates the lines of authority, areas of responsibility, and job descriptions.
- 3.3.2 The laboratory shall also provide a scope of it's general capabilities.
- 3.3.3 The management of the Laboratory shall foster a good quality assurance attitude and provide the technical staff with a written policy directive to carry out a quality assurance plan.
- 3.3.4 The Laboratory facilities shall provide a working environment that is clean, climate controlled, well lit and safe.
- 3.3.5 The instrumentation and equipment shall be appropriate to the operational needs of the laboratory.
- 3.3.6 The Laboratory shall be kept as free from environmental interferences as is necessary to avoid contamination of the samples.

3.4 Methodology

- 3.4.1 Written procedure shall be readily available to all personnel which is essential to the systematic performance of operation and shall be reviewed periodically.
- 3.4.2 Sample collection procedures, sample handling and storage requirements shall be written.
- 3.4.3 Calibration procedures shall be written.
- 3.4.4 Analytical procedures shall be written.
- 3.4.5 There shall be a document - control system, to ensure that the written procedures are current and complete.

3.5 Metrology Systems

- 3.5.1 All systems for making measurements shall have written calibration procedures, including a description of a procedure for establishing traceability, description of calibration standards and a schedule for calibration.
- 3.5.2 There shall be written prevention maintenance procedures including a schedule for maintenance intervals.
- 3.5.3 There shall be records documenting any changes that may occur in any measurement system due to repairs and servicing of equipment, replacement of components or reagents or change of procedure.

- 3.5.4 Periodic performance control of the equipment shall be instituted and records of performance maintained. The use of control charts may be an aid in maintaining a record of performance.
- 3.5.5 All metrology systems shall have a record of calibration and maintenance schedules and there shall be a notation of any configuration changes that may have occurred in any system. Also, records of significant changes in calibration shall be noted and reviewed periodically.
- 3.6 Data Recording
- 3.6.1 The Laboratory shall keep records of submitted samples and completed analysis in a manner that provides for data retrievability, the sample preservation, the traceability of the sample source, the procedures and the persons responsible for the sampling and analysis. All laboratory data sheets shall be dated and signed by the Analyst and the laboratory Manager or his designee.
- 3.7 Data Validation
- 3.7.1 The laboratory shall keep records of analytical performance by means of audit procedures, reference sample programmes and inter-laboratory tests. Where applicable, quality control charts shall be used to report results from these validation activities.
- 3.7.2 If the data are collected manually, the validation procedures shall take into account the sampling, the sample handling, the analytical procedures and calculations. The sampling, the calibration, and the instrument performance shall be taken into account if the data are generated by instrumental monitoring.
- 3.8 Control of Analytical Performance
- 3.8.1 The establishment of reliability information on a standard is primarily concerned with the production of precision and accuracy data on the analyst, and on the analytical procedure.
- 3.8.2 The system for producing control data shall be flexible and reasonably economical to utilize because it shall be consistently and persistently applied on a daily basis.
- 3.8.3 As a general guideline, the laboratory shall perform quality control procedures on approximately 10% of its work-load.
- 3.8.4 A basic approach to produce information on the quality of the analytical performance is described by the terms, repeatability and percent recovery.
- 3.9 Control Of Instrumental Monitoring Performance
- 3.9.1 The data validation problems involved with instrumental monitoring shall be two-fold:
- (i) First, the instrumental operating condition shall be established. Generally, the manufacturer furnishes these instructions;
 - (ii) Second, the instrument response shall be validated. The response may be checked by spiking a known amount of the constituent of interest into the sample stream, or by a reference sample. An alternative is to perform parallel manual sampling and analytical Procedures for comparison to the instrumental monitoring results.

3.9.2 The calibration technique, the validation technique, and the results shall be recorded in instrument log.

3.9.3 All instruments shall be calibrated after service or repair.

3.10 Deficiency Correction

3.10.1 The organisational system shall provide the authority and the responsibility for a designated person or persons to investigate, out of control procedures and to inform the laboratory management of the problems that occur.

3.10.2 A current log shall be maintained of such deficiencies and the action taken to correct them.

3.10.3 When any laboratory result is found to be unsuitable for its purpose or when the quality or the reliability of its information is questioned, the following investigative trouble shooting covering all phases of the information gathering and reporting systems shall be carried out:

- (i) Sampling - Review the records of the sampling.
- (ii) Sample Handling - Check the record for the preservation technique, the time of transit, and the condition of the samples upon arrival at the laboratory.
- (iii) Analytical Procedure - Check methodology, calibration, and maintenance log on the measurement system used and the raw data that were recorded. Check the reagents used for quality and the data on expiration. Check the mathematics of all calculations.
- (iv) Carry a reagent blank through sampling and analytical procedures. In colorimetry, compare the reagent blank with distilled water, which allows the analyst to detect unusual reagent blank quality.
- (v) When the data are obtained through the use of standard curve, treat the points of the curve statistically and develop a regressive line for the purpose of the analysis.
- (vi) Deficiencies that have been discovered and corrected shall be recorded in a log filing system, stating the parameter involved, the problem, the action taken, and the date of the action. Only when the deficiencies have been discovered and corrected is a quality assurance plan in operation. It is by this means that better laboratory practices may be instituted.

4.0 LABORATORY SAFETY

4.1 Safety shall be considered in laboratory practices and shall be part of the laboratory routine (see Appendices VIII – D2 through VIII – D4).

4.2 Samples and reagents shall be handled in properly operating hoods in order to minimise the presence of noxious, harmful or interfering fumes in the laboratory environment.

4.3 Sinks shall not be used for samples or reagent disposal. The disposal area shall meet applicable environmental and safety standards. Disposal procedures for hazardous reagents and samples shall be properly defined for the laboratory personnel. Useful information shall be obtained from guides to control of hazardous chemical, spills and manuals on laboratory safety.

- 4.4 In order for the hoods to be effective in removing noxious, harmful or interfering fumes and aerosols from the laboratory environment, the hoods shall be operated at their designed capacity. They shall not be located in areas of countervailing drafts, such as between two doors.
- 4.5 The Laboratory shall be supplied with: Fire Extinguishers suitable for Class A, B, or C Fires; Spill Control materials for acids, bases and flammables, eye wash and safety shower facilities; eye protection and other safety devices; that may be consistent with the particular laboratory operation. The facilities shall provide for the safe disposal of reagents and samples with written instructions for the utilization of these procedures by all personnel.
- 4.6 Adequate bench space or working area per analyst shall be provided.

4.7 Safety and Chemical Hygiene Plan

4.7.1 Each laboratory shall develop and maintain a Safety and Chemical Hygiene Plan as part of their standard operating procedures.

4.7.2 The purpose of the Safety and Chemical Hygiene Plan shall be to identify the policies, practices, and procedures established at the laboratory to protect employees from exposure to potentially hazardous chemicals used in the laboratory.

4.7.3 The Safety and Chemical Hygiene Plan shall contain the following as a minimum:

- (a) Statement of Purpose**
- (b) Health and Safety Policy Statement**
- (c) Personnel Responsible for Chemical Hygiene Programme**
- (d) Standard Operating Procedures**
- (e) Criteria for Determination of Chemical Hazards and Implementation of Exposure Control Measures (such as engineering controls, personal protective equipment and hygiene (work practices)**
- (f) Provision of Additional Employee Protection for Work with Particularly Hazardous Chemicals, Reagents and Gases.**
 - (i) Select Carcinogens**
 - (ii) Reproductive toxins**
 - (iii) Chemicals with High Degree of Acute Toxicity**
 - (iv) Benzene**
 - (v) Lead and Lead Compounds**
 - (vi) Formaldehyde**
 - (vii) Mercury**
 - (viii) Acrylonitrile**
 - (ix) Chemicals of Unknown Hazard**
- (g) Operations which may require prior approval by the Safety and Chemical Hygiene Officer (however named), e.g. high-pressure systems, operations utilizing radiologic agents, non-ionization radiation, etc.**
- (h) Industrial Hygiene Monitoring Schedule.**
- (i) Provision of Employ Information and training materials**
 - (i) Content of information and training materials**
 - (ii) Person responsible for providing information and training**
 - (iii) Training Outline**
- (j) Provision of Medical Consultations and Examinations**

- (k) Requirements for proper function of laboratory fume hoods and other protective equipment.

4.8 Where safety practices are included in an approved method of analysis, they shall be strictly followed.

5.0 CRITERIA FOR LABORATORY ACCREDITATION

5.1 OBJECTIVE

5.1.2 These guidelines are established to:

- (i) Provide the criteria necessary for the approval of analytical laboratories competent to engage in consultancy and operational services to the petroleum industry in Nigeria.
- (ii) Streamline standard laboratory procedures and code of practices for efficiency and effectiveness.
- (iii) Maintain sufficient control of analytical services in the industry and prevent violations of permit specifications.
- (iv) Provide the basis for operating companies to develop their own code of conduct for in-house laboratories, and selection of criteria for contract laboratories.
- (v) Assure the oil companies of the permittee's compliance with the laboratory statutory requirements set forth in the permit.

5.2 CATEGORY OF ANALYTICAL SERVICES

5.2.1 Application for approval to operate laboratory services in the petroleum industry shall be under the following categories:

Group I

- Water and Waste Water Analysis

Group II

- Biodegradability
- Bioaccumulation
- Toxicity

Group III

- Mud & Cuttings
- Petroleum Products Quality Test
- Crude Oil Assay Analysis

Group IV

- Core Sample Analysis
- Biostratigraphical/Chemostratigraphic Studies

Group V

- Material/Corrosion Test
- Radiology/Radiographic Analysis/Radioactivity Assays

5.3 PERMIT APPLICATION

- 5.3.1** Owners and operators of analytical laboratories shall be required to seek approval from the Director, Petroleum Resources to engage in analytical, investigatory/confirmatory and consultancy services in the petroleum industry in Nigeria.
- 5.3.2** All prospective applicants and approved laboratories shall be subject to annual evaluation and routine audit by Department of Petroleum Resources personnel.
- 5.3.3** Only established operators with adequate facilities/personnel that meet the requirements stated herein shall be considered for annual accreditation. Affiliate member organizations shall be required to own self facilities for analytical services.
- 5.3.4** Applicants shall be required to seek approval separately for each group of specialization described in 5.2.1. Prescribed fees for application shall be paid.
- 5.3.5** Only laboratory facilities approved by the Director, Petroleum Resources shall be used to conduct analytical services.

5.4 LABORATORY ASSESSMENT CHECKLIST

5.4.1 General laboratory Requirements

- i.** The laboratory shall be legally identifiable.
- ii.** The lab shall have managerial staff with the authority and resources needed to discharge their duties.
- iii.** The lab shall have arrangements to ensure that its personnel are free from any commercial, financial and other pressure, which might adversely affect the quality of their work.
- iv.** The lab shall be organized in such a way that confidence in its independence of judgement and integrity is maintained at all times.
- v.** The lab shall have specified and documented schedule of responsibility, authority and interrelationship of all personnel who manage, perform or verify work affecting the quality of tests.
- vi.** The lab shall have supervision by persons familiar with the test methods and procedures, the objective of the test methods and procedures, the objective of the test and assessment of the results.
- vii.** The lab shall have a Technical Manager (however named) who has overall responsibility for the technical operations.
- viii.** The lab shall have a Quality Manager (however named) who has overall responsibility for the quality system and its implementation.
- ix.** The lab shall have deputies in case of absence of the technical or Quality Manager.
- x.** The lab shall have documented policy and procedure to ensure the protection of clients' confidential information and proprietary rights.

5.4.2 Facility

- i.** The lab's accommodation, test areas, energy sources, lighting, heating and ventilation shall be such as is needed to facilitate proper performance of the tests.

- ii. The lab shall be free from any environmental conditions, which may adversely affect the required accuracy of measurement.
- iii. The lab shall provide facilities for the effective monitoring, control and recording of environmental conditions as appropriate (e.g. due attention shall be paid to biological sterility, dust, electromagnetic, interference, humidity, mains voltage, temperature, and sound and vibration levels as appropriate).
- iv. The lab shall provide effective separations between neighbouring areas for the activities therein that are incompatible.
- v. Access to and use of all areas affecting the quality of testing shall be adequately defined and controlled.
- vi. The lab shall provide adequate measures to ensure good housekeeping.
- vii. The lab shall provide exhaust hoods for volatile materials.
- viii. The lab shall provide contamination-free work areas as necessary.
- ix. The lab shall have toxic chemical handling areas either stainless steel or an impervious material covered with absorbent material.
- x. The lab shall provide adequate facilities, including cold storage, for separate storage of sample, extracts, reagents, solvents, reference materials, and standards to preserve their identity, concentration, purity, and stability.
- xi. The lab shall have adequate procedures and facilities in place for collection, storage, and disposal of chemical wastes.
- xii. The lab shall where relevant, provide adequate procedures and facilities provided for handling materials that may transmit infectious agents.
- xiii. The lab shall have appropriate storage for volatile, corrosive or explosive chemicals and flammable solvents.
- xiv. The lab shall provide adequate separation of activities to ensure that no activity has an adverse effect on analyses.

5.4.3 Equipment:

- i. The lab shall be furnished with all items of equipment (including reference materials) required for the correct performance of tests.
- ii. The lab equipment shall be properly maintained; calibrated and periodically tested to perform satisfactorily.
- iii. Each item of equipment including reference materials, shall be labelled, marked or otherwise identified to indicate its calibration status.
- iv. The lab shall maintain records on each major item of equipment and all reference materials significant to the tests. The records shall include:
 - (a) the name of the item of equipment
 - (b) the manufacturer's name, type identification and serial number or other unique identification
 - (c) date received and date placed in service
 - (d) current location, where appropriate
 - (e) condition when received (e.g. new, used, reconditioned)
 - (f) copy of the manufacturer's instructions, where available
 - (g) dates and results of calibrations and/or verifications and date of the next calibration and/or verification
 - (h) details of maintenance carried out to date and planned for the future
 - (i) history of any damage, malfunction, modification or repair.

5.4.4 Quality System

- (i) The laboratory shall have in place a rigid quality assurance and quality control programme for monitoring and control of factors that contribute to accurate analytical data.**
- (ii) The lab shall have a documented system for uniquely identifying samples, to ensure that there can be no confusion regarding the identity of such items at any time.**
- (iii) The lab shall have documented procedures and appropriate facilities to avoid deterioration or damage to the sample, during storage, handling, preparation, and test.**
- (iv) The lab shall have documented procedures for the receipt, retention or safe disposal of test items, including all provisions necessary to protect the integrity of the lab.**
- (v) The lab shall have adequate written procedures for receipt and storage of samples to ensure that holding times are met for each analyte/methodology.**
- (vi) The laboratory shall establish and maintain a records system that ensures that all observations, calculations, defects, errors, etc are recorded in a permanent manner (such as laboratory notebooks, pro-format work sheets, computer disks etc)**

5.4.4.1 Established operators shall comply with the quality assurance programmes prescribed in Article 3.3.

5.4.5 Personnel

- (i) The laboratory shall have sufficient personnel having the necessary education, training, knowledge, and experience for their assigned functions.**
- (ii) The lab shall ensure that the training of its personnel is up-to-date.**
- (iii) The lab shall maintain records on the qualification, training, skills and experience of the technical personnel.**
- (iv) The lab shall maintain documented evidence of analyst proficiency for each test method performed.**

5.4.6 Safety

- (i) An HSE Manual is available. Operators shall ensure that lab personnel comply with general and customary safety practices as part of good laboratory procedures.**
- (ii) Licencees shall comply with safety practices prescribed in Article 4.0.**

APPENDIX VIII-D1 - RECOMMENDED TEST METHODS FOR PHYSICO-CHEMICAL PARAMETER ANALYSIS

S/N	PARAMETERS	RECOMMENDED METHODS
1	Acidity	ASTM D 1067) API-RP 45) Titration APHA 102 or 402) method
2	Alkalinity	ASTM D 1067 APHA 403) Titration API-RP Section 2.2) method
3	Biochemical Oxygen Demand (BOD ₅)	APHA 507 or EPA (5-day Method)
4	Chemical Oxygen Demand (COD)	ASTM D 1252 APHA 508) Dichromate
5	Carbonate(CO ₃ /2-) free CO ₂ & HCO ₃	ASTM D 513C or API-RP 45
6	Colour	APHA 204 C
7	Cyanidesm (CN-)	ASTM D 2036) APHA 413F) Amenable to Chlorination
8	Dissolved Oxygen (DO)	APHA 422B or EPA Iodometric method
9	Electrical Conductivity	ASTM D 1125 or APHA 145 (Field and Roofing laboratory method)
10	Chloride	APHA 408 C
11	Chlorine waste and Total residue	ASTM D 1 258 or APHA 409C
12	Nitrogen (Anlines)	API-RP Section 8.13
13	Nitrogen (Nitrate-Nitrite)	ASTM D 3867)Cadmium Reduction APHA 419C) method
14	Nitrogen (Nitrate)	ASTM D 3867) Urine method
15	Odour	ASTM D 1292
16	Total Hydrocarbon Content (THC)	ASTM D3921 (infra red spec.)/GC
17	PH	ASTMD1293B) APHA (460, 424)Electrometric API-RP 45 EPA)method

18	Phenolics Compounds	ASTM D 1 783 or APHA 222E
19	Salinity (Cl.)	API-RP45 section 2.8
20	Sulphate (SO ₄)	ASTM D 516) APHA 427C, 496)Turbidimetric API-RP45 section 2.7. 1)
21	Sulphate Reducing Bacteria	ASTM D 993 (Iodometric)
22	Sulphide (HS)	APHA 228A, 428D, ASTM B 1233, API-RP 45
25	Total Dissolved Solids (TDS) and Total Suspended Solids (TSS)	ASTM D 1868 or APHA 208D
26	Total Hardness	ASTM D1126) APHA 122B)Titration method API-RP 10
27	Total Phosphorous	ASTM D 51 5)Ascorbic APHA 425 C) Acid API-RP 45 Section 3.9)Method
28	Chromium Total	ASTM D 168, APHA 425C7, API-RP 45, APHA 301A and EPA (AAS method)
29	Chromium (Cr ⁶⁺)	ASTM D 2972, API-RP 45, EPA (AAS) and APHA (301A) (AAS method)
30	Arsenic (AS)	ASTM D 2972, API-RP 45, EPA (A or B and APHA (404A,301A) (AAS method)
31	Cadmium (Cd)	ASTM D 2576D and 3557A, API-RP 45. EPA (AAS) (AAS method)
32	Cobalt (Co)	ASTM D 3558A, API-RP 45, EPA (AAS) and APHA (301A) AAS method
33	Copper (Cu)	ASTM D 1688D, API-RP 45, EPA (AAS) and APHA (301A) (AAS method)
34	Iron (Fe)	ASTM D 106C, API-RP 45, EPA (AAS) and APHA (301A) (AAS method)
35	Mercury (Hg)	ASTM D 3229, API-RP 45, EPA (AAS) and APHA (301A) (AAS Method)
36	Lead (Pb)	ASTM D 3559, API-RP 45, EPA (AAS) and APHA (301A) (AAS Method)
37	Nickel (Ni)	ASTM D 1886 C API - RP 45, EPA AAS and APHA (301A) (AAS Method)
38	Zinc (Zn)	ASTM D 1691 C, API - RP 45, EPA and APHA (301A) AAS Method
39	Vanadium (V)	AAS Method API-RP 45, EPA (AAS) and APHA (301A)
40	Calcium (Ca) and Magnesium (Mg)	ASTM D 51 1, API - RP 45, EPA (Titrimetric and APHA 110C
41	Organic Carbon (Total)	ASTM D. 2579
42	Volatile Organic matter in H ₂ O	ASTM D. 2908 Aqueous Injection Gas Chromatography
43	Purgeable Organic Compounds	ASTM D. 3871

44	Aromatic traces in light saturated hydrocarbons (Benzene, Toluene and C-8 Aromatics)	ASTM D. 2600 Gas Chromatography
45	Phenols in water	ASTM D. 2580 Gas-Liquid Chromatography
46	Organic compounds	ASTM D. 4128 Gas-liquid chromatography and Electron Impact Mass Spectrometry
47	Chlorophenoxy Acid herbicides	ASTM D. 3478
48	Poly chlorinated bi-phenyls	ASTM D. 1942
49	Morpholine	ASTM D.3086
50	Organo-Chlorine	ASTM D 1428 - 64 (1971) Potassium and Sodium by flame photometry ASTM D 3561 - Potassium and sodium by AAS
51	Sodium (Na) and Pottasium (K)	ASTM D93 - 77
52	Flash Point (Ignitability)	ASTM D327 - 78
53	Corrosivity Toward Steel	WACE Standard TM-01-69 (1972 Revision)
54	Polynuclear aroniatic hydrocarbon	GC
55	Chlorinated hydrocarbon Chlorinated hydrocarbon	GC
56	BTEX	GC
57	Total Petroleum Hydrocarbon (TPH)	GC

APPENDIX VIII-D2 LABORATORY SAFETY AND TOTAL LOSS CONTROL
(TLC) GUIDELINE TO BE DISPLAYED IN EVERY LABORATORY

☐ KNOW YOUR LAB ORGANISATIONS

- FIRE PROTECTION SYSTEM
- FLOOR ARRANGEMENT
- STOCK-ROOM SYSTEM
- SECURITY SYSTEM

☐ KNOW YOUR CHEMICALS/REAGENTS

- TOTAL PROFILE

☐ KNOW YOUR SOLVENTS

- THEIR TOXICITY
- THEIR FLAMMABILITY

☐ KNOW YOUR HEAVY METALS

- THEIR TOXICITY

☐ KNOW YOUR PERSONAL PROTECTIVE GEAR

☐ KNOW YOUR FUME EXTRACTION SYSTEM

☐ KNOW YOUR INSTRUMENTS/EQUIPMENT

- HANDLING INSTRUCTIONS
- OPERATING INSTRUCTIONS
- MAINTAINANCE INSTRUCTIONS
- ELECTRICAL SENSITIVITY

☐ LABEL YOUR DRAWER SHELVES

☐ LABEL YOUR CONTAINERS

☐ CONSULT YOUR SUPERVISOR WHEN IN DOUBT

☐ DO NOT WORK ON INSTRUMENTS/EQUIPMENT ON WHICH YOU ARE NOT TRAINED

☐ EQUIPMENT IS EXPENSIVE

☐ BUT TRAINED MANPOWER IS INVALUABLE!

☐ TIDINESS IS NEXT TO GODLINESS.

APPENDIX VIII-D3 - LABORATORY ACCIDENT CAUSATION ANALYSIS

S/N	POTENTIAL CAUSES OF ACCIDENT	POTENTIAL	
		INCIDENT	LOSS
1	Reagent bottle uncovered after use	Inhaling Toxic gas, (e.g. CHCl ₃ , HCl, H ₂ CrO ₄)	Damage to body organ;,, chronic ill-health
2	Not rinsing wares after use.	Possible unwanted reaction	-body harm -material loss -equipment loss
3	Gas leakage.	Fire/Explosion	Injury, property damage (PD)
4	Not turning off Bunsen Burner after use	Fire	Wastage of gas/ property damage
5	Not switching covers of yeast bottles or similar bottles with gas generation.	Fire/Explosion	-Injury -PD
6	Not slackening covers of yeast bottles or similar bottles with gas generation	Explosion	-Injury -PD
7	Not enough water in the autoclave	Explosion	-PD
8	Not allowing autoclaves to come down to '0' Psi after sterilisation before removing their contents.	Steam 'explosion'/ burns	-Injury -PD
9	Not wearing face-shield, apron and gloves when putting in and removing bottles from 600C water bath or such hot water baths.	Bottle explosion, burns	-Injury (face)
10	Pouring H ₂ O into conc. acid or alkali	Explosion (exothermic reaction)	-Injury -PD
11	Not using safety wear in handling corrosive chemicals.	Chemical burns	-Injury -PD
12	Not labelling chemical containers.	Confusion of chemical	-Injury -PD/Waste
13	Not keeping benchwork tidy.	All kinds of accidents	-Injury -PD
14	Assuming that any colourless liquid is Water	Poisoning, Fire	-Injury -ill-health -PD
15	Chewing gum or kolanut or similar things while pipetting.	Swallowing poison, Choking	-Injury -ill-health
16	Cleaning around electrical socket	Electrical shock	-Injury

	outlet with wet cloth.		-Death
17	Spitting in the lab.	-Unhygienic act	-ill-health
18	Don't fail to keep your body and clothe tidy.	-Unhygienic act	-ill-health
19	Smoking in the lab.	-Fire/Explosion	-Injury -PD
20	Cooling of hot objects (glass wares suddenly)	-Explosion	-Injury -PD
21	Shaking shake bottles of volatile solids.	-Explosion -Fire	-Injury -PD
22	Use of broken apparatus	-Cuts	-Injury
23	Lifting hot objects without appropriate gloves.	-Burns -Dropping of object	-Injury -PD
24	Exposing your eyes to dangerous radiation.	-Eye damage -other damage	-Loss of eye sight -Sterility
25	Not wearing eye-goggles when needed.	-Eye damage -other damage	-Loss of eye sight -Sterility
26	No fire protection system.	-Poor fire control	-Injury -PD
27	Badly located fire extinguishers	-Poor fire control	-Injury -PD
28	No fire blankets	-Poor fire control	-Injury -PD
29	No regular inspection of fire extinguishing system.	-Poor fire control	-Injury -PD
30	No fire alarm/detection system	-Poor fire control	-Injury -PD
31	No fire escape plan.	-Poor fire control	-Injury -PD
32	No sprinkler system	-Poor fire control	-Injury -PD
33	Operating equipment without studying the instructions for its use.	-Damage of equipment -Other events	-Injury/PD -PD
34	Operating equipment not trained on/for.	-Damage of equipment -Other events	-Injury/PD -PD
35	Operating a lab. without toxic gas fume/vapour detector monitors	-Poisoning -Explosion	-Injury -ill-health
36	Over-crowding the lab. with people and or Object	-Falls striking	-Injury
37	Poor storage of materials in the	-Falls	-Injury/PD

	stock-room	-Dangerous reaction -Fire	
38	Poor ventilation	-Suffocation	-Injury
39	Poor airconditioning of storage.	-Deteriorating of chemicals	-PD
40	Using chairs or make-shift ladders instead of the appropriate ladder.	-Fall	-Injury/PD
41	Overstretching from ladder	-Fall	-Injury/PD
42	Improper lifting	-Over-stress of backbone	-Injury/PD
43	Improper holding of reagent bottle	-Falls and Fire	-Injury/PD
44	Lab. keys in too many hands	-Theft -Unauthorised Use	-PD -Injury
45	Poor stock control system	-Theft -Unauthorised Use	-Injury
46	Poor ergonomic engineering (benches, chairs, racks etc.)	-Human Body strained	-ill-health
47	Poor/no disaster control plan.	-Disaster does heavy damage	Heavy losses
48	No eye showers	Poor control of eye accidents	Eye damage
49	No/poor fume extraction system	-Spread of toxic fumes/Explosion	-Injury -Ill-health -PD
50	No/poor regular inspection of lab.	-Corrosion -Leakage -Fire/Explosion	-Injury -Ill-health -PD
51	No/poor signing and posturing for lab. Safety	-Increased accidents and productivity low	-Frequent injury/PD
52	No/poor incentives for lab. safety.	-Increased accidents and productivity low	-Frequent injury/PD
53	No/poor safety organisation of lab., safety	-Increased accidents and productivity low	-Frequent injury /PD
54	No/poor or unplanned training for all Lab	-Increased accidents	-Frequent injury/PD

		and productivity low	
55	No/poor safety policy.	-Increased accidents and productivity low	-Frequent injury/PD

APPENDIX VIII – D4

CHEMICALS SAFETY AND LOSS CONTROL

Safety and Loss Control Management demands thorough knowledge of the following:

1. **CHEMICAL NAMES:**
 - Scientific name
 - Trade names
 - Chemical Formula.
 - Chemical Structure

2. **APPLICATIONS.**
 - In the laboratory tests/operations
 - In the Industry (at least as it concerns the particular industry).

