THE E&P FORUM

OIL INDUSTRY OPERATING GUIDELINE FOR TROPICAL RAINFORESTS

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Oil Industry Operating Guideline
For Tropical Rainforests
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Preface

The E&P Forum has produced this Guideline for the use of member companies in exploration and production activities in tropical rainforests. Readers involved with exploration activities in these and other tropical areas may also wish to consult *Oil Exploration in the Tropics: Guidelines for Environmental Protection,* issued by the IUCN-World Conservation Union (Gland, Switzerland and Cambridge, UK, ISBN 2-8317-0018-3).

The E&P Forum

The Oil Industry International Exploration and Production Forum (E&P Forum) is the international association of oil companies and petroleum industry organizations formed in 1974. It was established to represent its members' interests at the International Maritime Organization and other specialist agencies of the United Nations, governmental and other international bodies concerned with regulating the exploration and production of oil and gas. While maintaining this activity, the Forum now concerns itself with all aspects of E&P operations, with particular emphasis on safety of personnel and protection of the environment, and seeks to establish industry positions with regard to such matters.

At present the Forum has 49 members made up of 36 oil companies and 13 national oil industry associations, operating in 52 different countries.

The work of the forum covers:

- monitoring the activities of relevant global and regional international organizations;
- developing industry positions on issues;
- advancing the positions on issues under consideration, drawing on the collective expertise of its members; and
- disseminating information on good practice through the development of industry guidelines, codes of practice, check lists, etc.

Disclaimer

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INTRODUCTION

Background

The world's rainforests exist primarily in an equatorial band around the earth. The major rainforests are located in Central and South America, Africa, Madagascar, S.E. Asia, Papua New Guinea, and on various tropical islands. A rain forest is typically comprised of an exceptionally wide variety of plants and animals, particularly insect species (much of it unknown to science), and it is sparsely settled by indigenous people. Much of the biota exists high up in the forest canopy where the difficulty of sample gathering has impaired the identification of species.

In the past, some rainforest areas were so vast that they were believed to be virtually immune to human exploitation. Growing physical evidence and recent scientific data now alert us to the fact that the area of rainforests is diminishing at a significant rate. Many scientists and environmental organizations have become active in the cause of saving the rainforests for a number of reasons:

- to preserve the diversity of species as an irreplaceable gene bank;
- burning of rainforests contributes to the enhanced greenhouse effect;
- the preservation of indigenous peoples' habitat;
- rainforests stabilize rainfall and temperature and prevent soil erosion;
- to develop sustainable uses of rainforest resources;
- to preserve the rainforest for its aesthetic value and as a heritage for future generations of people;
- to develop medicinal uses for exotic plants and herbs; and
- atmospheric oxygen production and carbon dioxide absorption.

All industrial developers and governments are being called upon to deal with rainforest issues in a way that preserves the rainforests and addresses the public concern.

Objective of this Guideline

The purpose of this guideline is to establish an internationally acceptable uniform guideline for environmental conservation of rainforests in conjunction with petroleum operations. Not all the measures discussed in this guideline will necessarily be appropriate for implementation in all geographical areas or under all conditions. Specific requirements and standards for petroleum operations in a particular area will be determined by coordination between the operating company and the appropriate authorities in the host country. Economics as well as environmental protection will be considered in these negotiations. Environmental concerns should mesh with practical and economic realities of operating in the tropical rain forest.

General Rules

Petroleum facilities should be designed and operated to minimize the direct and indirect impact of petroleum operations on the rainforest environment. Deforestation should be limited through minimal use of land.

One major cause of rainforest destruction is the practice of slash/burn agriculture resulting from roadside colonization along newly built access roads. Coordination with local authorities to minimize/control the extent of colonization is essential. The operating company should consider access options that will minimize colonization and encourage the local government to prevent colonization along oil field access roads. Although there are ways the operator can assist, it is the primary responsibility of the

local government to establish and enforce colonization policies. The operating company will then cooperate fully with the established government enforcement policies.

The petroleum industry will adhere to local government laws, regulations or policies regarding the payment of compensation for environmental as well as other damage to property caused by petroleum activities. Every effort will be made to avoid sacred and archaeological sites, and to prevent disturbance or damage.

The rights of the indigenous population should be identified and respected throughout the operation. These people should not be exposed to any influence that threatens their health, safety, or long term welfare. The integrity of the traditional native customs and lands should be maintained. Contact with the indigenous population should be coordinated with the local government agencies and recognized representatives where they exist. Local labour should only be used with the advice and consent of the local government, where it exists. However, it must be recognized that local government will not in all cases exist, be effective, or have priorities consistent with those of the local populace and indigenous peoples. Where the operating company believes that this may be the case, the company should take steps to ensure that appropriate consultation will occur directly with the local population regarding aspects of the project that will potentially affect their interests.