3. **HANDLING AND STORAGE:**
 - Handling and transportation
 - Storage
 - Disposal and pollution control
 - Spillage and control

4. **HEALTH HAZARDS/RISKS:**
 - Toxicity vis-à-vis the human body,
 - Diseases
 - Specified Threshold Exposure Limited (STEL).

5. **FIRST AID AGAINST TOXICITY**

6. **FIRE HAZARDS/RISKS AND FIRE PROTECTION**
 - Flammability (LEL)
 - Flash point
 - Autoignition
 - Fire Extinguishers

7. **PERSONAL PROTECTION GEAR.**
 - General body protective wear
 - Eye, Nose, Ear, hands protection

8. **SECURITY MEASURES**

TOXICITY CHARACTERISTIC LEACHING PROCEDURE TEST METHOD (TCLP)

1.0 SCOPE AND APPLICATION

- 1.1** The Toxicity characteristics Leaching Procedure is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.
- 1.2** If a total analysis of the waste demonstrates that individual analytes are not present in the waste, or that they are present but at such low concentrations that the appropriate regulatory levels could not possibly be exceeded, the TCLP need not be run.
- 1.3** If an analysis of any one of the liquid fractions of the TCLP extract indicates that a regulated compound is present at such high concentrations that, even after accounting for dilution from the other fractions of the extract, the concentration would be above the regulatory level for that compound, then the waste is hazardous and it is not necessary to analyze the remaining fractions of the extract.
- 1.4** If an analysis of extract obtained using a bottle extractor shows that the concentration of any regulated volatile analyte exceeds the regulatory level for that compound, then the waste is hazardous and extraction using the ZHE is not necessary. However, extract from a bottle extractor cannot be used to demonstrate that the concentration of volatile compounds is below the regulatory level.

2.0 SUMMARY OF METHOD

- 2.1** For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8 μm glass fiber filter, is defined as the TCLP extract.
- 2.2** For waste containing greater than or equal to 0.5% solids, the liquid, if any, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. A special extractor vessel is used when testing for volatile analytes (see Table 1 for a list of volatile compounds). Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 μm glass fibre filter.
- 2.3** If compatible (i.e multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

3.0 INTERFERENCE

- 3.1** Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

4.0 APPARATUS AND MATERIALS

4.1 Agitation apparatus: The agitation apparatus must be capable of rotating the extraction vessel in an end-over-end fashion (see Figure 1) at 30 ± 2 rpm.

4.2 Extraction Vessels

4.2.1 Zero-Headspace Extraction Vessel (ZHE). This device is for use only when the waste is being tested for the mobility of volatile analytes (i.e., those listed in Table 1). The ZHE (depicted in Figure 2) allows for liquid/solid separation within the device, and effectively precludes headspace. This type of vessel allows for initial liquid/solid separation, extraction, and final extract filtration without opening the vessel (see Section 4.3.1). The vessels shall have an internal volume of 500 - 600 ml, and be equipped to accommodate a 90 - 110 mm filter.

For the ZHE to be acceptable for use, the piston within the ZHE should be able to moved with approximately 15 psi or less. If it takes more pressure to move the piston, the O-rings in the device should be replaced. If this does not solve the problem, the ZHE is unacceptable for TCLP analyses and the manufacturer should be contacted.

The ZHE should be checked for leaks after every extraction. If the device contains a built-in pressure gauge, pressurize the device to 50 psi, allow it to stand unattended for 1 hour, and recheck the pressure. If the device does not have a built-in pressure gauge, pressurize the device to 50 psi, submerge it in water, and check for the presence of air bubbles escaping from any of the fittings. If pressure is lost, check all fittings and inspect and replace O-rings. If necessary. Retest the device. If leakage problems cannot be solved, the manufacturer should be contacted.

Some ZHEs use gas pressure to actuate the ZHE piston, while others use mechanical pressure. Whereas the volatiles procedure (see Section 7.3) refers to pounds per square inch (psi), for the mechanically actuated piston, the pressure applied is measured in torque-inch-pounds. Refer to the manufacturer's instructions as to the proper conversion.

4.2.2 Bottle Extraction Vessel: When the waste is being evaluated using the non-volatile extraction, a jar with sufficient capacity to hold the sample and the extraction fluid is needed. Headspace is allowed in this vessel.

The extraction bottles may be constructed from various materials, depending on the analytes to be analyzed and the nature of the waste (see Section 4.3.3). It is recommended that borosilicate glass bottles be used instead of other types of glass, especially when inorganics are not

concern. Plastic bottles, other than polytetrafluoroethylene, shall not be used if organics are to be investigated. Bottles are available from a number of laboratory suppliers. When this type of extraction vessel is used, the filtration device discussed in Section 4.3.2 is used for initial liquid/solid separation and final extract filtration.

4.3 Filtration Devices: It is recommended that all filtrations be performed in a hood.

4.3.1 Zero-Headspace Extractor Vessel (ZHE): When the waste is evaluated for volatiles, the zero-headspace extraction vessel described in Section 4.2.1 is used for filtration. The device shall be capable of supporting and keeping in place the glass fiber filter and be able to withstand the pressure needed to accomplish separation (50 psi).

NOTE: When it is suspected that the glass fiber filter has been ruptured, an
in-line glass fiber filter may be used to filter the material within the ZHE.

4.3.2 Filter Holder: When the waste is evaluated for other than volatile analytes, any filter holder capable of supporting a glass fiber filter and able to withstand the pressure needed to accomplish separation may be used. Suitable filter holders range from simple vacuum units to relatively complex systems capable of exerting pressures of up to 50 psi or more. The type of filter holder used depends on the properties of the material to be filtered (see section 4.3.3). These devices shall have a minimum internal volume of 300 ml and be equipped to accommodate a minimum filter size of 47 mm (filter holders having an internal capacity of 1.5 L or greater, and equipped to accommodate a 142 mm diameter filter, are recommended). Vacuum filtration can only be used for wastes with low solids content (<10%) and for highly granular, liquid-containing wastes. All other types of wastes should be filtered using positive pressure filtration.

4.3.3 Materials of Construction: Extraction vessels and filtration devices shall be made of inert materials which will not leach or absorb waste components. Glass, polytetrafluoroethylene (PTFE), or type 316 stainless steel equipment may be used when evaluating the mobility of both organic and inorganic components. Devices made of high density polyethylene (HDPE), polypropylene (PP), or polyvinyl chloride (PVC) may be used only when evaluating the mobility of metals. Borosilicate glass bottles are recommended for use over other types of glass bottles, especially when inorganics are analytes of concern.

4.4 Filters: Filters shall be made of borosilicate glass fiber, shall contain no binder materials, and shall have an effective pore size of 0.6 to 0.8 μm or equivalent. Pre-filters must not be used. When evaluating the mobility of metals, filters shall be acid-washed prior to use by rinsing with 1N nitric acid followed by three consecutive rinses with deionized distilled water (a minimum of 1 L per rinse is recommended). Glass fiber filters are fragile and should be handled with care.

- 4.5 pH Meters:** The meter should be accurate to + 0.04 units at 25 °C.
- 4.6 ZHE Extract Collection Devices:** TEDLAR^{®2} bags or glass, stainless steel or PTFE gas-tight syringes are used to collect the initial liquid phase and the final extract of the waste when using the ZHE device. The devices listed are recommended for use under the following conditions:
- 4.6.1** If a waste contains an aqueous liquid phase or if a waste does not contain a significant amount of nonaqueous liquid (i.e <1% of total waste), the TEDLAR[®] bag or a 600 ml syringe should be used to collect and combine the initial liquid and solid extract.
 - 4.6.2** If a waste contains a significant amount of nonaqueous liquid in the initial liquid phase (i.e >1% of total waste), the syringe or the TEDLAR[®] bag may be used for both the initial solid/liquid separation and the final extract filtration. However, analysts should use one or the other, not both.
 - 4.6.3** If the waste contains no initial liquid phase (is 100% solid) or has no significant solid phase (is 100% liquid), either the TEDLAR[®] bag or the syringe may be used. If the syringe is used, discard the first 5 ml of liquid expressed from the device. The remaining aliquots are used for analysis.
- 4.7 ZHE Extraction Fluid Transfer Devices:** Any device capable of transferring the extraction fluid into the ZHE without changing the nature of the extraction fluid is acceptable (e.g a positive displacement or peristaltic pump, a gas tight syringe, pressure filtration unit (see Section 4.3.2) or other ZHE device).
- 4.8 Laboratory Balance:** Any laboratory balance accurate to within ± 0.01 grams may be used (all weight measurements are to be within ± 0.1 grams).
- 4.9 Beaker or Erlenmeyer flask, glass, 500 ml.**

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4.10 Watchglass, appropriate diameter to cover beaker or Erlenmeyer flask.

4.11 Magnetic stirrer.

5.0 REAGENTS

5.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, It is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.2 Reagent water: Reagent water is defined as water in which an interferant is not observed at or above the method's detection limit of the analyte(s) of interest. For nonvolatile extractions, ASTM Type II water or equivalent meets the definition of reagent water. For volatile extractions, it is recommended that reagent water be generated by any of the following methods. Reagent water should be monitored periodically for impurities.

5.2.1 Reagent water for volatile extractions may be generated by passing tap water through a carbon filter bed containing about 500 grams of activated carbon (Calgon Corp., Filtrasorb-300 or equivalent).

5.2.2 A water purification system (Millipore Super-Q or equivalent) may also be used to generate reagent water for volatile extractions.

5.2.3 Reagent water for volatile extractions may also be prepared by boiling water for 15 minutes. Subsequently, while maintaining the water temperature at 90 ± 5 degrees C, bubble a contaminant-free inert gas (e.g nitrogen) through the water for 1 hour. While still hot, transfer the water to a narrow mouth screw-cap bottle under zero-headspace and seal with a Teflon-lined septum and cap.

5.3 Hydrochloric acid (1N), HCL made from ACS reagent grade.

5.4 Nitric acid (1N), HNO₃, made from ACS reagent grade.

5.5 Sodium hydroxide (1N), NaOH made from ACS reagent grade.

5.6 Glacial acetic acid, CH₃CH₂OOH. ACS reagent grade.

5.7 Extraction fluid.

- 5.7.1 Extraction fluid # 1: Add 5.7 ml glacial CH₃CH₂OOH to 500 ml of reagent water (See Section 5.2), add 64.3 ml of 1N NaOH, and dilute to a volume of 1 liter. When correctly prepared, the pH of this fluid will be 4.93 ± 0.05.**
- 5.7.2 Extraction fluid # 2: Dilute 5.7 ml glacial CH₃CH₂OOH with reagent water (See Section 5.2) to a volume of 1 liter. When correctly prepared, the pH of this fluid will be 2.88 ± 0.05.**

NOTE: These extraction fluids should be monitored frequently for impurities. The pH should be checked prior to use to ensure that these fluids are made up accurately. If impurities are found or the pH is not within the above specifications, the fluid shall be discarded and fresh extraction fluid prepared.

- 5.8 Analytical standards shall be prepared according to the appropriate analytical method.**

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

- 6.1 All samples shall be collected using an appropriate sampling plant.**

- 6.2 The TCLP may place requirements on the minimal size of the field sample, depending upon the physical state or states of the waste and the analytes of concern. An aliquot is needed for preliminary evaluation of which extraction fluid is to be used for the nonvolatile analyte extraction procedure. Another aliquot may be needed to actually conduct the nonvolatile extraction (see Section 1.4 concerning the use of this extract for volatile organics). If volatile organics are of concern, another aliquot may be needed. Quality control measures may require additional aliquots. Further, it is always wise to collect more sample just in case something goes wrong with the initial attempt to conduct the test.**

- 6.3 Preservatives shall not be added to samples before extraction.**

- 6.4 Samples may be refrigerated unless refrigeration results in irreversible physical change to the waste. If precipitation occurs, the entire sample (including precipitate) should be extracted.**

- 6.5 When the waste is to be evaluated for volatile analytes, care shall be taken to minimize the loss of volatiles. Samples shall be collected and stored in a manner intended to prevent the loss of volatile analytes (e.g samples should be collected in Teflon-lined septum capped vials and stored at 4 °C. Samples should be opened only immediately prior to extraction).**

- 6.6 TCLP extracts should be prepared for analysis and analyzed as soon as possible following extraction. Extracts or portions of extracts for metallic analyte determinations must be acidified with nitric acid to a pH < 2, unless precipitation occurs (See Section 7.2.14 if precipitation occurs). Extracts should be preserved for other analytes according to the guidance given in the individual analysis methods. Extracts or portions of extracts for organic analyte determinations shall not be allowed to come into contact with the atmosphere (i.e no headspace) to prevent losses. See Section 8.0 (QA requirements) for acceptable sample and extract holding times.**

7.0 PROCEDURE

7.1 Preliminary Evaluations

Perform preliminary TCLP evaluations on a minimum 100 gram aliquot of waste. This aliquot may not actually undergo TCLP extraction. These preliminary evaluations include: (1) determination of the percent solids (Section 7.1.1); (2) determination of whether the waste contains insignificant solids and is therefore, its own extract after filtration (Section 7.1.2); (3) determination of whether the solid portion of the waste requires particle size reduction (Section 7.1.3); and (4) determination of which of the two extraction fluids are to be used for the nonvolatile TCLP extraction of the waste (Section 7.1.4).

7.1.1 Preliminary determination of percent solids: Percent solids is defined as that fraction of a waste sample (as a percentage of the total sample) from which no liquid may be forced out by an applied pressure, as described below.

7.1.1.1 If the waste will obviously yield no liquid when subjected to pressure filtration (i.e is 100% solids) proceed to Section 7.1.3.

7.1.1.2 If the sample is liquid or multiphase, liquid/solid separation to make a preliminary determination of percent solids is required. This involves the filtration device described in Section 4.3.2 and is outlined in Sections 7.1.1.3 through 7.1.1.9.

7.1.1.3 Pre-weigh the filter and the container that will receive the filtrate.

7.1.1.4 Assemble the filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure.

7.1.1.5 Weigh out a subsample of the waste (100 gram minimum) and record the weight.

7.1.1.6 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged prior to filtration. Centrifugation is to be used only as an aid to filtration. If used, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the same filtration system.

7.1.1.7 Quantitatively transfer the waste sample to the filter holder (liquid and solid phases). Spread the waste sample evenly over the surface of the filter. If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature then allow the sample to warm up to room temperature in the device before filtering.

NOTE: If waste material (>1% of original sample weight) has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and

subtract it from the sample weight determined in Section 7.1.1.5 to determine the weight of the waste sample that will be filtered.

Gradually apply vacuum or gentle pressure of 1 - 10 psi, until air or pressurizing gas moves through the filter. If this point is not reached under 10 psi and if no additional liquid has passed through the filter in any 2 minute interval, slowly increase the pressure in 10 psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2 minute interval, proceed to the next 10 psi increment. When the pressurizing gas begins to move through the filter, or when liquid flow has ceased at 50 psi (i.e filtration does not result in any additional filtrate within any 2 minute period), stop the filtration.

NOTE: Instantaneous application of high pressure can degrade the glass fibre filter and may cause premature plugging.

7.1.1.8 The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

NOTE: Some wastes such as oily wastes and some paint wastes will obviously contain some material that appears to be a liquid. Even after applying vacuum or pressure filtration, as outlined in Section 7.1.1.7 this material may not filter. If this is the case, the material within the filtration device is defined as a solid. Do not replace the original filter with a fresh filter under any circumstances. Use only one filter.

7.1.1.9 Determine the weight of the liquid phase by subtracting the weight of the filtrate container (see Section 7.1.1.3) from the total weight of the filtrate-filled container. Determine the weight of the solid phase of the waste sample by subtracting the weight of the liquid phase from the weight of the total waste sample, as determined in Section 7.1.1.5 or 7.1.1.7.

Record the weight of the liquid and solid phases. Calculate the percent solids as follows:

$$\text{Percent solids} = \frac{\text{Weight of solid (Section 7.1.1.9)}}{\text{Total weight of waste (Section 7.1.1.5 or 7.1.1.7)}} \times 100$$

7.1.2 If the percent solids determined in Section 7.1.1.9 is equal to or greater than 0.5%, then proceed either to Section 7.1.3 to determine whether the solid material requires particle size reduction or to Section 7.1.2.1 if it is noticed that a small amount of the filtrate is entrained in wetting of the filter. If the percent solids determined in Section 7.1.1.9 is less

than 0.5%, then proceed to Section 7.2.9 if they nonvolatile TCLP is to be performed and to Section 7.3 with a fresh portion of the waste if the volatile TCLP is to be performed.

7.1.2.1 Remove the solid phase and filter from the filtration apparatus.

7.1.2.2 Dry the filter and solid phase at $100 \pm 20^{\circ}\text{C}$ until two successive weighing yield the same value within $\pm 1\%$. Record the final weight.

NOTE: Caution should be taken to ensure that the subject solid will not flash upon heating. It is recommended that the drying oven be vented to a hood or other appropriate device.

7.1.2.3 Calculate the percent dry solids as follows:

$$\text{Percent dry solids} = \frac{(\text{Wt. Of dry waste + filter}) - \text{tared wt. of filter}}{\text{Initial wt. of waste (Section 7.1.1.5 or 7.1.1.7)}} \times 100$$

7.1.2.4 If the percent dry solids is less than 0.5%, then proceed to Section 7.2.9 if the nonvolatile TCLP is to be performed and to Section 7.3 if the volatile TCLP is to be performed. If the nonvolatile TCLP is to be performed, return to the beginning of this Section (7.1) and with a fresh portion of waste, determine whether particle size reduction is necessary (Section 7.1.3) and determine the appropriate extraction fluid (Section 7.1.4). If only the volatile TCLP is to be performed, see the note in Section 7.1.4.

7.1.3 Determination of whether the waste requires particle size reduction (particle size is reduced during this step): Using the solid portion of the waste, evaluate the solid for particle size. Particle size reduction is required, unless the solid has a surface area per gram of material equal to or greater than 3.1 cm^2 , or is smaller than 1 cm in its narrowest dimension (i.e is capable of passing through a 9.5 mm (0.375 inch) standard sieve). If the surface area is smaller or the particle size larger than described above, prepare the solid portion of the waste for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described above. If the solids are prepared for organic volatiles extraction, special precautions must be taken (see Section 7.3.6).

NOTE: Surface area criteria are meant for filamentous (e.g paper, cloth, and similar) waste materials. Actual measurement of surface area is not required, nor is it recommended. For materials that do not obviously meet the criteria, sample specific methods would need to

be developed and employed to measure the surface area. Such methodology is currently not available.

7.1.4 Determination of appropriate extraction fluid: If the solid content of the waste is greater than or equal to 0.5% and if the sample will be extracted for non-volatile constituents (Section 7.2) determine the appropriate fluid (Section 5.7) for the non-volatile extraction as follows;

NOTE: TCLP extraction for volatile constituents uses only extraction fluid #1 (Section 5.7.1). Therefore, if TCLP extraction for non-volatile is not required, proceed to Section 7.3.

7.1.4.1 Weigh out a small subsample of the solid phase of the waste, reduce the solid (if necessary) to a particle size of approximately 1 mm in diameter or less, and transfer 5.0 grams of the solid phase of the waste to a 500 mL beaker or Erlenmeyer flask.

7.1.4.2 Add 96.5 ml of reagent water to the beaker, cover with a watchglass, and stir vigorously for 5 minutes using a magnetic stirrer. Measure and record the pH. If the pH is <5.0, use extraction fluid #1. Proceed to Section 7.2.

7.1.4.3 If the pH from Section 7.1.4.2 is >5.0, add 3.5 ml 1N HCl slurry briefly, cover with a watchglass, heat to 50 °C and hold at 50 °C for 10 minutes.

7.1.4.4 Let the solution cool to room temperature and record the pH. If the pH is <5.0 use extraction fluid #1. If the pH is >5.0 use extraction fluid #2. Proceed to Section 7.2.

7.1.5 If the aliquot of the waste used for the preliminary evaluation (Sections 7.1.1 - 7.1.4) was determined to be 100% solid at Section 7.1.1.1 then it can be used for the Section 7.2 extraction (assuming at least 100 grams remain). If the aliquot was subjected to the procedure in Section 7.1.1.7 then another aliquot shall be used for the volatile extraction procedure in Section 7.3. The aliquot of the waste subjected to the procedure in Section 7.1.1.7 might be appropriate for use for the Section 7.2 extraction if an adequate amount of solid (as determined by Section 7.1.1.9) was obtained. The amount of solid necessary is dependent upon whether a sufficient amount of extract will be produced to support the analyses. If an adequate amount of solid remains, proceed to Section 7.2.10 of the non-volatile TCLP extraction.

7.2 Procedure when Volatiles are not involved.

A minimum sample size of 100 grams (solid and liquid phases) is recommended. In some cases, a larger sample size may be appropriate, depending on the solids content of the waste sample (percent solids, See Section 7.1.1) whether the initial liquid phase of the waste will be miscible with the aqueous extract of the solid, and whether inorganics, semi volatile organics, pesticides, and herbicides are all analytes of concern. Enough solids should be generated for extraction such that the volume of TCLP extract will be

sufficient to support all of the analyses required. If the amount of extract generated by a single TCLP extraction will not be sufficient to perform all of the analyses, more than one extraction may be performed and the extracts from each combined and aliquoted for analysis.

7.2.1 If the waste will obviously yield no liquid when subjected to pressure filtration (i.e. is 100% solid, see Section 7.1.1) weigh out a subsample of the waste (100 grams minimum) and proceed to Section 7.2.9.

7.2.2 If the sample is liquid or multiphase, liquid/solid separation is required. This involves the filtration device described in Section 4.3.2 and is outlined in Section 7.2.3 to 7.2.8.

7.2.3 Pre-weigh the container that will receive the filtrate.

7.2.4 Assemble the filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure. Acid wash the filter if evaluating the mobility of metals (see Section 4.4).

NOTE: Acid washed filters may be used for all non-volatile extractions even when metals are not of concern.

7.2.5 Weigh out a subsample of the waste (100 grams minimum) and record the weight. If the waste contains <0.5% dry solids (Section 7.1.2) the liquid portion of the waste after filtration, is defined as the TCLP extract. Therefore, enough of the sample should be filtered so that the amount of filtered liquid will support all of the analyses required of the TCLP extract. For wastes containing >0.5% dry solids (Sections 7.1.1 or 7.1.2), use the percent solids information obtained in Section 7.1.1 to determine the optimum sample size (100 gram minimum) for filtration. Enough solids should be generated by filtration to support the analyses to be performed on the TCLP extract.

7.2.6 Allow slurries to stand to permit the solid phase to settle. Waste that settle slowly may be centrifuged prior to filtration. Use centrifugation only as an aid to filtration. If the waste is centrifuged, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the same filtration system.

7.2.7 Quantitatively transfer the waste sample (liquid and solid phases) to the filter holder (see Section 4.3.2). Spread the waste sample evenly over the surface of the filter. If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering.

NOTE: If waste material (>1% of the original sample weight) has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and subtract it from the sample

weight determined in Section 7.2.5 to determine the weight of the waste sample that will be filtered.

Gradually apply vacuum or gentle pressure of 1-10 psi. until air or pressurizing gas moves through the filter. If this point is not reached under 10 psi. and if no additional liquid has passed through the filter in any 2 minute interval, slowly increase the pressure in 10 psi increments to a maximum of 50 psi. After each incremental increase of 10 psi. if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2 minute interval, proceed to the next 10 psi increment. When the pressurizing gas begins to move through the filter, or when the liquid flow has ceased at 50 psi (i.e., filtration does not result in any additional filtrate a 2 minute period), stop the filtration.

NOTE: Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

7.2.8 The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase. Weigh the filtrate. The liquid phase may now be either analyzed (See Section 7.2.12) or stored at 4°C until time of analysis.

NOTE: Some wastes, such as oily wastes and some paint wastes, will obviously contain

some material that appears to be a liquid. Even after applying vacuum or pressure filtration, as outlined in Section 7.2.7, this material may not filter. If this is the case, the material within the filtration device is defined as a solid and is carried through the extraction as a solid. Do not replace the original filter with a fresh filter under any circumstances. Use only one filter.

7.2.9 If the waste contains <0.5% dry solids (see Section 7.1.2) proceed to Section 7.2.13. If the waste contains >0.5% dry solids (See Section 7.1.1 or 7.1.2) and if particle size reduction of the solid was needed in Section 7.1.3 proceed to Section 7.2.10. If the waste as received passes a 9.5 mm sieve, quantitatively transfer the solid material into the extractor bottle along with the filter used to separate the initial liquid from the solid phase, and proceed to Section 7.2.11.

7.2.10 Prepare the solid portion of the waste for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described in Section 7.1.3. When the surface area or particle size has been appropriately altered, quantitatively transfer the solid material into an extractor bottle. Include the filter used to separate the initial liquid from the solid phase.

NOTE: Sieving of the waste is not normally required. Surface area requirements

are meant for filamentous (e.g paper, cloth) and similar waste materials. Actual measurement of surface area is not recommended. If sieving is necessary, a Teflon coated sieve should be used to avoid contamination of the sample.

7.2.11 Determine the amount of extraction fluid to add to the extraction vessel as follows:

$$\text{Weight of extraction fluid} = \frac{\text{20 x percent solids (Section 7.1.1) x weight of waste filtered (Section 7.2.5 or 7.2.7)}}{100}$$

Slowly add this amount of appropriate extraction fluid (see Section 7.1.4) to the extractor vessel. Close the extractor bottle tightly (it is recommended that Teflon tape be used to ensure a tight seal), secure in rotary agitation device, and rotate at 30 ± 2 rpm for 18 ± 2 hours. Ambient temperature (i.e temperature of room in which extraction takes place) shall be maintained at 23 ± 2 °C during the extraction period.