The operating company should estimate the manpower required for development and operation of oil prospects. Local authorities and leaders should be informed of these estimates so population influx and changes in employment can be anticipated and infrastructure can be planned. This effort should also include an assessment of cultural impact and ways of counteracting such impacts.

Legal Requirements

Some developing countries have passed legislation and have adopted administrative rules generally applicable to petroleum activities. Any special rules focusing on certain areas within the host country should be strictly adhered to.

Although there are no known current international agreements specifically related to oil industry activities in rainforests, there are broad environmental agreements which encompass the environmental protection of such areas—a number of these are listed at Appendix 1.

Environmental Management

Environmental considerations should be included throughout the project planning process from project conception to project closure and abandonment. Environmental management is a line management responsibility and appropriate resources should be made available to implement the necessary procedures by the operating companies.

Environmental Profile

The first stage of environmental management is the preparation of an environmental profile which should be conducted during considerations for acquisition of exploration acreage. This should include as a minimum a review of national legislation, current land use, proposed land planning, and the identification of protected areas, national parks and any other restricted areas.

Preliminary Environmental Impact Assessment
Prior to exploration activities (including seismic and drilling) a preliminary environmental impact assessment should be prepared, identifying the sensitivities of the area, the relevant environmental issues and recommended environmental control and protection measures including the presence of endangered species. In addition consultation/involvement with controlling authorities, local organizations and institutes etc. will be required.

Full Environmental Impact Assessment
An environmental impact assessment for all but very limited exploration activities and for all production activities is a fundamental part of environmental protection management and should be viewed as an essential part of the Petroleum Development Application.

The environmental impact assessment should assess the existing environment and the field development plan, identify potential environmental impacts and recommend mitigative actions to minimize these impacts. It should also include an abandonment plan to be implemented upon completion of the project.

An essential part of this process is the development of an oil spill contingency plan. The environmental impact assessment will provide a guideline governing the subsequent operations and developments. When more than one operator is involved in an area, joint plans should be made in a consistent manner to avoid omission, duplication of effort and cumulative impacts.

There may also be a requirement to appoint an environmental adviser for the duration of the construction and early stages of production depending on the scale of the project. The adviser would have overall responsibility for ensuring that the environmental management and monitoring plan was implemented and also act as liaison person with statutory and local authority agencies.

Environmental Monitoring
Appropriate environmental monitoring will take place during exploration, construction, and the operation of oil production facilities to verify the effectiveness of control measures. In many parts of the world it may well be expected that there will be a legal requirement for appropriate monitoring to be performed. The objective of an environmental monitoring programme is to ensure the minimization of impact during the life of the project.

Environmental Audit
Environmental auditing will be conducted by the operator to ensure that applicable environmental standards are being maintained and that company policies are being adhered to during the development phase. This is a head office line management responsibility to ensure enforcement of company policy procedures and standards. Environmental audits should be undertaken at each production operation at least every three years.

The environmental audit process provides continued assessment of environmental performance during the operational phase of project developments. It acts as an internal control process to ensure that environmental protection management procedures are being enforced rigorously. Environmental audits will:

- examine line management systems, plant operations and monitoring practices and data;
- verify the predictions in an EIA and ensure that recommendations are being implemented;

- identify current and potential environmental problems; and
- recommend continued improvements to the management of the operation.

EXPLORATION SURVEYS

Satellite and Aerial Geomagnetic Surveys

The acquisition of acreage which may encompass protected or sensitive areas does not necessarily mean that exploration activities will result in any conflict with these conservation interests.

Oil exploration using remote sensing and aerial geomagnetic survey techniques is unlikely to conflict with environmental interests. Indeed such data collected by remote means over National Parks and protected areas may provide useful information for the interpretation of geological structures in adjacent unprotected areas where more extensive on-the-ground exploration may be possible. In this respect the acquisition of exploration data on protected areas may be justified.

It should be noted, however, that in some countries there is legislation controlling low level overflights in protected and sensitive areas.

Seismic Surveys

In remote forests or plantation areas access for seismic survey teams is usually on foot using hand transportable equipment and helicopter logistical support. Seismic lines are essentially straight lines proceeding along a specific compass bearing. The lines are cleared of obstructing vegetation leaving root stock and top soil in place to provide a footpath approximately one metre wide. During clearance, large trees (those over 20 cm in diameter) and endangered or protected species identified in the Environmental Impact Assessment should be avoided where at all possible and the line deviated accordingly. This also contributes to a reduction in ‘line of sight’ impact. Access ‘dog legs’ should be used to screen the seismic line from access routes if necessary.

In some remote areas, seismic operations would need to be helicopter supported requiring the construction of helipads along the seismic lines. Helipads should be located and constructed to meet safety and operational needs with minimum environmental impact and with plans for erosion control and restoration. Flight access routes should similarly be selected to minimize impact. Helicopter support can negate the necessity for road access. Where vehicular access is required for the transport of equipment, the width of access tracks should be kept as narrow as possible. The number and size of clearings should be minimized based on operational, safety and economic consideration.

Along the seismic line, shallow holes are drilled at regular intervals in which small charges of explosives are detonated to provide the seismic energy source for the measurement to be recorded. Any remaining shot holes should be back filled to reduce the chance of subsequent erosion.

In some locations bulldozers are used to prepare access routes and seismic lines. The circumstances under which bulldozers are used should be strictly controlled (e.g. for vibriosis operations).

The whole seismic data collection operation usually passes a given point

within a few weeks and should result in minimal disturbance. There should be no significant waste products—any that do arise should be removed and appropriate records kept.

Access

During seismic survey, gaining access by vehicle to the survey area is likely to give rise to the most significant impacts. Environmental impacts will result directly from the clearance of vehicle tracks and establishment of small base camps. More significant indirect impacts may result from the movement of local people into the survey area. Local people are attracted by the easy access provided by new tracks and by the hope of work or compensation payments. The advice and co-operation of authorities responsible for local land use, planning and development should be sought to control immigration and access.

Where practical, construction of roads should be avoided. Roads should be constructed in such a way as not to impede natural drainage and not lead to future erosion problems. Operating companies should work with local non-governmental organizations (NGOs) where appropriate to encourage and help local authorities in developing balanced long-range views to guide land use legislation and allocation of lands.

Camp Sites

Local authorities should be consulted in advance on preferred base camp location which is normally selected to coincide with existing access.

Seismic exploration involves a considerable workforce and a base camp is required to accommodate personnel and equipment. In forested regions the area of clearance should always be kept to a minimum compatible with operational, health and safety requirements.

The base camp should be self-contained and may provide workforce accommodation, canteen facilities, radio room, water supply, vehicle maintenance and parking area, helipad, a bunded area for the storage and handling of fuels, provision for the collection, treatment and disposal of sewage effluent and for the collection and burning of refuse. Special provisions must be made for safe handling and storage of explosives.

The base camp site should be selected to minimize impact on local communities, cultivated areas or logging interests. As the site will only be used for a few months it should be selected with plans for abandonment in mind.

Alternatively in an undisturbed forest area the site should have potential for recolonization by indigenous forest scrub and trees.

Waste disposal is a common problem for base camps in areas where water treatment and waste disposal facilities do not exist. In most cases provision must be made for waste disposal or treatment on site. A major concern must always be the control of disease and infection, and the prevention of contamination derived from waste. All canteen wastes, solid wastes and other putrifiable material should be collected regularly and burned or buried as appropriate. Sewage and water effluents should be disposed of through a soakaway system of permeable earth covered beds in such a manner as not to impair potable water supplies.

It should be noted that most countries have regulations for controlling solid and liquid waste disposal and local authority consent may be required

for waste disposal methods. Furthermore, there are usually regulations and guidelines regarding water quality standards for discharges into lakes, rivers and possibly groundwater. These standards are particularly important in inhabited areas where drinking water supplies may be affected.

The prohibition of hunting, trapping and gathering of forest fruits by seismic workers should be enforced. Camps should not be supplied with meat from animals killed in the rain forest by seismic workers or food harvested from the rainforest by such workers.

Abandonment and Restoration

At the end of the operation, practical, expeditious steps should be taken to restore the site to as near as possible to its original condition, promote natural revegetation and prevent erosion.

Line stakes and markers (other than datum pegs, bench marks, and permanent survey markers) should be removed and disposed of in a responsible manner without impairing soil, water or other resources.

The authorities responsible for local land use, planning and development should be consulted on the most effective means of natural re-vegetation and prevention of immigration. However, it should be noted that some authorities may wish to retain certain roads.