NOTE: As agitation continues, pressure may build up within the extractor bottle

for some types of wastes (e.g limed or calcium carbonate containing waste may evolve gases such as carbon dioxide). To relieve excess pressure, the extractor bottle may be periodically opened (e.g after 15 minutes, 30 minutes, and 1 hour) and vented into a hood.

7.2.12 Following the 18 ± 2 hour extraction, separate the material in the extractor vessel into its component liquid and solid phases by filtering through a new glass fiber filter, as outlined in Section 7.2.7. For final filtration of the TCLP extract, the glass fiber filter may be changed, if necessary, to facilitate filtration. Filter(s) shall be acid-washed (see Section 4.4) if evaluating the mobility of metals.

7.2.13 Prepare the TCLP extract as follows:

7.2.13.1 If the waste contained no initial liquid phase, the filtered liquid materials obtained from Section 7.2.12 is defined as the TCLP extract. Proceed to Section 7.2.14.

7.2.13.2 If compatible (e.g., multiple phases will not result on combination), combine the filtered liquid resulting from Section 7.2.12 with the initial liquid phase of the waste obtained in Section 7.2.7. This combined liquid is defined as the TCLP extract. Proceed to Section 7.2.14.

7.2.13.3 If the initial liquid phase of the waste, as obtained from Section 7.2.7, is not or may not be compatible with the filtered liquid resulting from Section 7.2.12, do not combine these liquids. Analyze these liquids, collectively defined as the TCLP extract, and combine the results mathematically, as described in Section 7.2.14.

7.2.14 Following collection of the TCLP extract, the pH of the extract should be recorded. Immediately aliquot and preserve the extract for analysis.

Metals aliquots must be acidified with nitric acid to pH <2. If precipitation is observed upon addition of nitric acid to a small aliquot of the extract, then the remaining portion of the extract shall be analyzed as soon as possible. All other aliquots must be stored under refrigeration

(4 °C) until analyzed. The TCLP extract shall be prepared and analyzed according to appropriate analytical methods. TCLP extracts to be analyzed for metals shall be acid digested except in those instances where digestion cause loss of metallic analytes. If an analysis of the undigested extract shows that the concentration of any regulated metallic analyte exceeds the regulatory level, then the waste is hazardous and digestion of the extract is not necessary. However, data on undigested extracts alone cannot be used to demonstrate that the waste is not hazardous. If the individual phases are to be analyzed separately, determine the volume of the individual phases (to ± 0.5%), conduct the appropriate analyses, and combine the results mathematically by using a simple volume-weighted average:

$$\text{Final Analyte Concentration} = \frac{(V_1) (C_1) + (V_2) (C_2)}{V_1 + V_2}$$

where:

V₁ = The volume of the First phase (L).

C₁ = The concentration of the analyte of concern in the first phase (mg/L).

V₂ = The volume of the second phase (L).

C₂ = The concentration of the analyte of concern in the second phase (mg/L).

7.2.15 Compare the analyte concentrations in the TCLP extract with the levels identified in the appropriate regulations. Refer to Section 8.0 for quality assurance requirements.

7.3 Procedure When Volatiles are Involved

Use the ZHE device to obtain TCLP extract for analysis of volatile compounds only. Extract resulting from the use of the ZHE shall not be used to evaluate the mobility of non-volatile analytes (e.g, metals, pesticides, etc.).

The ZHE device has approximately a 500 ml internal capacity. The ZHE can thus accommodate a maximum of 25 grams of solid (defined as that fraction of a sample from which no additional liquid may be forced out by an applied pressure of 50 psi), due to the need to add an amount of extraction fluid equal to 20 times the weight of the solid phase.

Charge the ZHE with sample only once and do not open the device until the final extract of the solid) has been collected. Repeated filling of the ZHE to obtain 25 grams of solid is not permitted.

Do not allow the waste, the initial liquid phase, or the extract to be exposed to the atmosphere for any more time than is absolutely necessary. Any manipulation of these materials should be done when cold (4 °C) to minimize loss of volatiles.

- 7.3.1 Pre-weigh the (evaluated) filtrate collection container (See Section 4.6) and set aside. If using a TEDLAR[®] bag, express all liquid from the ZHE device into the bag, whether for the initial or final liquid/solid separation, and take an aliquot from the liquid in the bag for analysis. The containers listed in Section 4.6 are recommended for use under the condition stated in Sections 4.6.1. - 4.6.3.**
- 7.3.2 Place the ZHE piston within the body of the ZHE (it may be helpful first to moisten the piston O-rings slightly with extraction fluid). Adjust the piston within the ZHE body to a height that will minimize the distance the piston will have to move once the ZHE is charged with sample (based upon sample sizes requirements determined from Section 7.3 Section 7.1.1 and/or 7.1.2). Secure the gas inlet/ outlet flange (bottom flange) onto the ZHE body in accordance with the manufacturer's instructions. Secure the glass fiber filter between the support screens and set aside. Set liquid inlet/outlet flange (top flange) aside.**
- 7.3.3 If the waste is 100% solid (see Section 7.1.1), weigh out a subsample (25 gram maximum) of the waste, record weight and proceed to Section 7.3.5.**
- 7.3.4 If the waste contains < 0.5% dry solids (Section 7.1.2), the liquid portion of waste, after filtration, is defined as the TCLP extract. Filter enough of the sample so that the amount of filtrated liquid will support all of the volatile analyses required. For wastes containing ≥ 0.5% dry solids (Sections 7.1.1 and/or 7.1.2), use the percent solids information obtained in Section 7.1.1 to determine the optimum sample size to charge into the ZHE. The recommended size is as follows:**

- 7.3.4.1 For wastes containing < 5% solids (see Section 7.1.1), weigh out a 500 gram subsample of waste and record the weight.
- 7.3.4.2 For waste containing ≥ 5% solids (see Section 7.1.1), determine the amount of waste to charge into the ZHE as follows:

$$\text{Weight of waste to charge ZHE} = \frac{25}{\text{Percent solids (Section 7.1.1)}} \times 100$$

Weigh out a subsample of the waste of the appropriate size and record the weight.

- 7.3.5 If particle size reduction of the solid portion of the waste was required in Section 7.1.3. proceed to Section 7.3.6. If particle size reduction was not required in Section 7.1.3. proceed to Section 7.3.7.
- 7.3.6. Prepare the waste for extraction by crushing, cutting or grinding the solid portion of the waste to a surface area or particle as described in Section 7.1.3. Wastes and appropriate reduction equipment should be refrigerated, if possible, to 4°C prior to particle size reduction. The means used to effect particle size reduction must not generate heat in and of itself. If reduction of the solid phase of the waste is necessary, exposure of the waste to the atmosphere should be avoided to the extent possible.

NOTE Sieving of the waste is not recommended due to the possibility that volatiles may be lost. The use of an appropriately graduated ruler is recommended as an acceptable alternative. Surface area requirements are meant for filaments (e.g., paper, cloth) and similar waste materials. Actual measurement of surface area is not recommended.

When the surface area or particle size has been appropriately altered, proceed to Section 7.3.7.

- 7.3.7 Waste slurries need not be allowed to stand to permit the solid phase to settle. Do not centrifuge wastes prior to filtration.
- 7.3.8 Quantitatively transfer the entire sample (liquid and solid phases) quickly to the ZHE. Secure the filter and support screens onto the top flange of the device and secure the top flange to the ZHE body in accordance with the manufacturer's instructions. Tighten all ZHE fittings and place the device in the vertical position (gas inlet/out flange on the bottom). Do not attach the extract collection device to the top plate.

NOTE: If waste material (>1% of original sample weight) has obviously adhered to the container used to transfer the sample to the ZHE, determine the weight of this residue and subtract it from the sample weight determined in Section 7.3.4 to determine the weight of the waste sample that will be filtered.

Attach a gas line to the gas inlet/outlet valve (bottom flange) and, with the liquid inlet/outlet valve (top flange) open, begin applying gentle pressure of 1-10 psi (or more if necessary) to force all headspace slowly out of the ZHE device into a hood. At the first appearance of liquid from the liquid inlet/outlet valve, quickly close the valve and discontinue pressure. If filtration of the waste at 4 °C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering. If the waste is 100% solid (see Section 7.1.), slowly increase the pressure to a maximum of 50 psi to force most of the headspace out of the device and proceed to Section 7.3.12.

7.3.9 Attach the evacuated pre-weighed filtrate collection container to the liquid inlet/outlet valve and open the valve. Begin applying gentle pressure of 1-10 psi to force the liquid phase of the sample into the filtrate collection container. If no additional liquid has passed through the filter in any 2 minute interval, slowly increase the pressure in 10 psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if no additional liquid has passed through the filter in any 2 minute , proceed to the next 10 psi increment. When liquid flow has ceased such that continued pressure filtration at 50 psi does not result in any additional filtrate within a 2 minute period, stop the filtration. Close the liquid inlet/outlet valve, discontinue pressure to the piston, and disconnect and weigh the filtrate collection container.

NOTE: Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

7.3.10 The material in the ZHE is defined as the solid phase of the waste and the filtrate is defined as the liquid phase.

NOTE: Some wastes, such as oily wastes and some paint wastes, will obviously contain some material that appears to be a liquid. Even after applying pressure filtration, this material will not filter. If this is the case, the material within the filtration device is defined as a solid and is carried through the TCLP extraction as a solid.

If the original waste contained <0.5% dry solids (see Section 7.1.2), this filtrate is defined as the TCLP extract and is analysed directly. Proceed to Section 7.3.15.

7.3.11 The liquid phase may now be either analyzed immediately (See Sections 7.3.15) or stored at 4 °C under minimal headspace conditions until time of analysis. Determine the weight of extraction fluid #1 to add to the ZHE as follows:

$$\text{Weight of extraction fluid} = \frac{20 \times \text{percent solids (Section 7.1.1)} \times \text{weight of waste filtered (Section 7.3.4 or 7.3.8)}}{100}$$

7.3.12 The following Sections detail how to add the appropriate amount of extraction fluid to the solid material within the ZHE and agitation of the ZHE vessel. Extraction fluid #1 is used in all cases (See Section 5.7).

7.3.12.1 With the ZHE in the vertical position, attached a line from the extraction fluid reservoir to the liquid inlet/outlet valve. The lines used contain fresh extraction fluid and should be preflushed with fluid to eliminate any air pockets in the line. Release gas pressure on the ZHE piston (from the gas inlet/outlet valve), open the liquid inlet/outlet valve, and begin transferring extraction fluid (by pumping or similar means) into the ZHE. Continue pumping extraction fluid into the ZHE until the appropriate amount of fluid has been introduced into the device.

7.3.12.2 After the extraction fluid has been added, immediately close the liquid inlet/out valve and disconnect the extraction fluid line. Check the ZHE to ensure that all valves are in their closed positions. Manually rotate the device in end-over-end fashion 2 or 3 times. Reposition the ZHE in the vertical position with the liquid inlet/outlet valve on top. Pressurize the ZHE to 5-10 psi (if necessary) and slowly open the liquid inlet/outlet valve to bleed out any headspace (into a hood) that may have been introduced due to the addition of extraction fluid. This bleeding shall be done quickly and shall be stopped at the first appearance of liquid from the valve. Re-pressurize the ZHE with 5-10 psi and check all ZHE fittings to ensure that they are closed.

7.3.12.3 Place the ZHE in the rotary apparatus (if it is not already there) and rotate at 30 ± 2 rpm for 18 ± 2 hours. Ambient temperature (i.e., temperature of room in which extraction occurs) shall be maintained at 23 ± 2 °C during agitation.

7.3.13 Following the 18 ± 2 hours agitation period, check the pressure behind the ZHE piston by quickly opening and closing the gas inlet/outlet valve and noting the escape of gas. If the pressure has not been maintained (i.e., no gas release observed), the device is leaking. Check the ZHE for leaking as specified in Section 4.2.1. and perform the extraction again with a new sample of waste. If the pressure within the device has been maintained, the material in the extractor vessel is once again separated into its component liquid and solid phases. If the waste contained an initial liquid phase, the liquid may be filtered directly into the same filtrate collection container (i.e., TEDLAR® bag) holding the initial liquid phase of the waste. A separate filtrate collection container must be used if combining would create multiple phases, or there is not enough volume left within the filtrate collection container. Filter through the glass fiber, using the ZHE device as discussed in Section 7.3.9. All extract shall be filtered and collected if the TEDLAR® bag is used, if the extract is multiphasic, or if the waste contained an initial liquid phase (see Sections 4.6. and 7.3.1).

NOTE: An in-line glass fiber filter may be used to filter the material within the ZHE if it is suspected that the glass fiber filter has been ruptured.

7.3.14 If the original waste contained no initial liquid phase, the filtered liquid material obtained from Section 7.3.8 is defined as the TCLP extract. If the waste

contained an initial liquid phase, the filtered liquid material obtained from Section 7.3.13 and the initial liquid phase (Section 7.3.9) are collectively defined as the TCLP extract.

- 7.3.15 Following collection of the TCLP extract, immediately prepare the extract for analysis and store with minimal headspace at 4 °C until analysed. Analyse the TCLP extract according to the appropriate analytical methods. If the individual phases are to be analyzed separately (i.e., are not miscible), determine the volume of the individual phases (to 0.5%). Conduct the appropriate analyses, and combine the results mathematically by using a simple volume-weighted average.

$$\text{Final Analyte Concentration} = \frac{(V_1) (C_1) + (V_2) (C_2)}{V_1 + V_2}$$

where:

- V_1 = The volume of the first phases (L).
- C_1 = The concentration of the analytes of concern in the first phase (mg/L).
- V_2 = The volume of the second phase (L).
- C_2 = The concentration of the analyte of concern in the second phase (mg/L).

- 7.3.16 Compare the analyte concentrations in the TCLP extract with the levels identified in the appropriate regulations. Refer to Section 8.0 for quality assurance requirements.

8.0 QUALITY ASSURANCE

- 8.1 A minimum of one blank (using the same extraction fluid as used for the sample) must be analyzed for every 20 extractions that have been conducted in an extraction vessel.

- 8.2 A matrix spike shall be performed for each waste type (e.g., wastewater treatment sludge, contaminated soil, etc.) unless the result exceeds the regulatory level and the data are being used solely to demonstrate that the waste property exceeds the regulatory level. A minimum of one matrix spike must be analyzed for each analytical batch. As a minimum, follow the matrix spike addition guidance provided in each analytical method.

- 8.2.1 Matrix spikes are to be added after filtration of the TCLP extract and before preservation. Matrix spikes should not be added prior to TCLP extraction of the sample.

- 8.2.2 In most cases, matrix spikes should be added at a concentration equivalent to the corresponding regulatory level. If the analyte concentration is less than one half the regulatory level, the spike concentration may be as low as one half of the analyte concentration, but may not be less than five times the method detection limit. In order to avoid differences in matrix effects, the matrix spikes

must be added to the same nominal volume of TCLP extract as that which was analyzed for the unspiked sample.

8.2.3 The purpose of the matrix spike is to monitor the performance of the analytical methods used, and to determine whether matrix interferences exist. Use of other internal calibration methods, modifications of the analytical methods, or use of alternate analytical methods may be needed to accurately measure the analyte concentration in expected analytical method performance.

8.2.4 Matrix spike recoveries are calculated by the following formula:

$$\%R \text{ (% Recovery)} = 100 (X_s - X_u) / K$$

where:

X_s = measured value for the spiked sample,
 X_u = measured value for the unspiked sample, and
 K = known value of the spike in the sample.

8.3 All quality control measures described in the appropriate analytical methods shall be followed.

8.4 The use of internal calibration quantitation methods shall be employed for a metallic contaminant if:

- (1) Recovery of the contaminant from the TCLP extract is not at least 50% and the concentration does not exceed the regulatory level, and;
- (2) The concentration of the contaminant measured in the extract with 20% of the appropriate regulatory level.

8.4.1 The method of standard additions shall be employed as the internal calibration quantitation method for each metallic contaminant.

8.4.2 The method of standard additions requires preparing calibration standards in the sample matrix rather than reagent water or blank solution. It requires taking four identical aliquots of the solution and adding known amounts of standard to three of these aliquots. The fourth aliquot is the unknown. Preferably, the first addition should be prepared so that the resulting concentration is approximately 50% of the expected concentration of the sample. The second and third additions should be prepared so that the concentrations are approximately 100% and 150% of the expected concentration of the sample. All four aliquots are maintained at the same final volume by adding reagent water or a blank solution, and may need dilution adjustment to maintain the signals in the linear range of the instrument technique. All four aliquots are analyzed.

8.4.3 Prepare a plot, or subject data to linear regression, of instrument signals or external-calibration-derived concentrations as the dependant variable (y - axis) versus concentrations of the additions of standard as the independent variable (x-axis). Solve for the intercept of the abscissa (the independent variable, x-axis) which is the concentration in the unknown.

8.4.4 Alternatively, subtract the instrumental signal or external-calibration-derived concentration of the unknown (unspiked) sample from the instrumental signals or external-calibration-derived concentrations of the standard additions. Plot or subject to linear regression of the corrected instrument signals or external-calibration-derived concentrations as the dependant variable versus the independent variable. Derive concentrations for unknowns using the internal calibration curve as if it were an external calibration curve.

8.5 Samples must undergo TCLP extraction within the following time periods:

SAMPLE MAXIMUM HOLDING TIMES (DAYS)				
	From: Field Collection	From: TCLP Extraction	From: Preparative Extraction	
	To: TCLP Extraction	To: Preparative Extraction	To: Determinative Analysis	Total Elapsed Time
Volatiles	14	NA	14	28
Semi- volatiles	14	7	40	61
Mercury	14	7	40	61
Metals, except Mercury	28	NA	28	56
	180	NA	180	360

NA = Not applicable

If sample holding times are exceeded, the values obtained will be considered minimal concentrations. Exceeding the holding time is not acceptable in establishing that a waste does not exceed the regulatory level. Exceeding the holding time will not invalidate characterization, if the waste exceeds the regulatory level.

9.0 METHOD PERFORMANCE

9.1 Ruggedness. Two ruggedness studies have been performed to determine the effect of various perturbations on specific elements of the TCLP protocol. Ruggedness testing determines the sensitivity of small procedural variations which might be expected to occur during routing laboratory application.

9.1.1 Metals - The following conditions were used when leaching a waste for metals analysis:

Varying Conditions	
Liquid/solid ratio	19.1 vs. 21.1
Extraction time	16 hours vs. 18 hours
Headspace	20% vs. 60%
Buffer #2 acidity	190 meq vs. 210 meq
Acid-washed filters	Yes vs. no
Filter type	0.7 µm glass fiber vs. 0.45 µm vs. polycarbonate
Bottle type	Borosilicate vs. flint glass

Of the seven method variations examined. Acidity of the extraction fluid had the greatest impact on the results. Four of 13 metals from an API separator sludge/electroplating waste (API/EW) mixture and two of three metals from an ammonia lime still bottom waste were extracted at higher levels by the more acidic buffer. Because of the sensitivity to pH changes, the method requires that the extraction fluids be prepared so that the final pH is within ± 0.05 units as specified.

9.1.2 Volatile Organic compounds - The following conditions were used when leaching a waste for VOC analysis:

Varying Conditions	
Liquid/Solid ratio	19:1 vs. 21:1
Headspace	0% vs. 5%
Buffer #1 acidity	60 meq vs. 80 meq
Method of storing extract	Syringe vs. Tedlar[®] bag
Aliquotting	Yes vs. no
Pressure behind piston	0 psi vs. 20 psi

None of the parameters had a significant effect on the results of the ruggedness test.

9.2 Precision. Many TCLP precision (reproducibility) studies have been performed, and have shown that, in general, the precision of the TCLP is comparable to or exceeds

that of the EP toxicity test and that method precision is adequate. One of the more significant contributions to poor precision appears to be related to sample homogeneity and inter-laboratory variation (due to the nature of waste materials.)

- 9.2.1 Metals** - The results of a multi-laboratory study are shown in Table VIII-D6, and indicate that a single analysis of a waste may not be adequate for waste characterization and identification requirements.
- 9.2.2 Semi-Volatile Organic** - The results of two studies are shown in Tables VIII-D7 and VIII-D8. Single laboratory precision was excellent with greater than 90 percent of the results exhibiting an RSD less than 25 percent. Over 85 percent of all individual compounds in the studies concluded that the TCLP provides adequate precision. It was also determined the high acetate content of the extraction fluid did not present problems (i.e., column degradation of the gas chromatograph) for the analytical conditions used.
- 9.2.3 Volatile Organic Compounds** - Eleven laboratories participated in a collaborative study of the use of the ZHE with two waste types which were fortified with a mixture of VOCs. The results of the collaborative study are shown in Table VIII-D9. Precision results for VOCs tend to occur over a considerable range. However, the range and mean RSD compared very closely to the same collaborative study metals results in Table VIII-D6. Blackburn and Show concluded that at the 95% level of significance:
- 1) recoveries among laboratories were statistically similar;
 - 2) recoveries did not vary significantly between the two sample types, and;
 - 3) each laboratory showed the same pattern of recovery for each of the two samples.

10.0 REFERENCES

1. Blackburn, W.B. and Show, I. "Collaborative Study of the Toxicity Characteristics Leaching Procedure (TCLP). " Draft Final Report Contract No. 68-03-1958, S-Cubed, November 1986.
2. Newcomer, L.R., Blackburn, W. B., Kimmell, T.A. "Performance of the Toxicity Characteristics Leaching Procedure." Wilson Laboratories, S-Cubed, U.S. EPA, December 1986.
3. Williams, L.R., Francis. C.W.; Maskarinec M.P., Taylor D.R., and Rothman, N. "Single-Laboratory Evaluation of Mobility Procedure for Solid Waste." EMSL. ORNL, S-Cubed, ENSECO.

Table VIII-D5 Volatile Analytes^{1,2}

Compound	CAS No.
Acetone	67-64-1
Benzene	71-43-2
n-Butyl alcohol	71-36-3
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroform	67-66-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethylene	75-35-4
Ethyl acetate	141-78-6
Ethyl benzene	100-41-4
Ethyl ether	60-29-7
Isobutanol	78-83-1
Methanol	67-56-1
Methylene chloride	75-09-2
Methyl ethyl ketone	78-93-3
Methyl isobutyl Ketone	108-10-1
Tetrachloroethylene	127-18-4
Toluene	108-88-3
1. 1.1. - Trichloroethane	71-55-6
Trichloroethylene	79-10-6
Trichlorofluoromethane	75-69-4
1.1.2 - Trichloro-1.2.2.-trifluoroethane	76-13-1
Vinyl chloride	75-01-4
Xylene	1330-20-7

1 When testing for any or all of these analytes, the zero-headspace extractor vessel shall be used instead of the bottle extractor.

- 2 Benzene, carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichloroethane, 1-dichloroethylene, methyl ethyl ketone, tetrachloroethylene, and vinyl chloride are toxicity characteristic constituents.

Table VIII-D6 Multi - Laboratory TCLP Metals, Precision

Waste	Extract ion Fluid	Metal	\bar{X}	S	%RSD
Ammonia Lime Still Bottoms	#1	Cadmium	0.053	0.031	60
	#2		0.023	0.017	76
	#1	Chromium	0.015	0.0014	93
	#2		0.0032	0.0037	118
	#1	Lead	0.0030	0.0027	90
	#2		0.0032	0.0028	87
API / EW Mixture	#1	Cadmium	0.0046	0.0028	61
	#2		0.0005	0.0004	77
	#1	Chromium	0.0561	0.0227	40
	#2		0.105	0.018	17
	#1	Lead	0.0031	0.0031	100
	#2		0.0124	0.0136	110
Fossil Fuel Fly Ash	#1	Cadmium	0.080	0.069	86
	#2		0.093	0.067	72
	#1	Chromium	0.017	0.014	85
	#2		0.070	0.040	57
	#1	Lead	0.0087	0.0074	85
	#2		0.0457	0.0083	18
% RSD Range					
Mean % RSD					
- 17 - 118					
- 74					

NOTE: \bar{X} - Mean results from 6 - 12 different laboratories
Units - mg/L
Extraction Fluid #1 - pH 4.9

Table VIII-D7 Single - Laboratory Semi -Volatiles, Precision

Waste	Compound	Extraction Fluid	\bar{X}	S	%RSD
Ammonia Lime Still Bottoms	Phenol	#1	19000	2230	11.6
		#2	19400	929	4.8
	2-Methyl phenol	#1	2000	297	14.9
		#2	1860	52.9	2.8
	4-Methyl phenol	#1	7940	1380	17.4
		#2	7490	200	2.7
	2,4-Dimethyl phenol	#1	321	46.8	14.6
		#2	307	45.8	14.9
	Naphthalene	#1	3920	413	10.5
		#2	3827	176	4.6
	2-Methyl naphthalene	#1	290	44.8	15.5
		#2	273	19.3	7.1
	Dibenzofuran	#1	187	22.7	12.1
		#2	187	7.2	3.9
	Acenaphthylene	#1	703	89.2	12.7
		#2	663	20.1	3.0
	Fluorene	#1	151	17.6	11.7
		#2	156	2.1	1.3
	Phenanthrene	#1	241	22.7	9.4
		#2	243	7.9	3.3
Anthracene	#1	33.2	6.19	18.6	
	#2	34.6	1.55	4.5	
Fluoranthrene	#1	25.3	1.8	7.1	
	#2	26.0	1.8	7.1	
API/EW Mixture	Phenol	#1	40.7	13.5	33.0
		#2	19.0	1.76	9.3
	2,4-Dimethyl phenol	#1	33.0	9.35	28.3
		#2	43.3	8.61	19.9
	Naphthalene	#1	185	29.4	15.8
		#2	165	24.8	15.0
	Naphthalene	#1	265	61.2	23.1
		#2	200	18.9	9.5

	2-Methyl naphthalene				
33	%RSD Range = 1 - Mean % RSD = 12				

NOTE: Units = ug/L
 Extractions were performed in triplicate
 All results were at least 2x the detection limit
 Extraction Fluid #1 - pH 4.9
 #2 - pH 2.9

Table VIII-D8 Multi - Laboratory Semi-Volatiles, Precision.

Waste	Compound	Extraction Fluid	\bar{X}	S	%RSD
Ammonia Lime Still Bottoms (A)	BNAs	#1	10043	7680	76.5
		#2	10376	6552	63.1
API/EW Mixture (B)	BNAs	#1	1624	675	41.6
		#2	2074	1463	70.5
Fossil Fuel Fly Ash (C)	BNAs	#1	750	175	23.4
		#2	739	342	46.3
54	Mean %RSD -				

NOTE: Units - µg/l
 X - Mean results from 3 - 10 labs
 Extraction Fluid #1 - pH 4.9
 #2 - pH 2.9

% RSD Range for Individual Compounds

- A. #1 0 - 113
- A. #2 28 - 108
- B. #1 20 - 156
- B. #2 49 - 128
- C. #1 36 - 143
- C. #2 61 - 164

TABLE VIII-D9 Multi - Laboratory (11 Labs) VOCs, Precision

Waste	Compound	\bar{X}	S	%RSD
Mine Tailings	Vinyl chloride		6.36	100
	Methylene chloride	6.36	11.8	98
	Carbon disulfide	12.1	2.83	51
	1,1 - Dichloroethene	5.57	27.7	127
	1,1 - Dichloroethane	21.9	25.4	81
	Chloroform	31.4	29.2	63
	1,1 - Dichloroethane	46.6	33.6	70
	2- Butanone	47.8	36.9	85
	1,1, 1 - Trichloroethane	43.5	20.9	100
	Carbon tetrachloride	20.9	8.2	68
	Trichloroethene	12.0	21.2	86
	1,1,2 - Trichloroethene	24.7	10.9	56
	Benzene	19.6	28.7	76
	1,1,2,2	37.9	25.6	73
	Tetrachloroethene	34.9	11.2	38
	Toluene	29.3	19.3	54
	Chlorobenzene	35.6	2.80	66
	Ethyl benzene		4.40	155
	Trichlorofluoromethane	4.27	110.8	144
	Acrylonitrile			
Ammonia Lime Still Bottoms		3.82	4.71	94
	Vinyl chloride	76.7	13.1	92
	Methyl chloride		2.07	61
	Carbon disulfide		38.8	75
	1,1 - Dichloroethene	5.00	25.6	49
	1,1 - Dichloroethane	14.3	28.4	44
	Chloroform		31.5	73
	1,2 - Dichloroethane	3.37	39.6	67
	2 - Butanone	52.1	40.9	76
	1,1,1 - Trichloroethane	52.8	6.1	86
	Carbon tetrachloride	64.7	34.2	60
	Trichloroethene	43.1	4.7	70

	1,1,2 - Trichloroethene	59.0	26.8	44
	Benzene	53.6	2.1	66
	1,1,2,2 -		18.5	27
	Tetrachloroethane	7.10	12.0	17
	Toluene	57.3	2.2	58
	Chlorobenzene	6.7	4.8	119
	Ethyl benzene	61.3	34.8	118
	Trichlorofluoromethane			
	Acrylonitrile	3.16		
		69.0		
		71.8		
		3.70		
		4.05		
		29.4		
- 144			%RSD Range = 17	
			Mean %RSD = 75	

NOTE: Units - µg/L

APPENDIX VIII – D6 LABORATORY ACCREDITATION PERMIT APPLICATION.

1.0 Laboratory Name:

**Address:
Tel:
Fax:**

**2.0 Application for (state category of Analytical services/Area of Specialisation).
Application for New Permit/Repermit.**

3.0 Analytical capability:

Type Only. Incomplete Application will be returned.

Analyte/ Properties	Instru- ment	Age	No	Method name	Referenc e	Limit of Detectio n	Est. annual throughpu t

4.0 Dimensions of Resources and Services

4.1 Staff

- Give number of staff employed at this location. (please supply an organisation chart)
- Supply the names and qualifications/experience of key staff, including those who sign off analytical results.
- Supply details of the qualifications of those laboratory staff not included above.

QUALIFICATION	NUMBERS

- Supply outline details of training policy.

4.2 Accommodation

- Supply details of laboratory space (ft² .m²) provided at the location for analytical services applied for,
- provide details of facilities available at the same location.

4.3 Operation:

- **Supply details of the logging and tracking system of samples and the recording and storage of results.**
- **Supply details of the “chain of custody” procedures at the facility.**
- **State policy for the retention, storage and disposal of samples.**

4.4 Quality system

- **Provide details of quality control institute for use.**
- **Provide details and copies of previous accreditation by DPR/other local and international enforcement agencies.**

5.0 Reporting

Provide details of format (paper/electronic) used for reporting of results.

6.0 References.

- **Provide details of previous work experience, including names of clients and type of job performed.**

5.0 B I B L I O G R A P H Y

- 1 Annual Book of ASTM Standards. Volumes 11.01, 11.02, 11.03, 14.01, 14.02. ASTM, 1916 Race Street, Philadelphia, PA.
- 2 Manual on Water (ASTM SPECIAL TECHNICAL PUBLICATION, STP), C. E. Hamilton, Dow Chemical Company.
- 3, Standard Methods of Chemical Analysis; F. J. Welcher, 6th Edition, Volume Two, Part B, pages 2310 2333, 2388 - 2398.
4. Manual of Methods for Chemical Analysis of Water and Wastes U.S. Environmental Protection Agency (EPA), Office of Technology Transfer, Cincinnati, Ohio.
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- 13 Test Methods for Evaluating Solid Waste Physical/Chemical Methods (2nd Edition). Office of solid Waste and Emergency Response, Washington, DC. 20460. pp. 96-109.
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14. **Blackburn, W.B. and Show, I. "Collaborative Study of the Toxicity Characteristics Leaching Procedure (TCLP). " Draft Final Report Contract No. 68-03-1958, S-Cubed, November 1986.**
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16. **Williams, L.R., Francis. C.W.; Maskarinec M.P., Taylor D.R., and Rothman, N. "Single-Laboratory Evaluation of Mobility Procedure for Solid Waste." EMSL. ORNL, S-Cubed, ENSECO.**

E METHODOLOGIES FOR BIOLOGICAL MONITORING OF

EFFLUENTS AND RECIPIENT ENVIRONMENT

1.0 BACKGROUND

- 1.1 In most monitoring programmes, contamination is measured in terms of physical, chemical and biological characteristics. The chemical analysis provides an indication of the concentrations of pollution indicator parameters that have been selected for evaluation. Since pollution implies effects, it is usually assessed in relation to biological characteristics. In pollution monitoring, therefore, biological information is required. Moreover, reliance on physical and chemical analyses alone for studies of biological effects has serious shortcomings. Thus, slight, and in analytical chemical terms, insignificant changes in the concentrations of certain chemicals, can markedly affect water quality from the biological standpoint. Also, chemicals, which by them would have been harmless, may cause effects by interacting in the general milieu of contaminated waters. Further, chemicals whose identity is unknown or whose presence is not even suspected may produce effects. Finally, without observations linking levels in the water or sediment with tissue concentrations and then with effects on organisms, populations and communities and ultimately, with the wellbeing of the ecosystems as a whole, an adequate assessment of pollution is impossible. This is the rationale for using biological variables to monitor the effects of pollution.
- 1.2 Biological monitoring of effluent consists of the effects monitoring for environmental changes (ecological) and it includes three basic activities:
- (i) Measurement of the biological effects of effluents, using captive organisms exposed to the effluent in the laboratory and/or in the environment as summarised in Table VIII-EI, and
 - (ii) Measurement of effects of effluents on bio-ecological integrity of the recipient environments as summarised in Table VIII-E5
 - (iii) Measurement of the concentrations of pollutants in the natural biota of the recipient environment.
- 1.3 The objectives of these guidelines and standards which cover aquatic and terrestrial recipient environments are as follows;
- (i) Implement effluent biological monitoring programmes for areas that are polluted or likely to be polluted due to petroleum activity;
 - (ii) Evaluate biological/microbiological characteristics of the environments impacted by operational discharges;
 - (iii) Assess the impact of the discharges on flora and fauna;
 - (iv) Assist in developing impact control strategies;
 - (v) Protect human health;
 - (vi) Determine spatial and temporal trends in contamination and its effects on the ecosystem;
 - (vii) Provide environmental management data;

2.0 BIOLOGICAL MONITORING METHODS

2.1 In monitoring the biological effects of effluents, many methods are available for selection. Some of the possible acute and chronic toxicity evaluations are summarized in Table VIII-E2. Among all the variables that have been subjected to some systematic examination two major categories shall be used as specified below:

2.1.1 Acute Toxicity Bioassay or Toxicity testing

2.1.1.1 This is a test in which the strength of a stimulus (chemical or physical) is determined by the responses of living organisms to it. Acute toxicity bioassays (toxicity testing) shall be required for the specific operations already identified by the guideline and standards.

2.1.2 Chronic Toxicity Bioassays Under Sublethal Concentrations.

2.1.2.1 These are long-term tests carried out under sublethal concentrations, at times typical of prevailing concentrations of effluent constituents in recipient ecosystems, aimed at detecting subtle chronic changes or effects in exposed organisms over time such as retardation and/or disruptions of physiological & biochemical functions, malformations, morphological changes and bioaccumulation of non-degradable pollutants/emissions in living tissues. Bioaccumulation, which is to be emphasized in this series of chronic bioassays, measures the net gain of material absorbed from the medium/environment. Bioaccumulation shall be mandatory only where an operator discharges effluent or crude oil into sensitive environment; evaluation of the effects of effluents on the biological integrity of recipient environment. EERs shall also be required at the discretion of the Director, Petroleum Resources, for all operations discharging effluents into the environment.

TABLE VIII-E1 USE OF CAPTIVE ORGANISMS IN BIOMONITORING AND TOXICITY TESTS

TYPE OF TEST	PHYTO-PLANKTON	ZOO-PLANKTON	PERI-PHYTOL	MACR-OPHYTES	MACRO-BENTHOS	FISH
1. <u>In situ- tests</u>						
(i)						
Bioaccumulation	x	x		x	x	x
Toxic metals	x					
Hydrocarbon	x	x		x	x	x
Flesh tainting	x					
(ii) Toxicity					x	
(Bioassay)	x					
test						
Acute toxicity						
2. <u>In-Plant tests</u>						
<u>Effluents</u>						
(i)						
Bioaccumulation						
Toxic metal						
Hydrocarbons			x		x	x
Flesh tainting	x					
(ii) Toxicity tests			x		x	x
(Bioassay) :	x					
Acute					x	
Toxicity	x					
3. <u>Laboratory tests</u>						
(i)						
Bioaccumulation	x	x		x	x	x
Toxic metal	x					
Hydrocarbons						
Skin tainting						
(ii) Toxicity tests						
(Bioassay) :	x	x		x	x	x
Acute Toxicity	x					
	x					
						x
	x	x				x
	x					

TABLE VIII-E2 - USE OF BIOLOGICAL VARIABLES IN EFFLUENT MONITORING

TYPE OF METHOD	BIOLOGICAL VARIABLES
1. Bioassay (Toxicity test)	LC ₅₀ , EC ₅₀ , Toxicity curves
2. Bioaccumulation (Tissue analysis)	Flesh tainting, toxic organic and metal contents, etc.
3. Biochemical effects	Lysosomal stability, taurine/glycine
4. Genetic effects	Chromosomal abnormalities, mutagenicity assay, terotogenicity
5. Physiological effects	Feeding rate, body condition index, growth rate
6. Morphological & Pathological effects	Liver as percentage body weight, ulcers. fin - erosion, vertebral damage, assymetry, neoplasia/lesions, tumors
7. Ecological effects	Community biomass, abundance, diversity, alteration in distribution, species density, growth rate, reproduction (gonad as % body weight), population structure

2.2 Bioassay (Toxicity Testing)

2.2.1. Background

2.2.1.1 The value of bioassays for detecting and evaluating the toxicity of chemicals and industrial waste in connection with their treatment and safe disposal is being realised increasingly. Chemical examination alone, as said earlier, of complex industrial wastes does not provide sufficient information on their effects on the aquatic biota for the protection of the aquatic environment. Moreover, the toxicity of the complex mixture of wastes and chemicals cannot be determined by chemical means. The toxicity of effluents can be influenced greatly by interactions between their individual components, by waste already present, and by the dissolved minerals naturally occurring in widely varying amounts in receiving waters. Different kinds of aquatic organisms are not equally susceptible to toxic substances and much of the pertinent published information is based on experiments with hardy species most of which are not native to Nigeria. Therefore, the toxicity of the petroleum wastes to local biota must be detected and evaluated through bioassay under appropriate experimental conditions.

2.2.2. Scope of Utilization. Toxicity testing technique is used for determining:

- (i) The amount of waste treatment needed to meet water pollution control requirement;
- (ii) The effectiveness of different waste treatment methods;
- (iii) Permissible discharge rates for effluents;
- (iv) Compliance with water quality standards, effluent requirement and discharge permit;
- (v) Water quality requirement for aquatic life;
- (vi) The relative sensitivity of aquatic organisms to an effluent or toxicant;
- (vii) The relative toxicity of different wastes to selected species or a number of species;

- (viii) The effect of various combinations of these environmental factors on Toxicity of waste and;
- (ix) The Lethal effects of industrial effluents on selected species of economic importance,

2.2.3. Types Of Bioassay Techniques. The method of assessing toxic effects of pollutants in the aquatic environment using bioassay technique includes, acute lethal toxicity tests, and sublethal toxicity tests. Both tests have usefulness and limitations. The acute lethal toxicity tests usually give information on the concentration, in relation to time, that will cause death to test organisms. Results from these tests have to be interpreted with care as laboratory tests are usually, simple and of single variable. But in the field, many complex variables which interplay, sometimes may make results from acute toxicity tests **of limited interpretation**. However, acute toxicity test results are useful in identifying indicator organisms in the assessment of pollution. On the other hand, sublethal toxicity tests reveal the effect of pollution on the organism which does not necessarily result in death in the course of the experiment. This is a very useful technique in estimating the longterm effect of pollution in the ecological web. The acute lethal toxicity test shall be the recommended method for assessing the toxic effects of pollutants to aquatic organisms in local environment

2.2.4. Procedure Of Acute Toxicity Testing for Effluents Direct measurement of the toxic properties of effluents prior to discharge shall be conducted using one or a few species of organisms that are selected because of their relative greater sensitivity to toxicants, ease of culture or because they are considered representative of the indigenous organisms in the recipient water. The selected organisms are summarized in Table VIII-E3.

TABLE VIII-E3 SELECTED TEST ORGANISMS FOR EFFLUENT TOXICITY TESTS

ORGANISMS	MEDIA	SPECIES
Shrimps	FreshWater Marine/Brackish	Desmoscaris trispinosa africanus Palaemonetes africans
Fish	Fresh Water	Foerschichthys flavipinni
	Fresh Water /Brackish	Dormitator lebretonis , Tilapia guineenis (fry)
	Marine/Brackish	Aplocheilichthys Spilauchen; Tilapia guineenis (fry)
Hermit Crab	Brackish	Clibanarius africanus (Highly tolerant)

- (i) For the determination of an LC₅₀ a control, and at least, five concentrations of test effluent within the chemical activity range shall be used.

- (ii) Ten (10) test organisms shall be desirable at each concentration. If organisms are large, it shall be necessary to split them between two or more test chambers.
- (iii) Physico-chemical Analysis of the properties of the effluents shall be carried out in accordance with the requirement in PART VIII-D, Article 2.4 of the LC₅₀.
- (iv) Data analysis results shall be as follows:
 - (a) The probit method shall be used to calculate the LC₅₀ and confidence limit.
 - (b) A computer programme shall be used to calculate a LC₅₀ or EC₅₀ value and confidence limit;
 - (c) Results shall be expressed as a 96hr LC₅₀, with confidence limits.
- (v) Report presentation to the Director, Petroleum Resources shall include the following:
 - (a) A complete file of the test procedure and results as specified in Tables VIII-E4 and VIII-E5;
 - (b) A detailed description of the effluent, including its source, method, date and time of collection, composition, known physical and chemical properties, variabilities and how it was stored;
 - (c) Detailed information about the test organisms including scientific name, source culture, methods, quality and quantity of food fed to the culture, disease and acclimatization procedure used;
 - (d) A brief description of test procedure, dilution series, number of organisms per test concentration, method of randomly distributing organisms, and test brakers;
 - (e) The description of the adverse effect (death, immobility, floating etc.) used in the test and summary of general observations of other effects or symptoms;
 - (f) The number and percentage of organisms in each test chamber (including the control chamber) that died or showed the 'effect' used to measure toxicity;
 - (g) The calculated 96 hr LC₅₀, or EC₅₀ result shall be reported.

2.2.5. Toxicity Tests Of Chemicals

- (i) Operators shall be required to undertake toxicity tests of all low toxic base oil, oil based mud system, drilling fluid, chemical dispersants or any other chemical on standard aquatic organisms under Nigerian environmental conditions.
- (ii) Operators shall use laboratory facilities approved by the Director, Petroleum Resources to conduct toxicity tests.
- (iii) The procedure for the determination of the acute toxicity of chemicals under Nigerian environmental conditions shall be as follows;
 - (a) Objective: The objective is to determine the 96 hour median lethal concentration (96hour LC₅₀ and median lethal times (LT₅₀) of **chemicals** to standard aquatic organisms. The toxicity tests will cover acute toxicity determinations using semi-static agitation test procedure. (Stirring should be

every 8 hour (each for 5 min.) also stir initially for 5 minutes before introducing animal). The test results will be submitted to the Director, Petroleum Resources for evaluation and subsequent selection and approval of the chemicals for use in Nigeria in accordance with the application sought.

- (b) Test Material: A sufficient quantity of the test materials will be supplied by the chemical supplier and/or Operator (sponsor). As soon as the laboratory collects the chemical sample, it should be stored at between 26^o & 28^oC temperature. Adequate physico-chemical specification, as well as priority hazardous constituents (e.g. cadmium, mercury and percent aromatic contents) shall be provided by the chemical supplier and/or operator (sponsor). Special reference to hazardous properties, storage conditions and material safety data sheet (MSDS) shall also be provided by the sponsor. Where the physico-chemical and the priority hazardous constituents are not provided by the supplier they shall become part of the tests to be conducted by the approved Nigerian laboratories.
- (c) Test Species:
1. Organism selection: The Species recommended for the toxicity tests, shall be as follows: **(Also see Table VIII-E3):**
 - * Freshwater - Desmocarid trispinosa
 - * Brackish water - Palaemonetes africanus. Other species that could be raised and maintained in laboratory cultures, should be explored for the tests. Organisms of known history are preferred for toxicity tests and the use of cultured organisms could cut costs.
 - 1.1 **Accredited and selected laboratories should conduct toxicity tests at about the same time. The laboratories should collect test organisms at the same time and from the same habitat (i.e. fresh and brackish waters). Organisms collected from the habitat (wild) should be properly acclimatized and stabilized before use. If the test organism is to be changed or substituted from the stipulated organism(s), approval shall first be obtained from the Director, Petroleum Resources before testing commences.**
 2. Justification for the Selection of Test Species: Based on the previous studies on the toxicity of Nigerian crude oil and work of other scientists on the toxicity of Nigerian crude to aquatic organisms, the standard test species are chosen because of their sensitivity, availability and relative ease in handling. This is without prejudice to current research on this issue.
 3. Specification of Test Animals: The test animals shall be purportedly healthy. An estimate of the weight and length of the test animals is determined by measurement of the control specimens on completion of the study. There shall be no more than a two-fold difference between the minimum and maximum sizes (as body length) of specimens used.
- (d) Collection and Transportation: The species shall be aerated immediately they are collected. Plastic bash bags should be used in collection and transportation.

- (e) Acclimatization: The stock population shall be held in laboratory conditions for a minimum of ten (10) days and fed on 3% of bulk weight daily on a diet of which should be stated in the report results. They shall be held for a minimum of three days at $28 \pm 2^{\circ}\text{C}$ before being transferred to test vessels. Food shall be withheld throughout the test period
- (f) Test Apparatus: The test vessels shall be constructed of dark or amber colour glass and some of working capacity, in order to accommodate the ratio of 1 gm of test organism to 1 litre of test solution. A stirring system shall be used. During siphoning teflon material shall be used. A steel net shall be used to cover the test containers.
- (g) Identification of Test System: The individual test vessels shall be identified by the study number and the exposure concentration.
- (h) Dilution Water: The water from the habitat from where the organisms were collected shall be used after filtration. This will however, depend on the requirements of the test organisms, pH, conductivity **and temperature**.
- (i) Lightening: There should be light control; 12 hours of light and 12 hours of darkness are recommended.
- (j) Test Temperature: The test shall be carried out at $28 \pm 2^{\circ}\text{C}$.
- (k) Type of Tests and Test Concentrations: On the basis of current toxicological statistics, it is recommended that emphasis shall be on an even spread of test concentrations along predetermined toxicity range of compounds. Water from the medium shall be used as control. Diesel shall be used as a reference for drilling fluids. Tests at five (5) concentrations in triplicate shall be made and a range test also performed. Joint action studies with dispersants and selected crude oil shall be carried out as defined below:
- (i) For the dispersants, test shall be performed according to the manufacturers dispersants-to-oil mixture ratio. The following tests shall be carried out using the above mixture:
1. Test dispersant and Bonny Light.
 2. Test dispersant alone
 3. Test crude oil - Bonny light alone
 4. Test Sodium Dodecyl Sulphate (SDS) alone.
- (ii) For base Oils and mud systems, the following tests shall be performed:
1. Oil water. mixture
 2. Water Soluble fraction
 3. Suspended particle phase
 4. Diesel Oil alone
- These tests shall be undertaken when possible so that results obtained could be compared with data obtained from tests performed outside Nigeria. Recommendations will be made on the basis of the relative LC_{50} values.
- (l) Preparation of Test Solution: The test material shall be prepared by the addition of the test material to the surface of the test vessel and then agitated. For the preparation of Water Soluble Fraction (WSF) for Base Oil and Mud Systems tests, the ratio mixture shall be 1.9, shaken for 24 hours and allowed

to settle for 12 hours. Recommended shaking rate shall be 120 rpm (max). For the preparation of Suspended Particle Phase (SPP), of the Base oil and Mud system tests, the mixture ratio of 1:9, shall also be used, stirred for 30 minutes at the same rate as WSF, allowed to settle for 15 minutes and the mid layer siphoned using a teflon tube. The mixture shall be shaken vigorously for 8 hours and allowed to settle for 24 hours before extraction of the water layer. All solution of the test material should be expressed as mg/l, ml/l or µg/l.

- (m) Media Parameters Monitoring: The following parameters shall be measured before and after the replacement of each test solution; pH, conductivity, dissolved oxygen and temperature. Both pH and conductivity shall be adjusted to that of the original solution.
- (n) Procedure: Appropriate volume of dilution water shall be added to each test vessel (see item (e)). Twenty (20) animals shall be placed into each vessel and the required amount of test materials added. Sufficient time shall be allowed for the test material to disperse before water samples are taken for determination of parameters. This procedure shall also be used when test solutions are replaced during the test. Mortalities shall be recorded at frequent intervals during the initial period of the test and after 24, 48, 72 and 96 hours exposure. The test solutions shall be replaced every 24 hours. The test shall be of 96 hours duration. If more than 10% of test animals die in the control, the test shall be invalidated and shall be repeated. Also the control test results shall be rejected if there is any death in the control.
- (o) Moult Deaths. Moult deaths are test animals which have moulted and have been cannibalised. They shall be Identified:
- (1) As partially eaten soft bodied animals and;
 - (2) When a moult case is present and the number of test animals is deficient by one. Moult deaths shall be recorded in the study records, and shall be included in any calculations of the mortality for a test population.
- (p) Data Analysis: The mortalities recorded at 24, 48, 72, and 96 hours shall be tabulated and the LC₅₀ (median lethal concentration) for these times and their confidence intervals also calculated, based upon the probit method of analysis. When there are three or more calculated LC₅₀ values, they shall be plotted onto a dose response graph. The slope and 95 percent confidence interval of the slope should be determined.

Note: i. LC₅₀ is a typical dose response curve, which is based on the principles of

statistical probabilities of an event occurring within described concentrations and exposure. In this regard, its calculations and interpretations are as valid as the limits of its statistical confidence limits. Hence, for every experiment aimed at determining LC₅₀ values it shall be mandatory that:

- mean values are obtained from at least three(3) replicates
- statistical confidence limits are provided, e.g. fudicidal limit at 95% confidence level
- slope of the curve is provided to ascertain the fitness of the plot.

- ii Laboratories must perform the range finding test. This is to enable the laboratory establish a working range by obtaining the least concentration that gives no effect and the highest concentration that gives 100% death. Probit analysis for reporting mortality shall use the analysis as in "TOXIC" Software for LC₅₀ and LT₅₀ determination. Use of other non-probit analytical techniques are not recognised.
- iii For each test carried out, the toxicity factor should be included in the report in terms of a base fluid and mud system and synergistic ratio in case of a dispersant.

$$\text{Toxicity Factor} = \frac{\text{LC}_{50} \text{ of Sample}}{\text{LC}_{50} \text{ of Reference chemical}}$$

$$\text{Synergistic Ratio} = \frac{\text{LC}_{50} \text{ of Crude Oil}}{\text{LC}_{50} \text{ of Mixture of Crude Oil and Dispersant.}}$$

The values of all results must be reported in mg/l.

- (q) Records: All measurements and observations made during the study shall be recorded and original data achieved at the Testing Laboratory for any follow-up reference where necessary.

2.3 Bioaccumulation

2.3.1 Background:- Bioaccumulation can be viewed simply as a result of the competing rates of chemical uptake and elimination in organisms; the later comprising biotransformation and excretory processes. Thus bioaccumulation occurs because the organism was able to absorb the materials directly across body surfaces, membranes and ingested contaminated food and water at a faster rate than they were able to metabolise and excrete the materials leading to a net gain of the pollutants in their body tissues. The ecological and atimes public health implications of bioaccumulation is that in the wild, the accumulated pollutants can be transferred to higher carnivorous and harbivorous (as the food source may be) organisms including man that feed on the other organisms contaminated and tainted as a result of Bioaccumulation factors (BCF) at the next lower step in the food chain or web. Biological organisms such as fish, molluscs and plant species are able to bioaccumulate whenever necessary. Where good accumulators which are edible occur in contaminated ecosystems that receive effluents, such accumulators shall be monitored via regular tissue analysis to safeguard public health of human communities.

2.3.2 Bioaccumulation Test Procedure Or Methodology:

- (i) Bioaccumulation tests shall be conducted on clean organisms experimentally exposed to effluent and recipient water media;
- (ii) The species recommended for the bioaccumulation (bioconcentration) tests shall be *Tympanotonus ruscatus*, *clibanarius africanus* and any benthic/sedentry animal.

- (iii) All organisms in a test shall be collected from the same source and shall be as uniform as possible in size and age. Tests shall be conducted with juvenile organism that is, postlarval or older and actively feeding, but not sexually mature or spawning. Fishes shall be relatively small in weight, less than 10gm each, and the standard length (tip of snout to end of caudal peduncle) of the longest fish shall not be more than twice that of the shortest fish. All molluscs shall be large enough so that the test material can be measured in individual organism and in adductor muscles. All organisms shall be well cared for to avoid unnecessary stress and;
- (iv) The preservation, extraction and analytical procedures shall all be in accordance with specified standard methods as in ASTM E,1022- 84.
- (v) Report presentation to the Director, Petroleum Resources shall include the following;
 - a. A complete file of the test procedure and results;
 - b. A detailed description of the effluent and recipient water media including their sources, method, date and time of collection, composition, known physical and chemical properties, variability and method of storage;
 - c. Detailed information about the test organisms, including scientific name, source, culture methods, quality and quantity of test material fed to the culture, disease and acclimatisation procedure used;
 - d. A brief description of test procedure, dilution series, number of organisms per test concentration, etc.;
 - e. A description of the observed bioaccumulation in terms of apparent steady-state and projected steady-state bioaccumulation factors, uptake and depuration rate constants, whole body of fishes, total soft tissue for bivalve mollusc and edible portions especially if ingestion of the test material by humans is a major concern;
 - f. The description of the adverse effect (death, immobility, floating, etc.) used in the test and summary of general observations of other effects or symptoms and;
 - g. The number and percentage of organisms in each test chamber (including the control chamber) that died or showed the effect used to measure bioaccumulation.