Wherever possible, new access routes, camp sites and seismic lines should be rendered inaccessible to the public. Appropriate methods include breaking up of compacted surfaces to encourage re-vegetation and removal of key bridges specifically installed for the seismic operation.

EXPLORATORY DRILLING

Introduction

In the event of the seismic survey indicating the possible presence of hydrocarbons, the next step would be exploration drilling. This involves the drilling of one or more wells from road or helicopter serviced well sites and necessitates the setting up of a base camp. The exploration drilling phase is temporary. Drilling at a specified site will typically last 1—2 months, although a complete exploration drilling phase may last several years. The land take is minimal with an average well site, which is normally located on a seismic line, occupying an area of only a few hectares. All precautions are to be taken to minimize impact on the natural environment.

Access

For the majority of tropical rain forest oil field developments, the building of access roads is the greatest single cause of environmental impact from both the direct impact of forest clearance, drainage disruption and soil erosion, and from the indirect impacts associated with increased accessibility of the area and influx of local people. The alternative to road access to a well site is the use of helirig operations. These are appropriate where temporary access is required in remote areas or in areas likely to be affected by settlers.

Road construction should be carefully planned to avoid steep slopes and drainage courses. In undulating topography, cut and fill operations should be minimized. Slope engineering is critical and should incorporate prefer-

ential drainage courses or culverts, lined with gravel where necessary, to prevent erosion. Tree branches cut to provide access should be used wherever possible in soil conservation and erosion control. Exposed soil should be contoured to facilitate natural vegetation or revegetated with indigenous species to speed up the regeneration time. Forest clearing should be kept to the practical minimum required for safe operation.

Road construction is normally undertaken using local materials and occasionally using geotextiles (polyethylene sheeting) and gravel. Where possible the use of tropical timber should be minimized. Cutting for small timber outside the roadway allowed should be kept to a minimum. Road construction should incorporate drainage for run-off water, culverting and bridging as required by the terrain and local water conditions. Without some kind of weather proofing surface, roads will rapidly become pitted, eroded and degraded. Suitable surfacing materials should be applied in a manner that minimizes erosion.

It should be recognized that once built, roads are rarely removed and may remain as a means of access for many years. Highly engineered strengthened roads will provide an access route for a longer period of time than simple compacted soil roads.

The use of helicopters for the transportation of men and equipment will usually be preferable from an environmental perspective to road building or dredging. However it should be noted that the use of helirig equipment will often require the clearance of an additional area at well sites to provide a helicopter flyway. Benefits could include

- less tree destruction, thus a lower overall environmental impact, although a higher localized impact; and
- reduced access to site and minimization of forest clearing so that the impact is only over a limited area and of a temporary nature.

The disadvantages include higher costs for transportation and incurring the safety risks of flight operations.

Base Camp

A base camp is often required to accommodate personnel and to store equipment. Its location is normally selected to coincide with easy access and delivery routes. In forested regions the area of clearance should always be kept to a minimum to comply with operational and safety requirements. In some cases the site will be used for only a few months to support a single exploratory drilling operation. In other cases it may be used for a period of years for a phased exploratory drilling programme. In all cases the site should be selected with its anticipated needed life, abandonment, after-use and restoration in mind. Where possible consideration should be given to leaving large trees within the camp area to minimize damage and soil erosion and to improve camp shading.

The base camp should be self contained and may provide workforce accommodation, canteen facilities, radio room, surplus and scrap material handling, vehicle maintenance and parking area, helipad and finally bunded areas for the storage and handling of fuels. In addition there should be on-site provision for the collection, treatment and disposal of sewage effluent, and for the collection and incineration of refuse.

All sites should observe any relevant local regulations governing solid and liquid waste disposal and consent or permits may be required for waste disposal methods. There may also be regulations and guidelines which set

water quality standards for discharges into lakes, rivers and possibly groundwater. These standards are particularly important in inhabited areas where streams and other potable drinking water supplies may be susceptible to contamination. If no regulations exist then the standards from adjacent countries with well developed legislation should be adopted.

Solid and hydrocarbon wastes should be incinerated and the residue buried or removed off site. Liquid wastes that could damage the environment should never be disposed of or allowed to directly drain into a watercourse or groundwater formation.

Well Site Selection

Under normal circumstances exploratory well sites are only occupied for a short period. The well site should be selected with land use, stability, drainage and subsequent restoration in mind and should be located to minimize impact on local land use such as settlements, cultivated areas and logging interests.

It should be recognized that the most appropriate exploration well site need not necessarily dictate the location of a future appraisal/production well site should a discovery be made. However, once it appears likely that a production operation will follow, sites should be selected with a view toward their eventual use as production well sites and so minimize overall impact.