2.4 Effect Monitoring On Recipient Environment.

2.4.1 Internationally accepted methods such as those given in ASTM and Standard Methods for the Examination of Water and Waste Water (APHA), latest editions, are recommended

3.0 QUALITY CONTROL AND QUALITY ASSURANCE.

3.1 Operators shall institute appropriate quality control and quality assurance programmes in field sampling, taxonomic identification and laboratory analysis in order to ensure valid data documentation and interpretation.

3.2 The capture, collection and transportation of test organisms shall be done in a manner which minimizes injury and physiological trauma.

4.0 LABORATORY SAFETY PRECAUTION

4.1 Contact with all toxic agents and test solutions shall be minimized. Fume hoods shall be necessary for testing volatile substances.

- 4.2 Personnel shall be adequately informed of its toxicity to humans and recommended handling procedures before testing any agent.
- 4.3 Adequate health and safety precautions shall be taken prior to disposal of test solutions and organisms.
- 4.4 Rinsing of glassware and test apparatus with volatile solvents shall be performed only in well-ventilated areas.

5.0 GUIDELINES FOR THE LABORATORY DETERMINATION OF BIODEGRADABILITY OF CHEMICALS UNDER NIGERIAN CONDITIONS

A. GENERAL

- 1. Operators or vendors shall be required to undertake biodegradability testing of drilling and production chemicals, products or mixtures as may be specified by the Department of Petroleum Resources (DPR) under Nigerian environmental conditions.**
- 2. Only laboratory facilities approved by the Director, Petroleum Resources shall be used to conduct the tests.**
- 3. The biodegradability tests shall be conducted using test methods recommended by the DPR.**
- 4. The Solid Phase biodegradability test procedure- adapted to a closed system shall be used for testing the biodegradability of non-soluble drilling and production chemicals or mixtures as may be specified by the DPR under Nigerian conditions.**
- 5. The biodegradability tests shall be conducted separately under standard specific freshwater and saline conditions.**

B. OBJECTIVES.

The objective is to determine the biodegradability of oil industry chemicals in specific standard conditions in Nigeria as a permit requirement for their use in the Nigerian oil industry.

C. THE SOILD PHASE BIODEGRADABILITY TEST

1. OVERVIEW

The Solid Phase test method simulates conditions that closely parallel those found in the aquatic sedimentary environment in terms of microbiology, anaerobic conditions, sediment type and physico-chemical parameters. The method measures the residual amount of a given test sample in a sediment matrix treated with a predetermined amount of the test sample.

Essentially, varying predetermined concentrations of the test material are mixed with clean sediment obtained from the seabed to a homogeneous blend. Glass jars are filled with the mixtures and kept under water in troughs containing water from the same aquatic environment. The tanks are connected to individual reservoirs and water is maintained under laminar flow in the tanks. Daily measurements of pH, temperature, salinity and dissolved oxygen of water are taken while sediments are sampled in triplicate at intervals of 0, 14, 28, 42, 56, 70, 90 and if necessary 120 days. At each sediment sampling day, physical observations and redox measurements are carried out in the jar under investigation together with chemical and microbial analysis. Residual total organic carbon (TOC) data is obtained from the chemical analysis while the microbiology yields total culturable bacteria and the total bacteria capable of utilising the test substance as sole carbon sources. TOC data obtained is then used to calculate the half-life for each test substance assuming the first order kinetics for the degradation of the base fluid.

2. EXPERIMENTAL SET - UP

- I. The Solid Phase test set-up testing one sample shall consist of six water circulating systems. Three each for freshwater and brackishwater sediments.**

One circulating system shall be used for the concentration treatments of the sediment and test substance while the other two shall be for negative and positive controls respectively.

- II. Each circulating system shall consist of a glass (or fire glass) water trough, an overhead plastic reservoir, a larger plastic water storage tank and a water pump.
- III. The dimensions of the water trough shall be approximately 1.5m length x 1m width x 0.3m depth. The overhead water reservoir shall have a capacity of approximately 25 gallons while the larger water reservoir shall have a capacity of approximately 25 gallons, the larger water tank shall be no less than 250 gallons.
- IV. The test set-up shall be such that the over head reservoir is situated above the glass water trough and shall re-fill the trough from an outlet and thus generate a lamina flow in it.
- V. The water trough shall have a drain to the larger plastic storage tank, from which the overhead reservoir shall be filled with the aid of the pump.
- VI. A separate circulating system shall be required for testing each different test material.

3. MATERIALS AND METHODS

I. Test Sample

- a) A sufficient quality of the test sample shall be supplied by the chemical supplier (vendor/operator/sponsor) to the DPR or as directed by the DPR.
- b) The test sample shall be stored under appropriate storage conditions as specified by the material safety data sheets (MSDS) as soon as collected from the supplier.
- c) Detailed physico-chemical characteristics, priority hazardous constituents and fingerprint of the test sample shall be provided by the vendor/supplier.
- d) Where the detailed physico-chemical characteristics, priority hazardous constituents and fingerprint of the test sample are not provided by the vendor/supplier, their determination shall become part of the test to be conducted by the approved laboratories. The fingerprinting shall be done using a GC-FID or GC-MS.
- e) The testing laboratory shall carry out total organic carbon (TOC) of the test sample soon after collection. The TOC shall be determined using an elemental carbon analyser or the wet oxidation method.
- f) The testing laboratory shall be a GC-FID with accessories such as:
 - Column- Ultra pure 1 methyl silicone non polar column
 - Dimensions- (25mmx 0.2mm internal diameter) coated with a 0.33µm film.
 - Detector – FID at 300°C.
- g) Peaks shall be assigned as test sample components on the basis of retention time. The peaks shall be summed up to arrive at a total organic extract (TOE) value for the test sample.
- h) The TOE value obtained shall be compared to the TOC previously obtained for the test sample and a TOC/TOE correction factor established.
- i) The solid phase test shall be applicable to any of the following chemicals/products:
 - i. Low toxic mineral oil base fluids

- ii. Synthetic base fluids
- iii. Non-soluble drilling and production chemicals
- iv. Any other chemical that the Director of Petroleum Resources shall require to be subjected to the biodegradability test.

II. Test Medium

- a) Aquatic Sediments. The test medium shall be aquatic sediment collected from freshwater and brackish/saline water environment.
- b) Sediment Collection
 - i. Sufficient quality of sediment shall be collected at low tide, 24 hours prior to the start of the biodegradability tests. The sediments shall be collected with a pre-rinsed clean dredge or other appropriate sediment sampler. The sediments shall be collected from a relatively pristine area.
 - ii. Pre-cleaned glass jars or other container lined with clean aluminium foil sheets shall be used for sediment collection.
 - iii. Sediments shall be kept cool when being transported to the laboratory.
 - iv. A sufficient amount of native water, enough to maintain the circulating systems previously described shall be collected along with the sediment.
- c) Pre-Test Treatment
 - i. Soon after collection, the sediment shall be sieved with native water through a 2mm, 1mm and 0.5mm sieve to remove large stones, molluscs, crustaceans and other macro fauna and debris. The sieved sediment shall be allowed to settle overnight.
 - ii. The following characteristics of the sediment shall be determined after sieving.
 - total organic carbon (TOC) (using an element analyser or wet oxidation method)
 - nitrogen content (using an elemental analyser or kjeldhal apparatus).
 - Median particle size (shaker or particle size laser analyser)
 - Moisture content (oven drying)
 - Baseline Hydrocarbon content using GC-FID fitted with a column as specified in 3.1.f above.

III. Test Jars

- a) Glass jars of approximately 8cm depth by 10cm external diameter shall be used

IV. Water Trough

- a) Water troughs made of glass or fiber glass material shall be used for the tests. The dimensions of the water troughs shall be no less than 1.5m length x 1m width x 0.3m depth. Each water trough shall have an outlet situated 16cm from the bottom of the trough.
- b) The water troughs shall be covered with dark screens on the sides and on top to prevent photodegradation and rapid evaporation.

V. Test Conditions

- a) The biodegradability test shall be conducted under a conditioned environment with temperature maintained at 22[±].2°C.

VI. Procedure

- a) Preparation of Test Concentration Treatments

- i. Pre-sieved sediment shall be mixed with the test sample to arrive at the chosen concentration for testing (500ppm, 5000ppm, 10,000ppm). These treatments refer to $500\mu\text{g g}^{-1}$, $5000\mu\text{g g}^{-1}$ and $10,000\mu\text{g g}^{-1}$ respectively, of TOC of test sample per dry weight of sediment.
- ii. As a negative abiotic control, a sub-sample of each concentration treatment of sediment and test sample shall be removed and poisoned with mercuric chloride or formaldehyde.
- iii. As a positive biodegradable control, the same concentration, treatments shall be prepared using olive oil.
- iv. Using a cement mixer or other appropriate apparatus, mixing shall be carried out for about 10 minutes to achieve homogeneity. The mixer shall be washed with solvent and cleaned, prior to mixing each new concentration treatment (test, substance, olive oil, poison). The poisoned sediment shall be mixed last.
- v. The various homogenized concentration treatments of sediment and test sample, olive oil and abiotic control shall be dispensed into separate properly labeled jars. The jars shall be filled to the top making sure there are no air bubbles and no overflow of sediment. Each concentration treatment shall be dispensed in triplicate jars.
- vi. The test jars containing different test substance treatments shall be kept in separate water troughs.
- vii. The jars shall be arranged in the troughs in order of concentration such that those containing the lowest concentration of test fluid are placed upstream from the jars containing the highest concentration.
- viii. The jars with poisoned sediment shall be kept together in a separate tank containing poisoned water to inhibit microbial contamination of sediment. Poisoning of water shall be done with phylatol, sodium hypochlorite or formaldehyde.
- ix. The olive oil jars shall be kept together in a separate trough.

b). Sediment Monitoring

- i. At set times of 0, 14, 28, 42, 56, 70, 90 days and if results are inconclusive, 120 days, triplicate sample jars shall be harvested for each concentration treatment of test sample, olive oil and abiotic control.
- ii. Day zero jars shall be sample after the jars have been immersed in the water troughs for about 10 minutes.
- iii. The following operation shall be carried out on the sediments in each of the harvested jars at the specific sampling day.
 - Measurement of Redox potential as specified VI –c of this protocol.
 - Enumeration of culturable bacteria as specified in section VI-d
 - Enumeration of bacteris capable of using the test sample as a sole carbon sources. – The sheen Screen Test as specified in section VI-c of this protocol.
 - Physical Observations as specified in section VI – f of this protocol.
 - Chemical analysis as specified in section VI-g of this protocol.

c. Measurement of Redox Potential.

- i. Immediately after the jars are harvested, the redox potential of the sediments in each harvest jar shall be measured at depth intervals of

- 0.5cm using a combination platinum/reference (Ag/AgCl) electrode held in an adjustable retort stand. The redox readings shall be taken from the surface to the bottom of the jar.
- ii. Redox readings shall be taken after every one minute and values of Zobells solution (gram per litre, potassium ferrocyanide, 1.399; ferricyanide, 1.087; potassium chloride, 7.456) and native water monitored after each depth profile.
 - iii. The redox potential shall be expressed as an E_h value where E_h is the electron motive force (in mV) of an oxidation reduction system referred to as a standard hydrogen half-cell. Actual reading shall be adjusted to E_h by adding 198 (Zobell 1946).
- d) Enumeration of Culturable bacteria
- i) Soon after redox readings are taken, surface and subsurface samples of sediment shall be collected aseptically in a pre-weighed plastic universal bottle containing 9ml of sterile brackishwater or freshwater (as the case may be) and carefully weighed to allow weight of sediment to be calculated.
 - ii) Surface sample shall be collected by scraping off 0.5g of the top 1.0mm of the sediment with a sterile spatula.
 - iii) Subsurface samples shall be collected using a sterile cork borer (not more than 15mm internal diameter) plunged into the sediment and removed to allow approximately 0.5g sample to be aseptically collected from the centre of the bottom of the core.
 - iv) The sediment suspensions shall be vigorously mixed for approximately 60 seconds and allowed to settle for 10 minutes.
 - v) A serial 10 fold dilution in sterile nativewater shall be prepared and 0.1ml aliquots of the appropriate dilutions spread into agar plated.
 - vi) Estimates of the number of aerobic, heterotrophic bacteria shall be made by plating onto an appropriate agar reagent 9e. g. nutrient agar or plate or plate count agar). Culturing of aerobic bacteria shall be carried out under ambient test conditions.
 - vii) With appropriate anaerobic agar reagents like wilkins Chalgren agar. The anaerobic bacteria shall be cultured in anaerobic jars using Oxoid Anaerogen packs (Unipath) with appropriate anaerobic agar reagents like Wilkins Chalgren agar.
- e) The Sheen Screen Test
- i. The number of bacteria per gramme (wet weight) of sediment, capable of growth on each of the test sample as a sole carbon sources shall be determined by the Sheen-Screen method.
 - ii. At the start of the experiment both clean sediment and sediment exposed to 500ppm of the test substance shall be included for 7 and 30 days and compared.
 - iii. Surface and subsurface samples of the incubated sediments shall be aseptically collected at the end of the incubation period. 1g of the collected sediment shall be vigorously mixed with 9ml Bushwell Haas (BH) medium or any other appropriate medium for 60 seconds and allowed to settle for 10minutes before a 10 fold serial dilution of the mixture is prepared in BH broth. The medium shall be supplemented

- with NaCl (1.0% w/v brackish water, 10% w/v marine water), NH_4NO_3 , (1g/l), KCl (0.4g/l) and $\text{mgSO}_4 \cdot 7\text{H}_2\text{O}$ (0.4g/l) to prepare BH broth for brackish water or marine sediments. Bushnell Hass medium for freshwater shall be prepared using fresh water for freshwater sediments.
- iv. Aliquots (180 μl) of the broth shall be added to each well of a 96 – well (12-column) microtitre tray, (one tray shall be required per test fluid)
 - v. Neat sediment suspensions (20 μl) shall be added to wells A – G of column 1 and (20 μl) of the first 10 fold dilutions shall be added to wells A- G of column 2 etc., until column 1-11 are filled.
 - vi. BH broth only shall be added to wells A-G of column 12.
 - vii. 3 μl of the test sample shall be added to each well of the microtitre and shall be incubated at the conditioned test temperature for 14 days after which time 50 μl of 0.5% (wt/vol) solution of p-iodonitroretrozolium violet is added to each well.
 - viii. The trays shall be incubated at the conditioned test temperature in the dark for one hour and then the number of wells in each column in which actively respiring bacteria had reduced the dye to a red colour is scored against the number of negatives (colourless).
 - ix. The number of bacteria (g^{-1} wet wt) of sediment shall be determined by the most probable number method by consulting the appropriate MPN table (Wardlaw 1985).
- f) **Physical Observations**
- i) Physical observations of colour and odour shall be carried out on the surface and subsurface of sediments in the harvested jars.
- g) **Chemical Analysis**
- i) Soon after samples for microbial analyses have been taken, the sediments in the jars under investigation shall be homogenised using a clean spoon or other implement.
 - ii) Sub samples of the following weights of homogenised sediments shall be transferred to a 250ml centrifuge tube.
 - 5g for 10,000 $\mu\text{g g}^{-1}$ treatments
 - 5g for 5,000 $\mu\text{g g}^{-1}$ treatments
 - 10g for 5000 $\mu\text{g g}^{-1}$ treatments
 - iii) An appropriate internal standard (see table of standards in appendix) followed by 20ml each of dichloromethane (DCM) and methanol shall be added to the weighed subsamples. The DCM shall be added before the methanol.
 - iv) The solution is mixed and then ultrasonicated for 5 minutes. The mixture shall then be centrifuged at 2000rpm for 8-10 minutes at 2-4°C and then the liquid decanted into a separating funnel containing about 18ml of HPLC grade distilled water.
 - v) The sediment shall be re-extracted with a further aliquot of DCM, centrifuged and the solvent decanted into a separating funnel.
 - vi) The DCM layer shall be isolated and decanted into a conical flask containing sodium sulphate (approx. 10g of washed sodium sulphate).
 - vii) The sodium sulphate shall then be washed with hexane and the washings kept in a conical flask.

- viii) Another 20ml of DCM shall be added to the same sediment mixture and the processes iv-vii above repeated. The washings from the second treatment shall be decanted into the same flask as the first washings.
- ix) The extract (washings) shall be rotary evaporated to about 1ml using a rotary evaporator making sure evaporation does not reach dryness. 50ml of hexane shall then be added to the reduced volume of 1 ml and the 51 ml mixture further reduced by rotary evaporation to 20ml for 10,000ppm and 5,000ppm concentration treatments and 5ml for the 500ppm concentration treatment. (see XVIII for extraction of olive oils).
- x) Approximately 150 μ l of the final extract volume shall be applied to a High Performance Liquid Chromatograph (HPLC) fitted with a metal free silica column.
- xi) The HPLC extract shall be further rotary evaporated to approximately 500 μ l.
- xii) The 500 μ l residue shall be further diluted with washings to give final volumes which are applied to the GC for the respective concentration treatments.
- xiii) The volumes for dilutions shall be;
- 150 μ l to 1 μ l for the 500ppm concentration treatment
 - 150 μ l - 2 μ l for 5,000ppm concentration treatment
 - 100 μ l to 2 μ l for 10,000ppm treatments
- xiv) The peaks from the GC-FD shall be assigned as test sample on the basis of retention time relative to the original test sample peaks and quantified using the appropriate internal standards.
- xv) The individual components of the test sample identified from the GC peaks shall be summed up to arrive at a total organic extract value representing the residual concentrations of the test sample in the sediment.
- xvi) The residual concentrations of the test sample shall be adjusted for water content of sediment and converted to TOC using the previously determined TOC/TOE correction factor.
- xvii) TOC results obtained shall be used to calculate half life and rate of loss of the test sample. The same procedures as outlined in i-viii above shall be followed for the olive oil. The remaining extraction procedure for olive oil shall be as follows;
- Evaporate to dryness.
 - Add 3ml di-methyl ether and transfer with washings to a test tube.
 - Adjust volume to 6ml either by diluting with diethyl ether or (in case of excess of di-ethyl ether) concentration by evaporation in warm water or a stream of nitrogen.
 - Transfer approximately 3ml of the mixture to a separate test-tube
 - Measure using a syringe, 200 μ l of Tetramethylammonium hydroxide (TMAH) and add to the measured 3ml and shake well for 4 minutes at room temperature.
 - Add sml of HPLC grade distilled water and Gently mix to get 2 clear phases.
 - Decant the upper organic phase to a 25ml round bottom flask and rotary evaporate to dryness.
 - Dilute and concentrate with iso-hexane to give an appropriate concentration of 0.1mg/cm³ and dry over sodium sulphate. Volumes of iso-hexane used for dilution shall be:-

- 1ml for 100ppm concentration treatments.
- 5ml for 500ppm concentration treatments.
- 20ml for 5,000ppm concentration treatments.
- 40ml for 10,000ppm concentration treatments.
- Apply 1µl of each concentrate to GC-FID.
- The GC conditions for olive oil shall be as follows:-
 - Column –fused silica gel DB wax capillary column.
 - Dimensions- 30mmx.25mm (internal diameter) coated with a 25 micron film.
 - Detector – fid at 300°C

h) Monitoring of Test Water

- i) Daily measurements of the following parameters of water in the test troughs shall be carried out.: dissolved oxygen (mg/l), salinity (ppt), pH, conductivity (µmole/cm), and maximum and minimum temperatures and chemical oxygen demand (COD, mg/l) of the water in the test troughs shall be taken.
- ii) Weekly measurements of chemical oxygen demand (COD,mg/l). iii) APHA methods shall be used for physico-chemical analysis of test water.
- iv) GC-FID analysis of test water shall be conducted at day 0, 14, 42, and 90 and observed hydrocarbon peaks compared.

VII Precautions

- a) The native water in the 250gallon reservoirs shall be diluted to the original mark as soon as increased salinity values are observed.
- b) Each water circulating system shall be fitted with a carbon filter. The filter shall be situated inside the over head reservoir at the outlet.
- c) All day zero sediment measurements and samples shall be taken only after the jars have been immersed in the native water for approximately 10 minutes.
- d) The results of the GC-FID and COD of the test water shall be used to monitor disappearance of test sample from sediment by washout.

VIII Presentation of Results

- a) The results of the biodegradability test for a given fluid shall be presented in a separate report.
- b) The report shall contain detailed of daily and weekly readings, and tabular results of all microbial as well as chemical analysis.
- c) Chromatograms of all GC – FID analyses, appropriate graphs, charts and tables and summaries of statistics of analytes will be presented in the report.
- d) The report will also contain colour photographs of the various sediment concentration treatments at each of the sampling days.
- e) Details of half life computations and statistical analysis of results shall also be reported.

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APPENDIX I: INTERNAL STANDARDS AND SAMPLE APPLICATION

Internal Standard	Sample Generic Name
1. Heptamethylnonane	Mineral Oil
	Internal Olephin (IO)
	Linear Olefin
	n-Paraffin
2. Squalene	Polyalpha Olefin (PAO)
3. Methyltricosanoate	Esters
	Olive Oil
	Acctals

APPENDIX II. EQUIPMENT AND MATERIALS FOR THE SOLID PHASE BIODEGRADABILITY TEST

A. Chemical Analysis

- GC –FID with accessories
 - an ultra 1 methyl silicone non-polar column (25mmx 0.2mm id) coated with a 0.33 µl film.
 - A fused silica gel BD wax capillary column dimensions of which are 30mmx.25mm (internal diameter) coated with a .25 micron film.
- PC with installed GC software
- Centrifuge (2000rpm temperature controlled)
- Elemental Carbon Analyser
- Ultrasonic bath
- HPLC
- HPLC bottles
- Weighing Balance
- Rotary Evaporator
- Dissolved Oxygen Meter
- Salinity/Conductivity Meter
- Sieves
- Round bottom flasks
- Flat bottom flasks
- Separating funnels
- 2ml vials
- Syringes (250µl, 100µl)
- Anhydrous Sodium Sulphate
- Methanol
- Di-chloromethane (DCM)]Analar Grade
- Tetramethylammonium hydroxide (TMAH)
- Sodium sulphate
- Olive Oil
- Standards
 - Heptamethylnonane
 - Squalene

- **Methyltricosanoate**

B. Microbial Analysis

- **Autoclave**
- **Incubator**
- **Microscope**
- **Core borer**
- **Spatulas**
- **Whirlmixer**
- **Anacrobic jar**
- **Petri dishes**
- **Micro-pipettes**
- **Oxoid Anaerogen gas packs**
- **Nutrient Agar**
- **Test – tubes**
- **Wilkins Chalgren anaerobic agar**
- **NaCl**
- **KCL**
- **Magnesium Sulphate (MgSO⁴)**
- **Anaerobic jar**
- **P- iodonitrotrazolium violet indicator**
- **BH Broth**
- **Colony counter**
- **Bushnell – Haas medium**

C. OTHERS

- **Uninterrupted Power Supply**
- **Standby Generating Set**
- **Deionizer**
- **Distiller(**
- **Constant Temperature bath**
- **Shaker.**

TABLE VIII-E4 WASTE ANALYSIS DATA SHEET

Conducted by :
 Checked by :
 Approved by :

Company Code: Date:
 Type of Data: Daily: Weekly: Monthly Average:
 Others (define):

Effluent source (particular cracking procedure; composite etc.)

.....
 Effluent collection procedure:

Specific analyses:

Variables	Concentration	Analytical Method Used
Ammonia		
5 day BOD		
TOC		
COD		
Lead		
Oil & Grease		
PH		
Phenols		
Conductivity		
Sulphates		
Suspended Solids		
Total Hardness		
Dissolved Oxygen		
Temperature		
Salinity		
Cyanide		
Total Chromium		
Chromium Hexavalent		
Iron		
Vanadium		

TABLE VIII-E5 TOXICITY TEST RECORD SHEET

Conducted by :
 Checked by :
 Approved by :

Toxicity Test Numbers:..... Date:.....
 Company Code: Starting Hour:
 Wastewater Tested:
 Possible Toxic substances:
 Date Wastewater collected:
 Source of Dillution water: Storage method:
 Test Species: Storage Temperature:
 LC50 Calcualtion method: Collection method:

Start (0h)

Concentration (%)							Control
Number of Individuals							
Dissolved Oxygen							
Temperature							
PH							
Conductivity							
Hardness							
Alkalinity							
Total Suspended Solid							

(4h)

Number surviving							
Percent surviving							
Other observations							

(8h)

Number surviving							
Percent surviving							
Other observations							

(24h)

Number surviving							
Percent surviving							
Other							

observations							
--------------	--	--	--	--	--	--	--

(48h)

Number surviving							
Percent surviving							
Dissolved Oxygen							
Temperature							
PH							
Conductivity							
Hardness							
Alkalinity							
Other observations							

SUMMARY

Hour	LC ₅₀	95% Confidence limit
4		
8		
24		
48, etc to 96hr		

Noted (especially changes in behaviour)

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PART VIII F. MANAGEMENT AND REMEDIATION OF CONTAMINATED LAND

1.0 BACKGROUND

1.1 Sources Of Contamination

1.1.1 The development of petroleum resources through E & P, processing of the crude and gas, transportation and marketing activities, have produced wastes and products that may contaminate land and underground waters. Such wastes include:

- **Spent drilling fluid/wastes**
- **Well treatment wastes**
- **Drill Cuttings**
- **Oil/product/chemical spillage & leaks**
- **Oil/hydrocarbon product sludge/debris/scales**
- **Organic sludge/residue (sanitary wastes)**
- **Spent oil/catalyst**
- **Produced sand/formation water**
- **Garbage**
- **Gaseous emissions**

1.1.1.1 The presence of some of these wastes and their constituents may induce changes to the quality

of soil/sediment and underground water, thereby posing immediate or long-term unacceptable risks to plants, animals, human health and amenities.

1.2 SUITABILITY FOR USE

1.2.1 The existence of contamination presents its own threats to sustainable development:

- (a) it impedes social progress, depriving local people of a clean and healthy environment;
- (b) it threatens wider damage to the environment and to wildlife;
- (c) it inhibits the prudent use of our land and soil resources, particularly by obstructing the recycling of previously-developed land and increasing development pressures on undeveloped areas; and
- (d) the cost of remediation represents a high burden on individual companies, home- and other land-owners, and the economy as a whole.

1.2.1.1 In this context, the objectives with respect to contaminated land **and underground water** are:

- (a) to identify and remove unacceptable risks to human health and **other resources – land, water, atmosphere e.t.c.**
- (b) to seek to bring damaged land/water resources back into suitable reasonable beneficial use; and
- (c) **to seek to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.**

1.2.1.1.1 The “suitable for use” approach then consists of three elements:

- (a) **Ensuring that land and water resources are suitable for their current use** – in other words, identifying any land or water resources where contamination is causing unacceptable risks to human health and the environment, assessed on the basis of the current use and circumstances of the land, and returning such **land and underground water** to a condition where such risks no longer arise (“remediating” the land);
- (b) **ensuring that land and groundwater are made suitable for any new use, as official permission is given for that new use** – in other words, assessing the potential risks from contamination, on the basis of the proposed future use and circumstances, before official permission is given for the development and, where necessary to avoid unacceptable risks to human health and the environment, remediating the land before the new use commences; and

(c) **limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or officially-permitted future use of the land** - in other words, recognising that the risks from contaminated land can be satisfactorily assessed only in the context of specific uses of the land, and that any attempt to guess what might be needed at some time in the future for other uses is likely to result either in premature work (thereby risking distorting social, economic and environmental priorities) or in unnecessary work (thereby wasting resources).

1.2.2 The one exception to the “suitable for use” approach to regulatory action applies where contamination has resulted from a specific breach of a specific environmental licence or permit. In such circumstances, the polluter is required to remove the remaining contamination as completely as is practicable **and as may be directed by the Director, Petroleum Resources.**

1.3 Management Strategy

1.3.1 **The management and control of contaminated land/water resources, produced by the oil and gas related activities in Nigeria, shall be carried:**

- i) **Through site investigation and to them compare the contaminants levels measured, with soil and ground water quality standards or criteria based on human toxicological and ecotoxicological values and;**
- ii) **On a voluntary basis, in the context of the Risk Based Corrective Action (RBCA) methodology.**

1.3.2 **The Department of Petroleum Resources is currently developing detailed sectoral guidance on the application of risk management of contaminated land, the Nigerian environment based on the RBCA methodology.**

1.4 Relevant Regulations

1.4.1 **The relevant legal authority are provided in the:**

- **Petroleum Act 1969, Section 8 (i) b(iii)**
- **Petroleum (Drilling and Production) Regulations, 1967, Sections 25, 36A, 36E and 40**
- **Oil Pipeline Ordinance Cap 145, 1956 as amended by Oil Pipeline Act 1995;**
- * **Petroleum Refining Regulations, 1974 Sections 27, 28 and 43.**

2.0 SCOPE

The scope of this guideline on the management and remediation of contaminated land, includes:

- (i) **The identification of potentially contaminated land/site(s) and the determination of the nature, concentration and distribution of such contaminants;**
- (ii) **The assessment of contaminated site(s) as to indicate the significance of the contaminants that will cause unacceptable risks hazards to known receptors (targets) and;**
- (iii) **The consideration of what remedial treatment is required and practical and if there is a future monitoring requirement.**

3.0 Site Identification

3.1 A licensee/lessee or waste generator, shall supply to the Director, Petroleum Resources, an inventory of all sites at the beginning of each year where:-

a) Wastes have been or are being disposed of, in soil and sediment. The site identification shall include maps/location maps, showing dimension of site, relationship to streets and waterways, and photographs showing topography, nature and existing structures. Information for each site should be accompanied by relevant:

- i. Material Safety Data Sheet (MSDS);**
- ii. Waste Material Data Sheet (WMDS) and;**
- iii. Hazard Identification and Assessment (Also see PART VIII – C for details).**

b) Oil/chemical spillage has occurred and the initial clean-up has not been certified as satisfactory by the DPR. Data should include the material spilt and the quantity involved. If it is not a common product, crude oil, petroleum, jet fuel, kerosene etc., a material data handling sheet should be included.

c) Due to historic and bad operational practices, accidents, change of use, sabotage, sale of businesses, etc. operator registered activities have contaminated land/water resources causing unacceptable risks to Human Health and the Environment. The contaminated resources shall be remedied to the the satisfaction of the Director, Petroleum Resources.

4.0 Assessment Action

4.1 At the discretion of the licensee/lessee, waste generator or the Director, Petroleum Resources, appropriate investigations shall be conducted by the licensee/lessee to identify/locate sites that are contaminated and to determine the nature, concentration and distribution (plume) of these contaminants and the application where appropriate of remediation (REMEDIAL TREATMENT ACTION or MONITORING ACTION). The intention and scope of such investigations shall be agreed with the Director, Petroleum Resources and a report submitted at completion.

4.1.1 The strategy for such investigation normally comprise the following phases Also See Figure VIII-FI)

4.1.1.1 Preliminary Investigation that will comprise of desk study and site reconnaissance or work-over surveys. From this a Conceptual Site Model and strategy for on-site investigation is developed.

4.1.1.2 Exploratory Investigation intended to confirm the presence of contamination and initial conclusions concerning the hydrology and geology of the site, and to provide information to aid the design of the main or detailed investigation.

4.1.1.2 Detailed Investigation, intended to fully characterise the extent of contamination, the hydrology and the geology, and to gather information required for hazard identification/assessment, risk assessment and post-impact assessment.

4.1.1.4 Risk Evaluation,

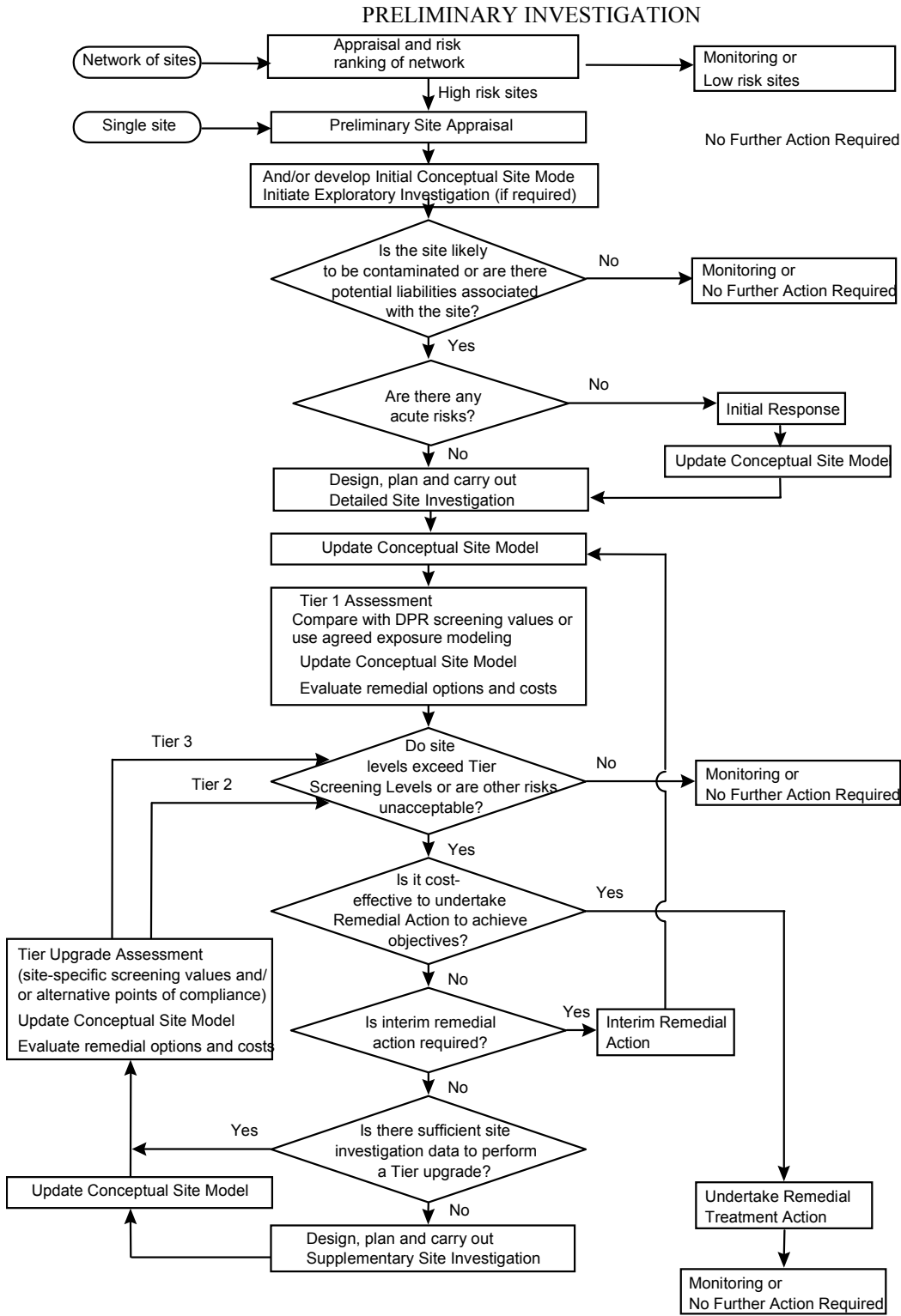
Currently the screening values 1 are those presented in Section 8.0.

Operators shall consult with the Department of Petroleum Resources to discuss the need (when and where necessary) to subject these screening levels to further analysis, following the detailed investigation.

4.1.1.5 Interim Action or Remediation Investigation, designed to confirm the applicability and feasibility of one or more potential amelioration/remedial options and collect information of relevance to application of selected remedial option/strategy.

4.1.1.6 Monitoring for Compliance and Performance, which seeks to confirm proper implementation and effectiveness of remedial measures.

Figure VIII-1: Site Assessment Action Process Flow Sheet



4.2 Sampling Design

4.2.1 Sampling shall be sufficient to confirm the nature and distribution of any significant chemical of concern, confirm relevant pathways and permit any necessary corrective action to be undertaken. For investigations of areas where there are no data on site or operational history such that targeted sampling can be undertaken then the main sampling pattern recommended for these investigations is the herringbone pattern. **However, the square grid and the stratified random patterns can be utilised with justification, satisfactory to the Director, Petroleum Resources.**

4.2.2 Operators shall institute strict quality assurance/quality control (QA/QC) procedures to assure the integrity of data.

4.3 During the assessment of the data the following points shall be taken into account:

- i.** That only a proportion of the site, can be sampled and examined during an investigation.
- ii.** To determine the need for **REMEDIAL TREATMENT ACTION** or **MONITORING ACTION** requires the magnitude, the distribution and significance of those samples which have shown the greatest contamination to be carefully considered
- iii.** A **SIGNIFICANT POLLUTANT LINKAGE** must be established if remediation is required. There must be evidence that the concentration of contaminants present are likely to give rise to significant harm (unacceptable risks) to realistic receptors via realistic pathways.
- iv.** The concentrations found in samples should be compared with the intervention and target values as listed/set in Section 8.0 or with RBSL'S (Risk Based Screening Levels) or SSTL's (Site Specific Target Levels) developed by an agreed suitable risk assessment method, or as published by the Department of petroleum Resources.
- v.** The fate and transport properties of chemicals including their potential to naturally attenuate in suitable conditions.

5.0 Reporting

5.1 The report shall include the following:

- (i)** An executive summary;
- (ii)** A site description;
- (iii)** A summary of the site ownership and use;
- (iv)** A summary of the past releases or potential source areas;
- (v)** A summary of current and completed site activities;
- (vi)** A description of regional hydrogeologic conditions;
- (vii)** A description of site – specific hydrogeologic condition;
- (viii)** A summary of beneficial use;
- (ix)** A summary of the ecological assessment;
- (x)** A site map of the location;
- (xi)** An extended site map to include local land use and ground water supply wells;
- (xii)** Site plan view showing location of structures, above ground storage tanks, underground storage tanks, buried utilities and conducts, Suspected/confirmed sources and so forth;
- (xiii)** Site photos, if available;
- (xiv)** A ground water elevation map;
- (xv)** Geologic cross-section(s);

- (xvi) Identification of the chemicals/contaminants of concern and relevant description of their known environmental fate and effects
- (xvii) **Dissolved plume map(s) of the chemical(s)/ contaminants of concern**
- (xviii) Information on complete or potentially complete pathways

5.2 Where a risk assessment procedure such as RBCA has been used the following should be added where appropriate.

A summary and discussion of the risk assessment (hazard identification, dose response assessment, exposure assessment, and risk characterization), including the methods and assumption used to calculate the RBSL or SSTL, or both;

A summary of the tier evaluation;

A summary of the analytical data and the appropriate RBSL or SSTL used.

5.2.1. Risk Assessment: Using the Tiers 1,2 &3 approach (RBCA)

5.2.1.1 Some information about RBCA is available in APPENDIX VIII-F2

6.0 Remedial Treatment Action

6.1 Remedial Treatment Action aims to achieve a standard that results in acceptable risks to human health, animals, plants and the environment, consistent with the existing and likely reasonable future uses of the site/land.

6.2 Where assessment has indicated Remedial Treatment Action is warranted techniques listed in Article 6.2.1 can be carried out to address the SIGNIFICANT POLLUTANT LINKAGE (Removal/treatment, containment or institutional controls). Figure VIII-F-2 aids selection of appropriate techniques. **Some of these techniques, which can be carried out in –situ or ex-situ,**

6.2.1 Stabilisation/Solidification

- i. **Excavation followed by replacement with clean material.**
- ii. **Isolation of the contaminated soil by covering with thick clean inert fill or hard cover.**
- iii. **Mixing the contaminated material with clean soil or sub-soil in order to reduce the maximum concentration to acceptable intervention and target values.**
- iv. **Solidifying the contaminated soil by appropriate clay or cement ratio and subjecting the solidified material to hardness (compressive strength), TCLP and other tests (See Part 11, Section E, 3.5.7.5)**

6.2.2 Chemical treatment includes

- i. **Oxidation**
- ii. **Chemical reduction**
- iii. **Dechlorination**
- iv. **Disinfection**

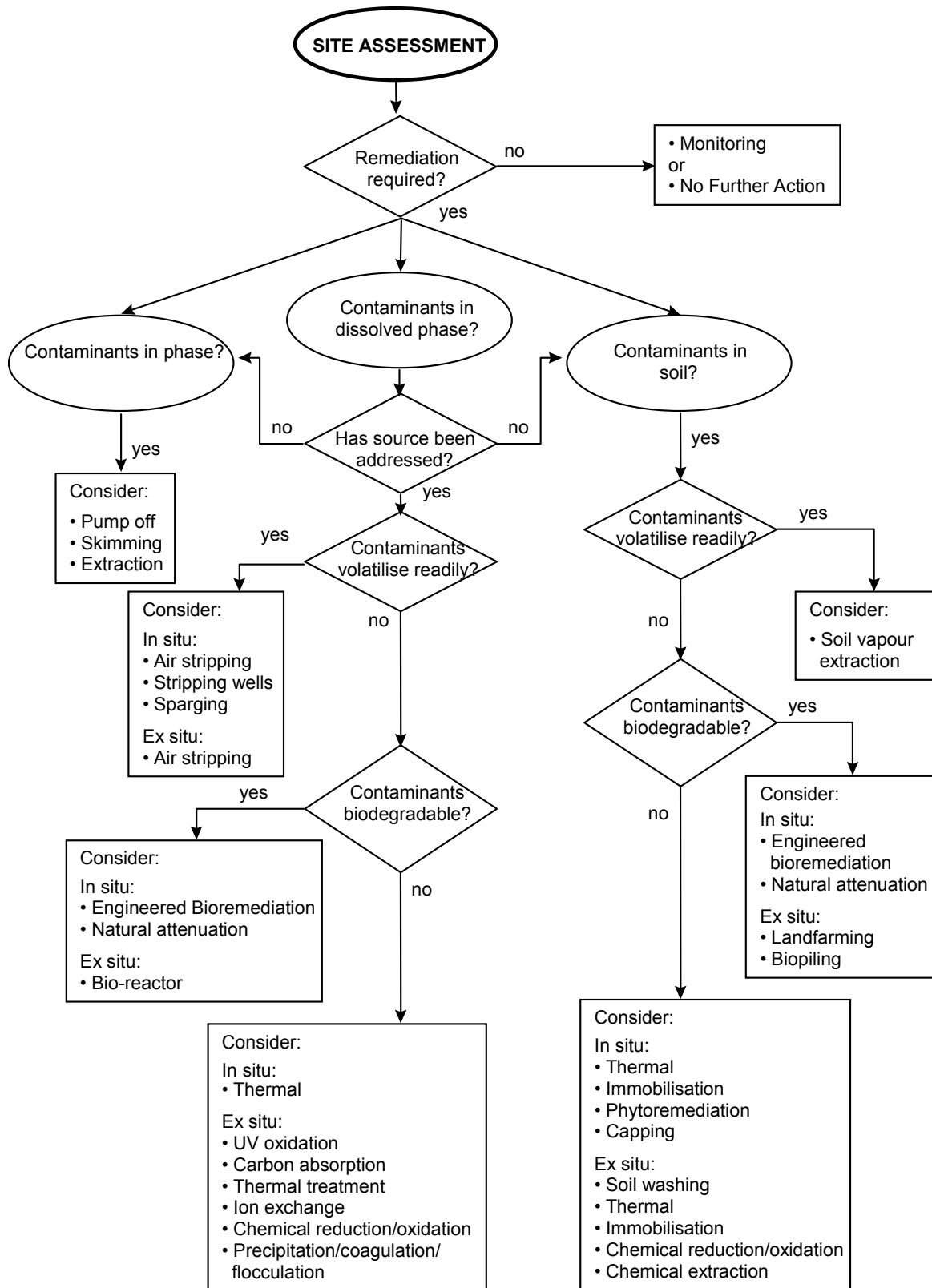
6.2.3 Biological treatment includes

- i. **Vegetable uptake**
- ii. **Indigenous bacteria preparation**
- iii. **Nutrient enhancement**

6.2.4 Thermal treatment includes

- (i) Hot Air Stripping**
- (ii) Steam Stripping**

Figure VIII F-2 : An Aid to Remediation Options Selection



6.2.5 Any other method(s) acceptable to the Director, Petroleum Resources can be used after an approval has been sought for and given.

6.3 Special Provisions

6.3.1 Special precautions shall be taken against known and unknown flammable and hazardous gases, emissions, radio-active materials, e.t.c, and appropriate action taken to control such hazards, during any remedial action.

6.3.2 The choice of an appropriate remediation scheme shall involve balancing technical requirements with the practicabilities of dealing with the site and the costs.

6.3.3 When the remediation method involves the use of bacteria, the microbial cultures/consortium must not contain:

- (i) Genetically engineered organisms.**
- (ii) Known pathogen to human or indigenous flora or fauna.**
- (iii) Chemical which has been restricted anywhere in the world for the use on land disposal sites without agreement.**

6.3.3.1 Products must be supported by data that demonstrate their effectiveness, toxicity (test to be performed on standard indigenous organisms found in fresh and brackish water, monitored by officials of the DPR) and the practicability of usage, on a large scale.

6.3.3.2 A formal approval to utilize the particular product/agent/method, on a large scale, will depend on the findings of the pilot scale experimentation.

6.4 Approvals

6.4.1 The approvals by the Director, Petroleum Resources to execute any remediation project, shall be in two stages:

- (i) Provisional approval on a pilot scale experimentation and;**
- (ii) Final/formal approval for large scale application, based on the finding/report of the pilot scale experimentation.**

6.4.2. Such provisional approval shall be subject to the following conditions;

- (i) That the consultant/company is duly accredited by the Department Petroleum Resources to render such services to the oil industry.**
- (ii) The application of the intention to use a particular product/agent/method, contains sufficient information to facilitate its screening and evaluation.**
- (iii) The pilot scale remediation project/experimentation is monitored by officials of the Department Petroleum Resources and;**
- (iv) The report of such pilot scale remediation project/experimentation is submitted to the Director, Petroleum Resources.**

Liability and Compensation

- 6.5.1** The licensee/lessee shall be responsible for the generation of the waste(s) and shall be liable for any contamination associated with such wastes.
- 6.5.2** Such licensee/lessee shall bear all the costs associated with the investigation, remediation and monitoring, even when same are conducted at the discretion of the Director, Petroleum Resources.
- 6.5.3** Adequate compensation shall be paid appropriately by such licensee/lessee, in consultation with the Local Government(s) and the Director, Petroleum Resources.

6.6 Remedial Action Closure

When Remedial Action Treatment has been undertaken and the intervention values, (RBSLs or SSTLs if RBCA is used) have been demonstrated to be achieved at the point of compliance, or containment or institution controls have been installed,
and monitoring and site maintenance are no longer required to ensure that conditions persists,
then no further action shall be necessary, except to ensure that suitable institutional controls (if any) remain in place.

7.0 MONITORING ACTION (FOR COMPLIANCE AND PERFORMANCE)

- 7.1** Where Monitoring Action has been determined to be required it must have an agreed purpose and duration.
- 7.2** Where Remediation Action has been undertaken and monitoring is considered necessary the monitoring programme shall be designed to consider :
- warning of actual, or possible, failure;
 - demonstrating the effectiveness of implemented remedial action measures, or confirming that current conditions persist or improve over time.

8.0 INTERVENTION AND TARGET VALUES.

8.1 In the interim period whilst suitable parameters are being developed, the guidelines on remediation of contaminated land shall make use of two parameters, i.e. intervention values and target values (TABLE VIII – F1).

8.1.1 The intervention values indicate the quality for which the functionality of soil for human, animal and plant life are, or threatened with being seriously impaired. Concentrations in excess of the intervention values correspond to serious contamination.

8.1.1.1 Intervention values are:

- Set for soil/sediments and for groundwater and apply to both terrestrial and to soil from the beds of rivers, lakes, etc.
- Related to the content of organic matter and clay in the soil and with the use of the formular (1) here under, the values of the standard soil can be converted to values applying to the actual soil concerned for inorganic compounds:

$$I_e = \frac{I_{st} \times A + B \times \% \text{clay} + C \times \% \text{org.mat}}{A + B \times 25 + C \times 10}$$

Where I_e = Intervention value applying for the soil being evaluated (mg/kg)

I_{st} = Intervention value for the standard soil (mg/kg)

$\% \text{clay}$ = Measured % clay in the soil being evaluated (the percentage by weight of the total dry material comprising mineral particle matter with a diameter of less than 2 μm)

$\% \text{Org. matter.}$ = Measured percentage organic matter in the soil being evaluated (percentage weight loss by volatilization on the total dry weight of the soil)

A,B,&C = Constants which depend on the substances (See TABLE VIII F-2)

(i) For organic compounds, use the formula:

$$I_e = I_{st} \times \frac{\% \text{Organic Matter}}{10}$$

Where: I_e = Intervention Value applying to the soil being evaluated (mg/kg)

I_{st} = Intervention Value for the standard soil (mg/kg)

$\% \text{Organic Matter}$ = Measured percentage organic matter in the soil.

Where the organic matter measured is more than 30% or less than 2%, values of 30% and 2% respectively are used.

8.1.2 Target Value

8.1.2.1 Target values indicate the soil quality required for sustainability or expressed in terms of remedial policy, the soil quality required for the full restoration of the soil's functionality for human, animal and plant life. The target values therefore indicate the soil quality levels ultimately aimed for.

- 8.1.2.2** These intervention and target values have also been tuned to the target values for underground waters.
- 8.1.2.3** In order to apply the soil type correction to target values, the intervention values in the Formula (section 8.1.1.1) are replaced by target values.
- 8.1.2.4** Compliance with the intervention and target values (See Section 8.0) shall be tested by a sampling protocol, based on a 7m x 7m x 0.5m rectangular grid/soil volume (or a nominal 25 cubic metre volume) or groundwater concentration in at least 100 cubic metre.

TABLE VIII-F1 TARGET AND INTERVENTION VALUES FOR MICROPOLLUTANTS FOR A STANDARD SOIL (10% Organic matter and 25% clay) mg/kg for soil/sediment, µg/l for Groundwater.)

SUBSTANCE	SOIL/SEDIMENT (mg/kg dry material)		GROUNDWATER (µg/l)	
	Target value	Intervention value	Target value	Intervention value
A. AROMATIC COMPOUNDS				
Benzene	0.05(dt)	1	0.2	30
Enthyl Benzene	0.05(dt)	50	0.2	150
Pnenol	0.05(dt)	40	0.2	2000
Toluene	0.05(dt)	130	0.2	1000
Xylene	0.05(dt)	25	0.2	70
B. METALS				
Arsenic	29	55	10	60
Barium	200	625	50	625
Cadmium	0.8	12	0.4	6
Chromium	100	380	1	30
Cobalt	20	240	20	100
Copper	36	190	15	75
Mercury	0.3	10	0.05	0.3
Lead	85	530	15	75
Nickel	35	210	15	75
Zinc	140	720	65	800
C. CHLORINATED HYDROCARBON				
1,2 – dichloro ethane	-	4	0.01(dt)	400
D. POLYCYCLIC AROMATIC HYDROCARBON (PAHS)				
PAH (Total of 10)*	1	40	0.1	70
Napthalene			0.02	5
Anthracene			0.02	5
Phenantrene			0.005	1
Fluoranthracene			0.002	0.5
Benzo(a) anthrancene				
E. OTHER POLLUTANTS				
Mineral oil	50	5000	50	600

dt = detection threshold

*** = Total of 10, include the five listed above and the following: Chrysene, benzo (a) pyrene, benzo (ghi) pryrelene, benzo(k) fluoranthene and indeno (1,2,3 -cd) pryrene.**

TABLE VIII F - 2 SUBSTANCE – DEPENDENT CONSTANTS FOR METALS

SUBSTANCES	A	B	C
Arsenic	15	0.4	0.4
Barium	30	5	0
CADMIUM	0.4	0.007	0.021
Chromium	50	2	0
Cobalt	2	0.28	0
Copper	15	0.6	0.6
Mercury	0.2	0.0024	0.0017
Lead	50	1	1
Nickel	10	1	0
Zinc	50	3	1.5

APPENDIX VIII F - 2

RISK – BASED CORRECTIVE ACTION FOR CONTAMINATED SITES.

A. BACKGROUND

1. The traditional method for assessing the need and extent for remediating contaminated land is to determine the level of contamination through site investigation and to then compare the contaminant levels measured with soil and ground water quality standards or criteria defined by legislation. The standards or criteria are often developed on the basis of generic assumptions about site condition. Consequently, the classical approach to contaminated land remediation ignores the fact that contaminated sites vary widely in terms of complexity, and therefore the potential risk they may pose to human health and the environment. Experience has shown that site remediation when based on comparison with contaminant levels and environmental quality criteria and standards frequently lead to excessive clean-up costs which outweigh the benefits provided to society through the reduction in risk provided.
2. Risk-Based corrective Action (RBCA) provided by American Society for Testing and Materials (ASTM) is a logical scientifically based framework for determining the extent and urgency of corrective action required at a contaminated site. It integrates risk and exposure assessment practices with site assessment activities and remedial measure selection to ensure that the chosen action is cost-effective and protective of human health and the environment.