When operating in an extensive continuously forested area it may be possible to locate the well site in a previously disturbed area or natural clearing. If an area has been logged previously, then existing roads and clearings as well as secondary forest (jungle) should be used rather than undisturbed or primary forest where environmental impacts may be much greater.

Well Site Preparation

Well site preparation will often determine the success of environmental management and subsequent restoration. The land is cleared of vegetation and the site graded to provide a level working surface. The working surface of the site should comprise suitable compacted materials (e.g. laterite).

- Well sites should be designed to occupy the minimum space required. This will reduce physical disturbance and the area to be restored. Clearance of vegetation should be kept to a minimum.
- The well site may not need to be completely levelled. On sloping ground consideration should be given to split-level or partially levelled sites. These considerations will provide a more stable land form which is less susceptible to erosion.
- Cleared vegetation should not be automatically burnt or removed. It can sometimes be used in soil conservation. Such materials can be utilized for foundations and structures, if needed and useable. However, cutting of additional timber should be avoided.
- Conservation of top soil should be achieved wherever practically possible. Storage of this soil by containment and replacement upon site abandonment will facilitate revegetation of the cleared area.
- Well sites should be prepared with drainage requirements in mind which may also serve to capture contaminants. Where possible contaminants should be captured separately from rain water to minimize the volume of fluid requiring special disposal. The well site location together with off-site drainage channels should prevent water flow across the site. Slope engineering should incorporate preferential

drainage channels. These channels may require lining (e.g. with gravel) to prevent erosion. All exposed slopes should be covered and revegetated as a priority with indigenous species only if natural colonization would not otherwise occur quickly enough to prevent erosion.

- All fuel and chemical storage areas should be sealed and bunded to contain any spillages and facilitate clean-up. Good housekeeping is essential in storage, handling and use of fuel and chemicals.
- An optimum store of essential equipment for oil spill clean-up should be maintained on-site within a dedicated container. Any oiled absorbent materials which cannot be disposed of at appropriate disposal sites should be incinerated in the burn pit. Contaminated soils should be disposed of in an environmentally acceptable manner so that the uses of soil and water resources are not impaired.
- In areas where groundwater or water courses are exploited for potable water supply, and disposal of muds in unlined pits may pose a threat to those water supplies, mud pits should be lined with impermeable material (e.g. bentonite). However, it should be noted that lining material is often regarded by the local communities as a valuable commodity and resource for their own use.
- Crude oil from well testing should be stored in temporary tanks and/or burned in appropriately lined pits e.g. cement. All pipework and manifolds should be oil tight. Under no circumstances should oil be spilled or discharged on-site, or dumped in the mud pits.

Local Workforce

In many countries there is a requirement to employ local labour, while in others their employment may be prohibited or undesirable. The introduction of a workforce from one area to another can result in conflict between local groups. In all cases, local authorities/governments should be contacted regarding the use of local labour and any restrictions on its use. When operating in remote, undisturbed or protected areas strict control must be exercised over poaching, hunting and fishing by the workforce. Hunting of and trade in a wide range of endangered species is illegal and should be prohibited by the operating company. This prohibition should be included in all contracts and enforced by all contractors.

Waste Handling

The principal industrial waste arising from drilling operations will be spent drilling muds and cuttings. In most cases waste disposal facilities will not be available and drilling mud disposal must be managed on-site. All wastes should be recorded, together with the location of the disposal site and route.

In all cases the methods for disposal of muds and cuttings will be based on a careful assessment of the muds to be used and the environmental conditions in the area being considered for their disposal. The environmental impact of drilling mud disposal is significantly determined by the mud formulation employed. Where water based muds are employed in exploration the use of additives containing heavy metal should be avoided. In the rare event that oil based muds are utilized stringent precautions should be taken to minimize spills. If oil based muds are used steel tanks or other provision for mud and cuttings collection, removal from site and disposal outside primary rainforest areas in appropriate reception facilities must be considered in the light of disposal facility availability and the means of transportation to be used. The process of minimizing loss needs to be addressed in the oil spill contingency plan. Under no circumstances should harmful drilling mud fluid be discharged directly into a watercourse (lake or river) or pumped over the ground surface. Drilling fluids should be discharged into a lined mud pit.