B. RBCA IMPLEMENTATION PROCEDURES AND REQUIREMENTS

- 1.0 Operators shall be required to adopt risk-based corrective action (RBCA) plan for the remediation of contaminated sites within their areas of operations, on a voluntary basis.
- 1.1 Prior to initiating an application for RBCA process, operators shall consult with the Department of Petroleum Resources to discuss the proposed project and to review the requirements and information necessary for the programme.
- 1.2 Applications shall be treated on a case-by-case basis and on individual merit.
- 2.0 **RBCA REPORT**
- 2.1 The RBCA report shall, at a minimum, include the following:
 - (i) An executive summary;
 - (ii) A site description;
 - (iii) A summary of the site ownership and use;
 - (iv) A summary of the past releases or potential source areas;
 - (v) A summary of current and completed site activities;
 - (vi) A description of regional hydrogeologic conditions;
 - (vii) A description of site – specific hydrogeologic condition;
 - (viii) A summary of beneficial use;
 - (ix) A summary and discussion of the risk assessment (hazard identification, dose response assessment, exposure assessment, and risk characterization),

including the methods and assumption used to calculate the RBSL or SSTL, or both;

- (x) A summary of the tier evaluation;
- (xi) A summary of the analytical data and the appropriate RBSL or SSTL used;
- (xii) A summary of the ecological assessment;
- (xiii) A site map of the location;
- (xiv) An extended site map to include local land use and ground water supply wells;
- (xv) Site plan view showing location of structures, above ground storage tanks, underground storage tanks, buried utilities and conducts, suspected/confirmed sources and so forth;
- (xvi) Site photos, if available;
- (xvii) A ground water elevation map;
- (xviii) Geologic cross-section(s); and
- (xix) Dissolved plume map(s) of the chemical(s) of concern.

2.2 Operators shall institute strict quality assurance/quality control (QA/QC) procedures for the RBCA process to assure the integrity of data.

3.0 MONITORING AND SITE MAINTENANCE

3.1 Upon completion of the RBCA process, operators shall establish a monitoring programme which shall demonstrate the effectiveness of implemented remedial action measures or to confirm that current conditions persist or improve with time.

4.0 REMEDIAL ACTION CLOSURE

4.1 When RBCA RBSLs or SSTLs have been demonstrated to be suitable, institutional controls (if any), and monitoring and site maintenance are no longer required to ensure that conditions persists, then no further action shall be necessary, except to ensure that institutional controls (if any) remain in place.

C. RISK-BASED CORRECTIVE ACTION PLANNING

1. Risk-Based Corrective Action (RBCA) uses a tiered approach to risk assessment, with each tier requiring more detailed information and making less conservative or more realistic assumptions. The three tiers of risk assessment are:

1.1 Tier 1: Site conditions and the nature of the contaminants are assessed and

prioritized on the basis of urgency of need for corrective action, based on the information collected from historical records, visual inspection, and site assessment data. The site is classified by the degree of threat it poses to human health, i.e. contaminant sources are identified including, obvious environmental impacts (if any), the presence of potentially impacted sensitive receptors (e.g., workers, residents, water bodies, e.t.c.), and potentially significant transport pathways (e.g., ground water flow, atmospheric dispersion, e.t.c). The site conditions are then compared with generic Risk-Based Screening Levels (RBSLs) contained in a reference table. If the site contamination exceeds those screening levels, the analysis moves to a second stage (Tier 2).

- 1.2 Tier 2:** During a Tier 2 evaluation, additional site specific data is collected and used to calculate Site –Specific Target Levels (SSTLs) and points of compliance. Unacceptable risks are presented by those substances whose site concentration levels exceeds its SSTL. The tier 2 SSTLs are derived using the same equation as for RBSLs except site specific parameters are used.
- 1.3 Tier 3:** Allows SSTLs to be determined for both direct and indirect pathways using site specific parameters. Tier 3 risk analysis requires considerably more effort and expertise than tier 1 or tier 2 risk analyses, and may include additional site assesement, probabilistic evaluations, and sophisticated chemical transport and fate modelling.
- 2.0** The tiered approach provides the advantage that the cost of assessment is proportionate to the level of risk posed by the contamination. An operator can elect to stop at any stage of the risk assessment and would normally do so if compliance could be demonstrated or if there are no advantages (normally cost savings from similar remediation options) to be found by proceeding to the next higher level. Generally, only seriously contaminated or complex sites would proceed to a tier 3 risk analysis.

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PART VIII – G DECOMMISSIONING OF OIL & GAS FACILITIES

A. GENERAL

- 1.0 Decommissioning programmes shall be planned, the objectives and implementation drawn – up during the project initiation and design phases.**
- 1.1 Such decommissioning objectives/activities shall incorporate remediation/restoration programmes. (See PART VIII – F);**
 - 1.1.1. If an Environmental Impact Assessment/Baseline/Sea-Bed Survey Report was not prepared for the project/activity prior to project implementation, the licensee or operator shall be requested to provide:
 - i) An Environmental Evaluation (post –impact) Report (PART VIII –A), specific to the activity and;**
 - ii) A Decommissioning Plan Report specific to the activity.****
 - 1.1.2 If an Environmental Impact Assessment/Baseline/Sea-Bed Report was prepared and approved by the Director, Petroleum Resources, only the Decommissioning Plan Report shall be submitted and approved by the Director, Petroleum Resources.**
- 2.0 Leasees/Licencees shall appropriately decontaminate, dismantle and remove structures from oil and gas installations and facilities after such installations/facilities have been abandoned and de-commissioned.**
- 2.1 Decommissioning activities (for facilities completely shut down and/or abandoned) shall commence at least one year after abandonment and be completed within six months.**
 - 2.1.1 Administrative on property acquisition and divestiture shall be complied, with and;**
- 2.2 Where possible, communities where such decommissioning is to take place (site) shall be consulted (public/community concern).**
- 3.0 Decommissioning Plan Report.**
- 3.1 The decommissioning plan report shall as a minimum contain:
 - (a) Peculiarity of the project.**
 - (b) The degree of abandonment (partial/wholly).**
 - (c) Methods to be used for the removal of the structure (explosives, mechanical cutting, touches, high pressure jetting, etc.)**
 - (d) Verification of method(s), when used.**
 - (e) Disposal of removed structures, debris and associated wastes (also check for LSA/NORM).**
 - (f) Environmental protection/monitoring (EIA and/or, EER, Restoration and Remediation plans).****
- 3.2 A Decommissioning Certificate shall be issued by the Director, Petroleum Resources, when the decommissioning activity is certified as satisfactory.**

B. Procedures/Strategies

1.0 Offshore/Deep Water Areas.

1.1 All abandoned installations standing in less than 100 meters (depth) of water and weighing less than 4000 tonnes in air, placed on the sea-bed, excluding the deck and the super structure, shall be removed entirely.

1.1.1 The process of removal shall avoid significant adverse effects upon navigation or the marine environment.

1.2 Well Abandonment

1.2.1 The provisions in article 4.2.1 shall apply.

1.3 After 1st January, 2003, no installation or structure is to be placed on any continental shelf or Exclusive Economic Zone, unless it is designed so that entire removal upon disuse would be feasible.

2.0 Inland and Nearshore Areas.

2.1 Well Abandonment.

2.1.1 Licencee/Operator shall:

- i) obtain appropriate permit from the Department of Petroleum Resources;**
- ii) isolate well from surface;**
- iii) plug and abandon downhole according to permit criteria;**
- iv) place surface cement plug below cellar, to allow removal of surface components, the process of removal should avoid any significant adverse effect on the environment;**
- v) isolate production interval to prevent communication between aquifers of different nature.**
- vi) Close pit appropriately.**
- vii) Satisfy other conditions as in API RP 57.**

2.2 Process Equipment/Facilities.

- i) Decontaminate appropriately;**
- ii) Dispose of equipment by recycling, selling e.t.c.;**
- iii) Demolish structures/buildings where appropriate.**
- iv) Minimize conflict with available land use.**

2.3 Pipeline/Flowline

- i) Decontaminate, plug and leave on-site, if adequate, otherwise excavate.**
- ii) All surface components/ancillary facilities shall be removed.**
- iii) Minimize conflict with available land use.**

2.4 An approval shall be sought for, from the Director, Petroleum Resources for strategies intended to be used for decommissioning activities.

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PART VIII-H ENVIRONMENTAL MANAGEMENT SYSTEM

1.0 Contents Of The Environmental Management System Manual

1.1 Environmental Policy

- 1.1.1 Top management shall define the organisation's environmental policy and ensure that it:
- Is appropriate to nature, scale and environmental impacts of its activities, products or services;
 - Includes a commitment to continual improvement and prevention of pollution
 - Includes a commitment to comply with relevant environmental legislation and regulations, and with other requirements to which the organization subscribes;
 - Provides the framework for setting and reviewing environmental objectives and targets;
 - Is documented, implemented and maintained and communicated to all employees;
 - Is available to the public

2.0 Planning

2.1 Environmental Aspects

- 2.1.1 The organisation shall establish and maintain (a) procedure(s) to identify direct and indirect significant aspects

2.1.2 Legal and Other Requirements

- 2.1.2.1 The organisation shall establish and maintain a procedure to identify and have access to legal and other requirements to which the organisation subscribes, that are applicable to the environmental aspects of its activities, products or services.

2.1.3 Objectives

- 2.1.3.1 The organisation shall establish and maintain documented environmental objectives and targets, at each relevant function and level within the organisation. The objectives and targets shall be consistent with the environmental policy, including commitment to prevention to pollution.

2.1.4 Environmental Management Programme(s)

- 2.1.4.1 The organisation shall establish and maintain (a) programme(s) for achieving its objectives and targets. It shall include designation of responsibilities and the means and time they are to be achieved.

3.0 Implementation and Operation

3.1 Structure and Responsibility

- 3.1.1 Roles, responsibility and authorities shall be defined, documented and communicated in order to facilitate effective environmental management. A specific management representative shall be appointed to ensure the environmental management system established and implemented.

3.2 Training, Awareness and Competence

- 3.2.1 The organisation shall identify training needs. It shall require that all personnel, whose work may create a significant impact upon the environment, have received appropriate training. It should make employees aware of the importance of conformance, their significant aspects, their roles and responsibilities and most importantly know the potential consequences of departure from specified operating procedures.

3.3 Communication

- 3.3.1 The organisation shall establish and maintain procedures for internal communication and receiving, documenting and responding to external communication.

3.4 Environmental Management System Documentation

- 3.4.1 The organisation shall establish and maintain information, in paper or electronic form to describe the core elements of the management system and provide direction to related documentation.

3.5 Document Control

- 3.5.1 The organisation shall establish and maintain procedures for controlling all documents to ensure that:

- They can be located
- They are periodically reviewed, revised and approved
- The current version of relevant documents are available at locations
- Obsolete documents are promptly removed from all points of use
- Any obsolete documents retained for legal or knowledge preservation purposes are clearly defined

Documentation shall be legible, dated (with dates of revision) and readily identifiable, maintained in an orderly manner and retained for a specified period.

3.6 Operational Control

- 3.6.1 The organisation shall identify those operations and activities that are associated with the identified significant environmental aspects in line with its policy, objectives and targets. The organisation shall plan activities, including maintenance, in order to ensure that they are carried out under specified conditions by:

- Establishing and maintaining documented procedures to cover where their absence could lead to deviations from the environmental policy, objectives and targets.
- Stipulating operating criteria in the procedures
- Establishing and maintaining documented procedures related to the identifiable significant aspects of goods and services used by the organisation and communicating relevant procedures and requirements to contractors.

3.7 Emergency Preparedness and Response

- 3.7.1 The organisation shall establish and maintain procedures to identify potential for and respond to accidents and emergency situations, and for preventing and mitigating the environmental impacts that may be associated with them. The organisation shall review and revise, where necessary, its emergency preparedness and response procedures and carry out drills to test such if such procedures are practicable.

4.0 Checking and Corrective Action

4.1 Monitoring and Measurement

The organisation shall establish and maintain documented procedures to monitor and measure, on a regular basis, the key characteristics of its operations and activities that can have significant impact on the environment. This shall include the recording of information to track performance, relevant operational controls and conformance with organisation's environmental objectives and targets.

Monitoring equipment shall be calibrated and maintained and records of this process shall be retained according to the organisation's procedures.

The organisation shall establish and maintain documented procedures for periodically evaluating compliance with relevant environmental legislation and regulations.

4.2 Non-conformance and Corrective and Preventive Action

- 4.2.1 The organisation shall establish and maintain procedures for defining responsibility and authority for handling and investigating non-conformance, taking action to mitigate impacts caused and for initiating and completing corrective and preventive action.

4.3 Records

- 4.3.1 The organisation shall establish and maintain procedures for the identification, maintenance and disposition of environmental records. These records shall include training records and results of audits and reviews. Environmental records shall be stored and maintained in such a way that they are easily retrievable and protected against damage, deterioration or loss. Their retention times shall be established and recorded.

4.4 Environmental Management System Audit

- 4.4.1 The system audit is to determine if the management system conforms to the planned arrangement, properly implemented and maintained. The audit is also carried out to provide information on the results of the audits to management. The audit programme including schedule, shall be based on the environmental importance of the activity concerned and the results of the previous audits.

5.0 Management Review

- 5.1 The organisation's top management shall, at intervals determine, review the environmental management system, to ensure its continuing suitability, adequacy and effectiveness. The management review shall address the possible need for changes to policy, objectives and other elements of the environmental management system, in light of the audit results, changing circumstances and the commitment to continual improvement.

PART VIII-I ENVIRONMENTAL AUDITS/REVIEWS

1.0 Licencees/operators shall conduct environmental audits to facilitate the management control of environmental practices and assessing compliance with the management system and regulatory requirements.

1.1 Essential Elements of the Environmental Audit

1.1.1 The essential elements of the environmental audit shall include:

- i. The commitment and support of operator's management of the audit and the follow-up of the findings;
- ii. The objectivity of an audit team, where the auditing team, should be as practicable as possible, independent of the activities to be audited; A professionally competent audit team
- iii. Well defined objectives, scope and systematic procedures;
- iv. Appropriate collection, analysis, interpretation of the documentation of sufficiently reliable, relevant and useful information sufficient to achieve audit reports
- v. Written reports that are candid, clear and appropriate on findings, corrective actions and schedules of implementation.
- vi. Quality control and assurance procedures, to assure the accuracy and thoroughness of environmental audits

1.2 Types of Environmental audits

- i) The following types of Environmental Audits, shall be carried out:
 - a) Management Audit
 - b) Compliance Audit
 - c) Site/Facility/Plant Audit

1.2.1 These audits, which can be 1st, 2nd and /or 3rd party audits, shall be carried out by competent and certified auditors. Such auditors shall also be registered by the Department of Petroleum Resources.

1.2.2 The frequencies (as a minimum) of conducting these audits are as follows:

- | | | |
|------|---------------------------|-----------|
| i) | Management Audit | 4 years |
| ii) | Compliance Audit | Quarterly |
| iii) | Site/Facility/Plant Audit | 2 years |

1.3 Access to Audit Reports

1.3.1 Access to environmental audit reports by the Director, Petroleum Resources is mandatory when there are reasonable grounds to believe that:

- i. The information being sought through the audit cannot be obtained from monitoring, reporting or other data otherwise available to the director, Petroleum Resources;
- ii. The audit findings will be relevant to a particular violation, necessary to its investigation and required as evidence

1.3.2 The licencees/operators, shall at the end of each year, submit a list of the environmental audits carried out to the Director, Petroleum Resources.

1.4 Environmental management Reviews (EMR)

1.4.1 Licencees/operators shall regularly conduct environmental management reviews and verification to evaluate the status and adequacy of the organisation's environmental policy, systems and procedures in relation to environmental issues, regulations and changing circumstances.

1.4.2 Operators' EMR reports shall be submitted to the Director, Petroleum Resources at the end of each year.

**PART IX SCHEDULE OF IMPLEMENTATION, PERMITS ENFORCEMENT
POWERS AND SANCTIONS**

1.0 INTRODUCTION

1.1 For compliance with the Guidelines and Standards of the Petroleum Industry in Nigeria, provisions have been established for: .

- (i) The registration of all point source discharges from petroleum operations
- (ii) The remodification and re-designing of existing sampling points as well as currently operating pollution treatment systems;
- (iii) The development and construction of pollution control devices for new projects;
- (iv) The monitoring of effluent discharges and recipient environments to meet the limitation standards.
- (v) The carrying out of relevant studies and the development of appropriate contingency plans.

1.2 These provisions shall be enforced on phased implementation schedules, specific permits and sanctions.

2.0 SCHEDULE OF IMPLEMENTATION/PROPOSED SANCTIONS

2.1 Existings Point Sources

The schedule of implementation shall be phased over a specific period of time as follows:

2.1.1 Registration of all existing point sources shall be effected within six (6) months after the promulgation of these Guidelines and Standards and shall be renewable every three(3) years.

2.1.2 Where a point source emission fails to meet the Guidelines and Standards specified therein, a “waiver” for a maximum of three (3) years may be granted by the Director of Petroleum Resources. Upon promulgation of these Guidelines and Standards, the operator or licensee shall apply within one (1) year for such a 'waiver' with detailed implementation programme to do one or more of the following activities in order to meet the limitations:

- (i) Installation of proper sampling points
- (ii) Modification and re-designing of existing operating systems;
- (iii) Construction and establishment of controls and monitoring devices or

equipment.

2.1.2.1 The waivers for the 3 year period, can only be extended, if there are reasonable grounds to indicate that the planned activities (programme) as identified in 2.1.2 above, have been and/or being satisfactorily implemented.

2.1.3 Within a maximum period of **five (5)** years, the implementation of these Guidelines and Standards for existing point sources shall be mandatory and violators shall attract the maximum specified sanctions.

2.1.4 The limitation set for existing service shall be reviewed once every (3) years.

2.2 New Sources

These shall call for the greatest degree of effluent reduction achievable through the application of the 'best available demonstrated control technology'. All new sources shall comply with provisions of article 3.1.2 hereunder.

2.3 The licensee or operator shall list hazardous or toxic pollutants as encountered during operations, as and at when necessary but not less than twice in a year.

3.0 PERMITS

3.1 The Director of Petroleum Resources shall issue permits for all aspects of oil related effluent discharges from point sources (gaseous, liquid and solid), and oil related project development. No operator therefore shall be permitted to discharge any effluent without a permit. All permits (notices, orders, consents or demands) shall be in writing and **shall attract appropriate fees to be determined by the Director of Petroleum Resources.** The format of such permits shall be prescribed by the Director of Petroleum Resources and used in all cases to which the forms are applicable.

3.1.1 Existing Sources

3.1.1.1 Environmental permits shall be issued for existing sources and the following conditions shall apply:

- (i) All industrial effluent discharge point sources shall be registered with the Director of Petroleum Resources;
- (ii) Such registered point sources shall be issued with permits;

3.1.2 New Sources:

3.1.2.1 Environmental permits shall be issued for new sources of effluent emission and the following conditions shall apply:

- (i) New plants shall be registered with the Director, of Petroleum Resources and an appropriate permit issued,
- (ii) Plans and specifications of the control technology shall be approved by the Director of Petroleum Resources.
- (iii) Preparation of Environmental Impact Assessment report shall be mandatory prior to construction,

- (iv) Certificate of Approval for construction must be issued by the Director of Petroleum Resources
- (v) Pre-commissioning inspection shall be undertaken by the Petroleum Resources Department and, -
- (vi) A certificate of Approval for operations shall be issued by the Director of Petroleum Resources.

3.2 The formatted Environmental permits (see Appendix IX(i-iv)) are as follows:

- (i) Application for an Industrial waste discharge/disposal permit
- (ii) Industrial waste Discharge/Disposal permit.
- (iii) Notification for compliance with permit conditions.

Notice of Revocation of permit.

Certificate of Sampling.

Drilling/Production waste injection well permits.

4.0 ENFORCEMENT POWERS AND SANCTIONS

4.1 For the purpose of enforcing compliance with the provisions of the Guidelines and Standards, the following conditions shall apply;

- a) Any authorised inspector may, without a warrant:-**
 - i) require to be produced, examine and take copies of any permit, licence, certificate or other document;**
 - ii) require to be produced and examine any equipment, system, sample or other item used in relation to the environmental non-conformance.**

4.2 Where any inspector, has reasonable grounds to believe that an offence has been committed against the provisions of the guidelines and standards;

- a) The inspector may without warrant.**
 - i) enter and search any oil and gas facility or structure, in which he has reasons to believe that an offence against the provisions of the guidelines and standards has been committed;**
 - ii) perform or cause to perform tests and take samples of any substance relating to the offence which is found in the oil and gas facility or structure searched pursuant to article 4.2(a(i)) above;**
 - iii) Cause to be arrested any person or persons, whom the inspector has reasons to believe has committed such offence.**

4.3 Any person or body corporate who:-

- a) wilfully obstructs any authorised inspector in the exercise of any of the powers conferred on him by the Petroleum Act 1969 and subsequent regulations; or**
- b) fails to comply with any lawful enquiries or requirements made by any authorised inspector, in accordance with the provisions of article 4.1,**
- iii. Commits an offence and shall on conviction be liable to a fine not exceeding =N=500,000 or to imprisonment for a term not exceeding 2 years or to both such fine, imprisonment and/or revocation of licence/permit.**

4.4 If a person or body corporate knowingly or recklessly makes any statement in the purported compliance with a requirement or to furnish information which is false in a material particular, the person or body corporate commits an offence and shall on conviction be liable to a fine not less than =N=150,000 or imprisonment for a term not less than two(2) years or to both such fine, imprisonment and/or revocation of licence/permit.

- 4.5 Any person or body corporate who contravenes any provisions of the environmental guidelines and standards, commits an offence and shall on conviction, where no specific penalty is prescribed therefore, be liable to a fine, imprisonment and/or revocation of licence/permit.**
- (a) where the offence is committed by a body corporate or by a member of a partnership, firm or business, every director and/or relevant management staff, shall be liable.**
- 4.6 Fines and Compensation shall be paid for the following specific non-conformance/offence on conviction.**
- 4.6.1 Any person, body corporate or operator who fails to register an existing point source(s) within the period specified in 2.1.1 shall be liable to a fine of ₦100,000 per day for as long as the violation persists.**
- 4.6.2 Oil/Chemical/Hazardous materials spillages: -**
- (a) All avoidable spillages, when they occur, shall attract a royalty not less than ₦500,000, to be deducted at source and additional fine of ₦100,000 for everyday the offence subsists;**
- (b) The spiller (operator or owner of vessel) shall pay adequate compensation to those affected and;**
- (c) The spiller shall restore/remediate the polluted environment to an acceptable level as shall be directed by the Director of Petroleum Resources.**
- 4.6.2.1 Any aggrieved party in case of disputes, shall be free to seek remedy at courts/tribunal.**
- 4.6.2.2 Effluents (Liquid).**
- 4.6.2.3 When the effluent quality of discharges is exceeded by twenty (20) percent of the allowed daily/monthly average concentration per parameter, a fine of ₦5,000.00 for every 50m³ of water discharged is imposed. In addition, upon conviction, an imprisonment for a term not exceeding 2 years shall apply for a first offender.**
- 4.7 Persistent Violators.**
- 4.7.1 Any person, body corporate or operator of a vessel or facility, who persistently violates the provisions of these guideline and standards shall have his lease, licence and/or permit revoked.**

APPENDIX IX-1

**ENVIRONMENTAL PERMIT APPLICATION FOR AN INDUSTRIAL-WASTE
DISCHARGE/DISPOSAL PERMIT**

MINISTRY OF PETROLEUM RESOURCES

- OIL PIPELINES ORDINANCE CAP 145, 1956/OIL PIPELINES ACT, 1965
 - PETROLEUM REGULATIONS, 1967
 - OIL IN NAVIGABLE WATERS DECREE/REGULATIONS, 1968
 - PETROLEUM DECREE NO. 51, 1969
 - PETROLEUM (DRILLING & PRODUCTION) REGULATIONS, 1969
 - PETROLEUM REFINING REGULATIONS, 1974
- (TICK APPROPRIATE REGULATION(S))

APPLICATION NO.....

FULL NAME AND ADDRESS OF REGISTERED PLANT:

.....
LOCATION OF SITE:

AUTHORITY TO OPERATE PLANT IN NIGERIA:

(LICENCE NUMBER):

LOCATION OF POINT SOURCES:

WASTE CHARACTERISTICS - TYPE: mode/state (Liquid, gaseous, solid etc.); constituents and their concentrations volume/quantity etc.; (Attach sheets when necessary)

.....
DETAILED DESCRIPTION OF THE TREATMENT(S) & DISPOSAL METHOD(S):

.....
DETAILED ENVIRONMENTAL DESCRIPTION OF THE RECIPIENT MEDIUM/MEDIA:

.....
(The description shall be in a form of an Environment Evaluation Report for already Operating plant and an Environmental Impact Assessment for new plants)

I declare that all the foregoing information is correct to the best of my knowledge.

.....
NAME/SIGNATURE OF
APPLICANT OR HIS ATTORNEY

.....
DATE

NOTE: Guidelines on the contents of the Environmental Impact Assessment and Environmental Evaluation Report are as made available by the Department of Petroleum Resources.

APPENDIX IX-2

ENVIRONMENTAL PERMIT.
INDUSTRIAL WASTE DISCHARGE/DISPOSAL PERMIT

- OIL PIPELINES ORDINANCE CAP 145, 1956/OIL PIPELINES ACT, 1965
 - PETROLEUM REGULATIONS, 1967
 - OIL IN NAVIGABLE WATERS DECREE/REGULATIONS, 1968
 - PETROLEUM DECREE NO. 51, 1969
 - PETROLEUM (DRILLING & PRODUCTION) REGULATIONS, 1969
 - PETROLEUM REFINING REGULATIONS, 1974
- (TICK APPROPRIATE REGULATION(S))

The Director of Petroleum Resources, hereby grants an industrial Waste Disposal Permit, in pursuant to Petroleum Decree No 51, 1969, Rules and Regulations Effective or promulgated under the authority of this Decree, other relevant Acts and Regulations, and in reliance on statements and presentations heretofore made in the application for Registration dated..... day of..... to:

FULL NAME AND ADDRESS OF APPLICANT:.....

.....

LOCATION OF SITE TO WHICH PERMIT RELATES

.....

TYPE OF FACILITY:.....

RECEIVING MEDIUM:.....

TYPE/VOLUME/QUALITY OF WASTE/WASTE STREAM OF WHICH DISPOSAL IS AUTHORISED:

.....

This permit to discharge/dispose is granted subject to satisfying the effluent limitations, monitoring requirements and other conditions as stipulated in the Guidelines and Standards.

This permit can be revoked if it is observed that the terms of the permit are not being complied with.

issued thisday of.....

.....
DIRECTOR OF PETROLEUM RESOURCES

NOTIFICATION FOR COMPLIANCE WITH PERMIT CONDITIONS

MINISTRY OF PETROLEUM RESOURCES

- OIL PIPELINES ORDINANCE CAP 145, 1956/OIL PIPELINES ACT' 1965
 - PETROLEUM REGULATIONS, 1967
 - OIL IN NAVIGABLE WATERS DECREE/REGULATIONS 1968
 - PETROLEUM DECREE NO. 51, 1969
 - PETROLEUM (DRILLING & PRODUCTION) REGULATIONS, 1969
 - PETROLEUM REFINING REGULATIONS, 1974
- (TICK APPROPRIATE REGULATION(S))

TO:

.....

Whereas the Director of Petroleum Resources on has granted you a waste disposal/discharge Permit relating to

And whereas it appears to Petroleum Resource Department that the following conditions) specified in the

Permit Nois/are not being complied with, namely:

.....
.....

Now the Petroleum Resources Department hereby requires you to comply with the said conditions before

.....
.....

Failure to do so shall result in the revocation of the Permit

Issued thisday of.....

.....
DIRECTOR OF PETROLEUM RESOURCES

NOTIFICATION OF REVOCATION OF PERMIT TO DISCHARGE/DISPOSE OF INDUSTRIAL WASTE

MINISTRY OF PETROLEUM AND MINERAL RESOURCES

- OIL PIPELINES ORDINANCE CAP 145, 1956/OIL PIPELINES ACT, 1965
 - PETROLEUM REGULATIONS, 1967
 - OIL IN NAVIGABLE WATERS DECREE/REGULATIONS, 1968
 - PETROLEUM DECREE NO. 51, 1969
 - PETROLEUM (DRILLING & PRODUCTION) REGULATIONS, 1969
 - PETROLEUM REFINING REGULATIONS, 1974
- (TICK APPROPRIATE REGULATION(S))

TO:

.....

.....
Whereas the Director of Petroleum Resources on..... granted you
a waste disposal/discharge Permit pertaining to.....
.....

...
And whereas it appears to Petroleum Resources Department that the continuation of activities to
which the
permit relates would cause pollution or danger to public health or would be so seriously detrimental
to the
amenities of the locality affected by the activities that the continuation of them ought not be
permitted and
that the pollution, danger or detriment cannot be avoided by modifying the conditions specified in
the
permit ;

And whereas a notice by the Department dated... .. requiring you to comply with the
following conditions namely;.....

.....
before..... was served upon you on..... and you
have not complied with the said conditions within the said period.

Now the Department HEREBY GIVES NOTICE that the said permit is REVOKED with effect from
.....

.....
DIRECTOR OF PETROLEUM RESOURCES

APPENDIX IX-5 CERTIFICATE OF SAMPLING

MINISTRY OF PETROLEUM AND MINERAL RESOURCES

- OIL PIPELINES ORDINANCE CAP 145, 1956/OIL PIPELINES ACT, 1965
 - PETROLEUM REGULATIONS, 1967
 - OIL IN NAVIGABLE WATERS DECREE/REGULATIONS, 1968
 - PETROLEUM DECREE NO. 51, 1969
 - PETROLEUM (DRILLING & PRODUCTION) REGULATIONS, 1969
 - PETROLEUM REFINING REGULATIONS, 1974
- (TICK APPROPRIATE REGULATION(S))

This is to certify that.....
(name of registered plant)

discharging treated waste/storm water into:
.....
(identify point of discharge)

from a treatment plant.....has collected water sample(s) from/at
(identity Unit code) (identity point source)

on..... at.....Sample(s) has/have been taken to
(time) (identity laboratory)

for the analyses of the following parameters:

- i)..... vi).....
- ii)..... vii).....
- iii)..... viii).....
- iv)..... ix).....
- v)..... x).....

SAMPLE PRESERVATION METHOD:.....

NAME & SIGNATURE OF SAMPLE COLLECTOR:.....

NAME AND SIGNATURE OF GOVERNMENT OFFICIAL:.....

NAME AND SIGNATURE OF OFFICER-IN-CHARGE

TREATMENT PLANT/POINT SOURCE:

APPENDIX IX – 6

DRILLING-PRODUCTION WASTE INJECTION WELL PERMIT APPLICATION.

1. APPLICATION FOR: (check one)	
<input type="checkbox"/> New waste injection	<input type="checkbox"/> Repermit of Existing waste injection
<input type="checkbox"/> New (NORM) waste injection	<input type="checkbox"/> Repermit of Existing (NORM) waste injection
<input type="checkbox"/> Conversion of Depleted Hydrocarbon well to waste injection.	<input type="checkbox"/>
	<input type="checkbox"/> Modification of Existing injection well permit

2. TYPE OF WELL: (Check One)	
<input type="checkbox"/> Industrial Non-Commercial Waste injection	<input type="checkbox"/> Industrial Commercial Waste injection
<input type="checkbox"/> Municipal waste injection	<input type="checkbox"/> Other: Specify

3. WELL INFORMATION		
4. WELL NAME & NUMBER:		5. SERIAL NUMBER (Conversion or Repermit Only):
6. L/GOVT. Plaquines	7. SECTION-TOWNSHIP -RANGE	8. LATITUDE: LONGTITUDE:
9. (X-Y) MAP COORDINATES:		10. LOCATION DESCRIPTION:

11. APPLICANTS NAME: (Individual, Corporation, or Other Name)
ADDRESS:
CITY, STATE,
TELEPHONE NO. WITH AREA CODE:
12. FACILITY NAME
MAILING ADDRESS:
CITY, STATE,
TELEPHONE NO. WITH AREA CODE:

31. Expected Surface Injection	32. Reservoir Pressure @ Depth:	33. Calculated Waste Front Radius @ Maximum Volume:
<p>34. CERTIFICATION:</p> <p>I, _____ (Name of Company Official) _____ (Title)</p> <p>certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are – significant penalties for submitting false information, including the possibility of fine or imprisonment.</p> <p>_____ (Signature) _____ (Date)</p>		
<p>35. Submit the following documents as an attachment to the Application Form:</p> <ul style="list-style-type: none"> A. Two copies (each) of the OML/OPL Permits. B. One Original and two copies of the application form, C. One original and two copies of all information required to be in the applicant's TECHNICAL REPORT as stipulated in: <ul style="list-style-type: none"> 1. Part III Appendix III –A Article C Section 2.0 (Treatment and Disposal by injection of Oilfield Wastes). 2. Part III Appendix III – A Article C Section 3.2 (Treatment and Disposal Criteria For NORM). D. One original and two copies of the certified location plan for each well E. Appropriate fees for each commercial/non commercial to be determined by the DPR. F Performance bond or other assurance of financial responsibility. 		
<p>36. Attach a simplified map which indicate the following:</p> <ul style="list-style-type: none"> A. Property boundaries of the disposal site, B. Location of the disposal well(s), C. General character of the surrounding area such as residential, industrial, undevelopment, etc. D. Boundaries and ownership of all land adjacent to the site, and E. Name and complete address of each adjacent property owner. 		

PART X DEFINITIONS AND ACRONYMS

1. Toxicity Test: This shall mean a test used to estimate the concentration of waste/chemical that produces an adverse effect on the test organisms in a specified period of time.
2. Acute: Involving a stimulus, severe enough to bring about a response speedily, usually, within four days for aquatic animals.
3. Amphibians, Aquatic Reptiles, Birds and Mammals: These are vertebrates that may be affected directly or indirectly by the discharges of pollutants and may be useful in monitoring the presence of toxic pollutants or long-term changes in water quality.
4. API: American Petroleum Institute
5. Backfill: This shall mean a low resistance material usually in a packed form in order to provide a low resistivity.
6. BAT: The best available technology economically achievable.
7. BCT: The best conventional pollutant control technology.
8. BDT: The best available demonstrated control technology, processes, operating methods, or other alternatives, including where practicable a standard no discharge of pollutants.
9. Bioaccumulation: This shall mean the net uptake of a material from water and from food.
10. Bioassay: This shall mean a test in which the quality or strength of material is determined by the reaction of living organism to it.
11. EMP: The best management practises.
12. BPCTA: The best practicable control technology currently available.
13. Coastal Water: These shall mean waters subject to tidal influence, (brackish and/or saline), including five kilometres (5 kms.) of the high seas from the shoreline.
14. Compliance Limit: These shall mean the end -of-pipe effluent limits based on the design specifications and proper operation of the control technology.
15. Composite Sample: This shall mean a mixture of grab samples collected at the sampling point at different times (Time-composite samples) They are most useful for example, in calculating the loading or the efficiency of a waste water treatment plant.
16. Conventional Parameters: These are waste streams that are peculiarly/typically characterised by the identified parameters. These parameters which include BOD5, TSS, pH and fecal coliform are used to control pollution load of effluents.
17. Concrete Raft: This shall mean a flat (floating) structure usually of rectangular cross-section made from concrete on top of which a horizontal UST may be set to rest.

18. Cradle: This shall mean a structure on which an underground tank may be supported while being installed or laid to rest.
19. Depots: These shall mean premises that receive supplies from refineries or installations by road, rail, water or pipeline or a combination of the methods. They may deliver directly into consumption area.
20. Dilution Water: This shall mean water in which pollutant is dissolved and used as the exposure medium in acute toxicity test.
21. Disaster: This shall mean an uncontrolled, well blow-out, well fires, pipeline rupture, storage tank failure, VLCC collision or sinking in Nigerian territorial waters that poses an imminent threat to the public health and welfare.
22. Discharge/Release: This shall include but not limited to any spilling, pumping, pouring, emitting, emptying or dumping of waste streams (liquids, gaseous or solids).
23. Effluent of end-of-pipe standards: These shall mean standards designed to control levels of pollutants from point sources or discharges.
24. Embankment: This shall mean a thick wall usually made of earth but sometimes concrete round a facility in order to prevent the entry of unauthorised persons.
25. Environmental Evaluation: A documented assessment of already 'Impacted' or "Polluted" environment (medium) as to decide and or design strategies for restoration.
26. Environmental Impact Assessment Report: This shall mean a documented activity designed to identify and predict the impact of an action of an intended project or groups of projects on human health and well-being, and interprets and communicate
27. Environmental Assessment Methodologies: This shall mean principles and concepts in the design and conduct of assessment studies.
28. Environmental Concentration: This shall mean the concentration, duration. From and location of a material in waters, sediments, or the food of aquatic organisms.
29. a) Filling Station: This shall mean a station that only has facilities for fuelling vehicles.
b) Service Station: This shall mean a station that has facilities for servicing vehicles.
30. Formation Water: This definition shall include any mixture originating from beneath the surface of the earth or beneath the seabed and regularly brought to the surface and discharged in the course of operation to produce crude oil and/or natural gas. This definition shall include any mixture of formation water with water of other origin when such mixture is formed in the normal course of oil and/or natural gas production.
31. Hazardous Substances : These shall include but not limited to any element, compound, mixture, solution which because of its quantity/concentration, or physical/chemical or infectious characteristics, may:
 - i) cause or significantly contribute to an increase in mortality, or incapacitating, reversible illness, or;

- ii) pose substantial hazards to human health or the environment when improperly treated, stored, transported, or disposed off, or otherwise managed.
 - iii) exhibit the following characteristics/criteria.
- a) Ignitability - a liquid and/or liquid waste other than an aqueous solution containing less than 24% alcohol, that has a flash point less than 60°C; a waste, not a liquid, which is capable under standard temperature and pressure of causing fire through friction, adsorption of moisture, or spontaneous charge and, when ignited, burns so vigorously and persistently as to create a hazard; an oxidiser, an ignitable compressed gas.
 - b) Corrosivity - is aqueous and has a pH of 2.0 or less or 12.0 or more, a liquid that corrodes steel at a rate greater than 5.0 mm per year.
 - c) Reactivity - forms toxic gases, vapours, fumes, or explosive mixture with water and when exposed to pH conditions between 2.0 and 12.5; normally unstable and capable of explosion if subjected to a strong igniting/heat source; an explosive capable of detonation or explosion at standard temperature and pressure.
 - d) Toxic - capable through chemical action, of killing, injuring or impairing an organism.
32. Hazard Assessment: This shall mean the identification of adverse effects likely to result from specified release(s) of a material.
 33. Inland Water: This shall mean fresh or non tidal (stagnant) water i.e. water above the low spring tide, and fresh waters of the fresh water swamp due to seasonal flooding.
 34. Initiator: This shall mean any company or agency of Government which intends to undertake a project, or group of projects, having possible environmental effects.
 35. Installations: These shall mean premises which receive supplies directly from a Refinery by ship, pipeline or rail, they make direct delivery to consumers in their immediate vicinity; they may transmit both bulk and packaged supplies by coastal ship, inland water barge, rail or road to depot.
 36. Interceptors: This shall mean a network of drain channels for collecting and channelling the flow of spills, waste oil, storm water, etc.
 37. IP. Institute of Petroleum
 38. Lethal: Causing death, or sufficient to cause it, by direct action.
 39. LC₅₀: The concentration of a substance that is lethal to 50 percent of the test organisms within a defined time period. EC₅₀ A reference point for expressing the effective concentration of a given pollutant to the average or typical organism.
 40. Macroinvertebrates: The larger invertebrates, defined here as those retained by the US standard No.30 sieve. They are generally bottom – dwelling organisms (Benthos).
 41. Macrophytes: The larger plants of all types. They are sometimes attached to the bottom (benthic), sometimes free-floating, sometimes totally submerged, and sometimes partly emergent. 'Higher' types usually have true roots, stems, and leaves. The algae are simpler but may have stem and leaf - like structures.

42. Major Release. This shall mean a release of any quantity of hazardous substances, pollutants, or contaminants that poses a substantial threat, to public health, or welfare or environment or results in significant public concern.
43. Major Spill: This shall mean a discharge of more than 250 bbls of oil into inland waters or more than 2,500 bbls of oil to the coastal waters. However, regardless of the above quantitative definitions, any discharge of oil that poses substantial threat to the public health or welfare or results in critical public concern shall be classed as a major spill.
44. Medium Release: This shall mean any release not meeting the criteria for classification as a minor or major release.
45. Medium Spill: This shall mean a discharge of oil to the inland waters of between 25 and 250 bbls or a discharge of oil to coastal waters of between 250 and 2,500 bbls.
46. Minor Spill: This shall mean any discharge of oil to the inland waters of less than 25 bbls or a discharge of oil to coastal waters of less than 250 bbls.
47. Minor Release: This shall mean a release of a quantity of hazardous substances, pollutants, or contaminants that poses minimal threat to public health or welfare or environment.
48. Misfires: This shall mean shots that fail to explode.
49. Nearshore Waters: These shall mean brackish and Saline waters subject to tidal influence, including five kilometres (5) of the high seas from the Shoreline e.g. swamp. estuary and coastal waters.
50. Offshore Site: Means any fixed or floating installation offshore for the disposal of hazardous wastes, acquired and managed by private firms and/or contractors.
51. Offshore Unit: Means any fixed or floating offshore installation or structure engaged in gas or oil exploration, exploitation or production activities, or loading or unloading of oil.
52. Offshore Water: These shall mean waters situated between 5km – 50kms from the shoreline.
53. Onsite: Site, for the disposal of neutralised hazardous wastes, which is within an operational area acquired and managed exclusively by the licensee, leasee or operator.
54. Oil and Gas Production Installation: This shall mean any permanent installation or facility whose primary function is to produce marketable crude oil and/or natural gas from beneath the surface of the earth or the seabed.
55. Oil. Means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products.
56. Oil Pollution Incident: Means a discharge of oil which poses or may pose a threat to the marine environment, or to the coastline or related interest of one or more states ' and which requires emergency action or other immediate response.

57. Peak Particle Velocity., This shall mean the rate of change of displacement which is proportional to the product of displacement and frequency. The normal displacement vibrograph measures displacement 'as a function of time, hence peak particle velocity can be calculated from the information obtained on a vibration record. Alternatively, it may be measured directly with a velocity recorder.
58. Percent Recovery . This shall mean that which is used to describe the ability of the analyst and the procedure of the analytical system to recover a known amount of a constituent added to a natural sample. This is the most realistic and useful term to be applied in the daily control of the analytical performance.
59. Periphytons (AUFWUCHS). A community of microscopic plants and animals associated with the surfaces of submerged objects. Some are attached, some move about. Many of the protozoa and other minute invertebrates and algae that are found in the plankton also occur in the periphyton.
60. Plankton: A community of plants (phytoplankton) and animals (zooplankton), usually swimming or suspended in water, non-motile or insufficiently motile to overcome transport by current.
61. Point of Discharge: This shall mean the medium used as the receptacle for the waste. The receptacle shall include but not limited to navigable, coastal and inland waters (fresh or brackish), the ocean waters, land surface and subsurface strata, and ambient air within Nigeria.
62. Point Source: This shall mean any discernible, confined and discrete conveyance from which pollutants are or may be discharged.
63. Pollutant or Contaminant: This shall include but not limited to any element, substance, compound or mixture, including disease causing agent which after release into the environment and upon assimilation into any organism either directly or indirectly from the environment through food chains, will or may reasonably be anticipated to cause malfunctions (including malfunctions in reproductions) or physical deformation in such organisms or their offspring.
64. Practicable: This shall mean as much as reasonably practicable having regard among other things to local conditions, and circumstances, to the current state of technical knowledge and financial implications.
65. Priority Pollutants: These shall represent the pollutants and classes of pollutants declared toxic by USEPA.
66. Receptacle: This shall mean a tank or container in which oily waste/effluent may be put into for safe disposal.
67. Repeatability : This shall mean the agreement among replicate observations of the test by a single scatter of results above an average value made by laboratory or analyst. The repeatability or the accepted measure is the standard expressed in a number of ways, but the most commonly is standard deviation.
68. Retail Outlets: These shall mean filling and/or service stations.

69. Ship: Means a vessel of any type whatsoever operating in a marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, and floating craft of any type.
70. Sub-Acute: Involving a stimulus which is less severe than an acute stimulus, which produces response in a longer time.
71. Sub-Lethal: Below the level which directly causes death.
72. Standard: These shall mean levels at which specific materials may be discharged to the environment, enforceable by legislation. Administrative procedures or by mutual agreement or voluntary acceptance.
73. **Standard: Limits made binding through government legislation or regulation which must**
Be observed (within the appropriate regulatory framework) in all cases where they are applicable.
74. Stagnant Water: This shall mean a body of inland water in which there is no flow or the only sensible flow is due to seasonal flooding or tidal action.
75. Taxa: General term for taxonomic groups whatever their ranks.
76. USEPA: United States Environmental Protection Agency.
- 77 **Deepsea Waters:_ Deep offshore waters situated at more than 50kms from the shoreline and greater than 200m depth.**
78. **Guidelines: Values to be complied with, and by use of professional judgement.**
- 79 **Venerable Shore Areas: Shall mean nearshore and offshore areas of less than 80 meters depth and/or highly biological productive areas.**
80. **attenuation - the reduction in concentrations of chemical(s) of concern in the environment with distance and time due to processes such as diffusion, dispersion, absorption, chemical degradation, biodegradation, and so forth.**
- 81 **chemical(s) of concern - specific constituents a that are identified for evaluation in the risk assessment process.**
- 82 **corrective action - the sequence of actions that include site assessment, interim remedial action, operation and maintenance of equipment, monitoring of progress, and termination of the remedial action.**
- 83 **direct exposure pathways - an exposure pathway where the point of exposure is at the source, without a release to any other medium.**
- 84 **ecological assessment - a qualitative appraisal of the actual or potential effects of chemical(s) of concern on plants and animals other than people and domestic species.**

- 85 **engineering controls** - modifications to a site or facility (for example, slurry walls, capping, and point of use water treatment) to reduce or eliminate the potential for exposure to a chemical(s) of concern.
- 86 **Exposure** - contact of an organism with chemical(s) of concern at the exchange boundaries (for example, skin, lungs, and liver) and available for absorption.
- 87 **Exposure assessment** - the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure.
88. **exposure pathway** - the course a chemical(s) of concern takes from the source area(s) to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to a chemical(s) of concern originating from a site. Each exposure pathway includes a source or release from a source, a point of exposure, and an exposure route. If the exposure point differs from the source, a transport/exposure point differs from the source, a transport/exposure medium (for example, air) or media also included.
- **exposure route** - the manner in which a chemical(s) of concern comes in contact with an organism (for example, ingestion, inhalation, and dermal contact).
 - **facility**-the property containing the source of the chemical(s) of concern where a release has occurred.
89. **institutional control** - the restriction on use or access (for example, fences, deed restrictions, restrictive zoning) to a site or facility to eliminate or minimize potential exposure to a chemical(s) of concern.
- 90 **petroleum** - including crude oil or any fraction thereof that is liquid at standard conditions of temperature and pressure (60°F and 14.7lb/in.² absolute ; (15.5°C and 1035.6 kg/m²)). The term includes petroleum-based substances comprised of a complex blend of hydrocarbons derived from crude oil through processes of separation, conversion, upgrading, and finishing, such as motor fuels, jet oils lubricants, petroleum solvents, and used oils.
- 91 **point(s) of compliance** - a location(s) selected between the source area(s) and the potential point(s) of exposure where concentrations of chemical(s) of concern must be at or below the determined target levels in media (for example, ground water, soil, or air).
92. **point(s) of exposure** - the point(s) at which an individual or population may come in contact with a chemical(s) of concern originating from a site.
- 93 **receptors** - persons, structures, utilities, surface waters and water supply wells that are or may be adversely affected by a release.
- **reference dose** - a preferred toxicity value for evaluating potential noncarcinogenic effects in humans resulting from exposure to a chemical(s) of concern.

- 94 **remediation/remedial action** - activities conducted to protect human health, safety, and the environment. These activities include evaluating risk, making no-further-action determinations, monitoring institutional controls, engineering controls, and designing and operating cleanup equipment.
- 95 **risk assessment** - an analysis of the potential for adverse health effects caused by a chemical(s) of concern from a site to determine the need for remedial action or the development of target levels where remedial action is required.
96. **risk reduction** - the lowering or elimination of the level of risk posed to human health or the environment through interim remedial action, remedial action, or institutional or engineering controls.
97. **risk-based screening** - level/screening levels (RBSLs) -- risk-based site-specific corrective action target levels for chemical(s) of concern developed under the Tier 1 evaluation.
- 98 **site** - the area(s) defined by the extent of migration of the chemical(s) of concern.
99. **site assessment** - an evaluation of subsurface geology, hydrology, and surface characteristics to determine if a release has occurred, the levels of the chemical(s) of concern, and the extent of the migration of the chemical(s) of concern. The site assessment collects data on ground water quality and potential receptors and generates information to support remedial action decisions.
- 100 **site classification** - a qualitative evaluation of a site based on known or readily available information to identify the need for interim remedial actions and further information gathering. Site classification is intended to specifically prioritize sites.
- 101 **site-specific target level** - (SSTL) -- risk-based remedial action target level for chemical(s) of concern developed for a particular site under the Tier 2 and Tier 3 evaluations.
- 102 **site-specific** - activities, information, and data unique to a particular site.
103. **source area(s)** - either the location of liquid hydrocarbons or the location of highest soil and ground water concentrations of the chemical(s) of concern.
- 104 **target levels** - numeric values or other performance criteria that are protective of human health, safety, and the environment.
- 105 **Tier 1 evaluation** - a risk-based analysis to develop non-site-specific values for direct and indirect exposure pathways utilizing conservative exposure factors and fate and transport for potential pathways and various property use categories (for example, residential, commercial, and industrial use). Values established under Tier 1 will apply to all sites that fall into a particular category.
- 106 **Tier 2 evaluation** - a risk-based analysis applying the direct exposure values established developed for a specific site and development of values for potential

indirect exposure pathways at the point(s) of exposure based on site-specific conditions.

- 107 **Tier 3 evaluation** - a risk-based analysis to develop values for potential direct and indirect exposure pathways at the point(s) of exposure based on site-specific conditions.
- 108 **user** - an individual or group involved in the RBCA process including owners, operators, regulators, underground storage tank (UST) fund managers, attorneys, consultants, legislators, and so forth.
- 109 **Contamination**
The presence in the environment of an alien substance or agent s or energy, with a potential to cause harm.
- 110 **Pollution**
The introduction by man into the environment of substances, agents or energy, in sufficient quantity or concentration as to cause unacceptable risks to human health, living resources and ecological systems, unacceptable damage to structure or amenity , or unacceptable interference with legitimate uses of the environment.
- 111 **Pathway**
One or more routes or means by, or through, which a receptor:
 (a) is being exposed to, or affected by, a contaminant, or
 (b) could be so exposed or affected.
- 112 **Receptor**
A living organism, a group or living organisms, an ecological system or a piece of property and which is being, or could be, harmed, by a contaminant.
- 113 **Contaminated Land**
Contaminated land is land, which appears to be in such a condition, by reason of substances in, or under the land significant harm is being caused, or there is a significant possibility of such harm being caused.
- 114 **Remediation**
Remediation has a wider meaning than it has under its common usage. It includes assessment action, remedial treatment action and monitoring action.
- 115 **Remediation Action**
Is any individual thing, which is being, or is to be done, by way of remediation;
- 116 **Remediation Package**
Is all the remediation actions, within a remediation scheme, which are referable to a particular significant pollutant linkage.
- 117 **Remediation Scheme**
Is the complete set or sequence of remediation actions (referable to one or more significant pollutant linkages) to be carried out with respect to the relevant land or water.

- 118 Remediation Goal**
A remedial treatment action that will achieve a standard that achieves acceptable risks to human health, animals, plants and the environment, consistent with the existing and likely reasonable future uses of the site/land.
- 119 Environmental Management Audit:**
A systematic evaluation to determine whether or not the Environmental Management System and the environmental performance it achieves conform to the planned arrangements and whether or not the system is implemented effectively, and is suitable to fulfil the organisations environmental policy and objectives.
- 120 Environmental Management Manual:**
The documentation describing the overall system, and making reference to the procedures for implementing the organisation's environmental management programme.
- 121 Environmental Effects Register:**
A list of the significant environmental effects, known or suspected, of the activities, products and services of the organisation.
- 122 Environmental Management Review:**
The formal evaluation by management of the status and adequacy of the organisation's environmental policy, systems and procedures in relation to environmental issues, regulations and changing circumstances.
- 123 Environmental Targets:**
Detailed performance requirements, quantified wherever practicable, applicable to the organisation or parts thereof, that arise from the environmental objectives and that need to be set and met in order to achieve those objectives.
- 123 Environmental Compliance Audit:**
A systematic evaluation to determine whether or not the EMS and the environmental performance it achieves, conform to regulatory requirements.
- 124 1st Party Audit:**
Audit carried out within the organisation, by qualified members of the organization.
- 125 3rd Party Audit**
Audit carried out by registered, certified third party, external and independent auditors
- 126 Disposal**
The discharge, deposit, injection, dumping, spilling, leaking or placing of any hazardous waste into or on any land or water so that such waste, or constituent thereof, may enter the environment.
- 127 Storage**
The containment of hazardous waste on a temporary basis, for such time that may be permitted by the DPR, in such a manner.

128 Re-usable Materials

Any waste material which is destined for reuse or reprocessing, but which because of quality concentrations, or physical or chemical characteristics may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or pose a substantial present or potential hazard to human health or environment when improperly treated, stored or disposed of.

129 Onsite

On the same lease or contiguous property owned by the lessor, or within the confines of a drilling unit and/or production facility.