Mud pits should be constructed with sufficient capacity to contain all waste mud and cuttings plus contingency for rain water. The mud pit should be surrounded by a raised bund which prevents ingress of run-off water from the well site and adjacent areas. Mud pits should be constructed from impermeable membrane and soil materials. Construction should be assessed on a site by site basis to determine the method of lining the pit to prevent seepage of fluids. Seepage of drilling mud fluids should not be allowed in areas of high groundwater table or where watercourses are close by. The mud pit should never be used for disposal of oily wastes, sewage effluents or other associated wastes. Should oil get into the mud pit, it should be skimmed off and incinerated or disposed of in an equally acceptable manner.

Spill Contingency Plans

Drilling well sites should be designed to prevent spills. Catchment systems should be included in all designs to minimize spill damage. Contingency plans should be prepared based upon the location and volume of potential spills.

The plan should include the type of spill response equipment and manpower required to respond to accidental spills, both large and small. It should address the identification and protection of vulnerable and sensitive areas should a spill occur.

The plan should clearly identify the actions necessary in the event of an oil spill: the communications network, and the individual responsibilities of key emergency personnel together with the procedures for reporting to the authorities. Finally the plan will also address the disposal of contaminated waste generated by a spill, and the transportation and housing of extra labour for cleanup work. The plan for these short duration activities should be updated and rehearsed on a regular basis.

Well Site Abandonment and Restoration

Wells that are not to be used in the future should be properly plugged and abandoned to positively isolate subsurface zones and protect useable surface waters. The well head, casing and concrete cellars should be removed to a depth sufficient to ensure no impairment of surface use. Any holes should be filled and the surface contoured to fit surrounding terrain.

The well site should be examined by a company representative and if necessary the surface broken up to restore water run-off and drainage courses compatible with surrounding land. For a sloping site, consideration should be given to restoration of something like the original contours. As a minimum the site should be left with terrain comparable contours which will not erode or act as a focus for instability.

Following the establishment of compatible contours and drainage, all equipment and debris should be removed. At this stage, the topsoil stripped from the site should be evenly respread. Revegetation should be conducted as appropriate, possibly using topsoil and a cover of vegetation saved from the original trees. A moderate application of fertilizer may be considered as an aid to plant establishment. Once a vegetation cover is established then surface erosion will be minimal.

Mud, burn and sump pits should be infilled and restored to form a stable surface without displacing the contents. The use of high void materials may be required where large volumes of liquids are present. Consideration should be given to reducing liquid volume by injecting into a non potable

water zone below deep casing strings if possible and if permitted by regulations. The finished surface of the mud pit should be contoured and restored, in line with the rest of the well site.

If temporary access roads have been built in a sensitive or undisturbed area, then these should be blocked, bridges removed and the road revegetated to restrict immigration of local people in accordance with the exploration agreement and in consultation with the regulatory authorities.

A further inspection by a company representative of the well site should take place after restoration, to establish whether any further action is necessary before a site is abandoned.

It should be noted that well sites which are to be used for subsequent hydrocarbon production, but have been temporarily shut in, should be restored to an acceptable standard.

DEVELOPMENT DRILLING/PRODUCTION

Land Clearing

Clearings will be made for well drilling sites, centralized petroleum processing facilities, and accommodation for oil workers. Clearing design should incorporate rain water drainage in a way that minimizes erosion and contamination of natural creeks and streams. When planning a location to be cleared for a well site, a central processing facility, or a base camp, an attempt should be made, consistent with safe and efficient operations, to minimize deforestation.

When trees are felled and a clearing is made for building a pipeline or a road, scientific research teams may be invited to take specimens and identify species in accordance with an agreed plan. Many trees are over 100 feet (30.5 metres) high so collecting specimens from standing trees is usually difficult.

Reforestation of cleared land should be undertaken with indigenous species to the extent that the land to be reforested is not needed for current operations. Reforestation efforts should include the prohibition of vehicular traffic in areas where saplings are planted.

Roads should be planned so that minimum road mileage is created but not at the expense of sensitive areas or potential severe erosion. While some crossing roads are necessary, these should be kept to a minimum. Existing crude oil exporting pipelines should be extended into the new oil fields parallel to either existing or newly constructed roads.

Drilling Operations

Reservoir development plans should employ directional drilling techniques wherever practicable considering geology and geography in order to cluster multiple wells on one site and minimize the number of well sites that have to be cleared. This will serve to reduce the overall area cleared, minimize habitat fragmentation and in some cases enhance field economics.

Steel tanks should be considered as one of the alternatives to earthen pits for storage and processing of mud, cuttings and other fluids. These mate-

rials should either be reclaimed, solidified or landfarmed or hauled to approved proper disposal sites or injected into non potable water zones below deep casing strings if permitted.

Every attempt should be made to reuse mud to minimize the disposal of used mud. Oil contaminated cuttings should, if possible, be hauled out of the rainforest for landfarming or other approved proper means of disposal. In considering whether landfarming operations are conducted in the immediate area or an area outside the rainforest the company must consider the likely relative impacts of transporting to locations outside the rainforest as against landfarming locally.

Construction

Construction of facilities, roads, camps and pipelines should be kept to the minimum for necessary operations. The consolidation of several functions at a single site will reduce the number of required sites. While one large site may appear to make a significant impact on the area of rainforest affected, this will usually be less than for several smaller sites. Site design should provide for minimum erosion and subsequent reforestation.

Central Processing Facilities
Factors to consider in designing central processing facilities should include the size of the area required for central facilities versus that of individual well facilities and the risk and size of potential spills. These facilities should have provisions for spill minimization and sumps at all oil drains. Produced water disposal and gas flaring operations should be at the same site as the oil dehydration/desalting operations.

Flowlines
Clearance corridors for flowlines/pipelines should be minimized and planned in parallel with access routes. Maximum use should be made of satellite stations to minimize the number of individual flowlines. Cluster well sites simplify the use of this technique.

Pipelines
Pipelines should be kept to an absolute minimum required to move the product out of the area. To have the least impact on the rainforest, these pipelines should be laid parallel to existing roads, where possible. This will also simplify access for inspection and repairs. Where any pipeline is laid on the surface it should not impede the flow of surface waters. In areas where animal mobility is of concern, consideration should be given to elevating the pipeline or burying it underground.

Base Camps
Housing camps within the virgin rainforest should be kept to a minimum by housing only workers. Workers should be transported to and from communities established for family habitation that are located outside undisturbed rainforest. These practices are intended to eliminate or minimize development of temporary, sub-standard housing near places of employment. Workers‘ housing camps should be adjacent to warehouses, central processing facilities, air strips, etc.

Roads
During road construction arrangements should be made to maximize erosion control and to facilitate natural surface drainage and revegetation. Roads may be surfaced with properly processed tank and vessel bottom material, to minimize the effect of vehicle dust on the rainforest, and to maintain the roads in passable condition in wet weather. Careful analysis

of the materials to be used is necessary to ensure that, after processing, they will not be environmentally hazardous and will constitute a stable surfacing material. The proper processing of tank and vessel bottom wastes for use as road surfacing material includes mixing these wastes with a suitably absorbent soil or other material such as lime. This practice is intended to prevent seepage or run-off of oil from the road.

Air Strips
Air strips should be located adjacent to camps taking into account safety considerations and the need to minimize the clearing of vegetation. Air strips should be kept to the minimum size necessary by using either short take off and landing (STOL) aircraft or helicopters.

Production Operations

Well Maintenance Activities
Well maintenance activities (acidizing, fracturing, solvent stimulation, etc.) should collect spent treatment fluids in steel tanks, not open pits. These fluids should either be injected into non-potable water zones below deep casings or be reclaimed, chemically neutralized and combined with produced fluids, incinerated, or disposed of in other equally acceptable ways.

Maintenance of Facilities and Equipment
Provision should be made to prevent the escape of produced fluids onto soil or into waterways during vessel and flowline maintenance activities.

Chemical Usage
Chemical application should be centralized whenever operations permit, allowing the use of bulk chemical storage tanks and reducing the number of drums on the site. Cluster well sites and satellite stations are ideal places for such centralization.

Waste Handling

Each site should have a waste minimization and disposal plan appropriate for that site and utilizing existing infra-structure.

Produced Water
Produced water should be reinjected into either the producing formation or another non-potable water formation which is unsuitable for human use. Where geological structures preclude this possibility, and surface discharge is the only option, the produced water should be treated to remove contaminants. The total quantity of produced water to be discharged annually, and its potential changes in composition for the lifetime of the discharge, as well as statutory control requirements, will need to be taken into account when determining treatment specification.

Rain Water Drainage
The design of each site will allow for drainage into natural streams in a way that minimizes erosion. This requirement may entail the installation of culverts to appropriately channel the rainwater and the use of oil interceptors in such channels.

Oil Leaks and Drainage Systems
Leak minimization is to be incorporated into facility design and maintenance procedures. Oil sumps should be provided for all drains to prevent contamination of rainwater drainage. Drip pans should be utilized where needed. There should be separate systems for rainwater and oil contaminated zones.

Combustible Waste
Paper, wood, oily rags, paint cans, oil filters, absorbent pads, plastic wraps, kitchen wastes, etc. will be disposed of on-site by a fired low emission incinerator. On-site incineration during construction and operations will almost eliminate landfill operations, and remove the desire of local inhabitants to reuse discarded waste. This practice will also minimize the potential for litter.

Drum Disposal
The accumulation and disposal of 55 gallon drums (and smaller) can be a difficult problem. The use of drums can be minimized by using bulk storage for high volume chemicals, lubricants, etc. Where drums are necessary, they should be returned to the original vendor for reuse, where possible. Where reuse is not possible, drums should be crushed and hauled off site for disposal. Contracts for construction or with service companies should include drum removal by the contractor along with controls on drum cleaning prior to any public sale.

Hazardous Waste
Certain production chemicals, such as descalers (acids or converters), biocides, fungicides, etc., will require special disposal techniques. These special techniques include such practices as chemical neutralization, incineration or other acceptable methods. As a part of waste minimization, it should be a policy to use all chemicals purchased. Unused chemicals that will be used in the near future should be properly stored. Other unused chemicals should be returned to the supplier for resale or proper disposal.

Tank and Vessel Bottom Wastes
Tank and vessel bottom wastes will be processed for proper utilization as road surfacing material or it will be incinerated where possible or landfarmed outside the rainforest area. The application of suitable non hazardous wastes as road surfacing material would involve the mixing of these wastes with absorbent soil or other material (e.g. lime). This practice is intended to prevent seepage and run-off of oil from the road.

Drilling Pit Waste
The use of cluster well sites will confine drilling activities and permit better control of wastes. Steel tanks can be used to contain fluids, minimize spills, and provide storage for subsequent disposal.

Atmospheric Emissions
Detailed engineering should provide for minimizing emissions into the air by appropriate control methods. Flaring of gas should be kept to a minimum. Where the volume of gas produced is far more than field operational requirements, an assessment of possible markets for the gas should be made. If a market is not available, gas reinjection should be considered as an alternative to flaring.

Contaminated Soil From Oil Spills
Oil storage tank bottom corrosion leaks should be prevented as far as possible with coatings and cathodic protection (both interior and exterior). A monitoring system should be employed for early detection of leaks. Contaminated soil can be landfarmed to use natural biodegradation.

Sanitary Wastes
Full treatment septic systems to process all sewage should be installed for all construction, drilling and production facilities, and camps. These wastes should be brominated or chlorinated or otherwise treated to

destroy harmful bacteria. These wastes may need to be monitored. In particular bromination or chlorination should be controlled and oxygenation should be used where necessary to prevent damage to aquatic life.

Spill Contingency Plans

Oil and salt water handling facilities, flowlines and pipelines should be designed to prevent spills. Catchment systems should be included in all facility designs to minimize spill damage. Contingency plans should be prepared based upon the location and volume of potential spills.

The plan should clearly identify the actions necessary in the event of an oil spill, the equipment needed, the communications network, and the individual responsibilities of key emergency response personnel, together with the reporting procedure to the authorities. In addition it should address the identification and protection of vulnerable and sensitive areas should a spill occur. The plan will also address the disposal of contaminated waste generated by a spill, and the transportation and housing of extra labour for cleanup work. Finally the plan should be exercised and tested (every six months) and updated accordingly.

Abandonment

Prior to the time when commercial hydrocarbon extraction is no longer possible, a complete abandonment plan should be developed and reviewed with government. In the course of development of this plan, contact should be made with local people, communities and host government entities. From these contacts will come an abandon-salvage plan for the entire oil field. Recipients of facilities or infrastructure to be left for other uses should be properly instructed in safe operating methods as well as appropriate care and maintenance.

All cement, steel or wood installations not being left to others will be removed to at least one metre below ground level or to the level required under relevant national legislation. All pits, cellars, and holes will be cleaned and filled to ground level and all oil and otherwise contaminated soil must be removed. Wells will be plugged and abandoned in accordance with appropriate industry standards.

Roads and well or facility sites designated to be abandoned will have all paving and man-made structures removed to a sufficient depth below ground level to allow revegetation. The surface will be contoured for drainage and control of erosion and the soil prepared for planting. Indigenous plant species should be planted in an array compatible with surrounding rainforest habitat.

APPENDIX:
INTERNATIONAL CONVENTIONS
AND DECLARATIONS
APPLICABLE TO RAIN FORESTS

1. *The convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (The Western Hemisphere Convention)*

The aim of this convention is to 'protect and preserve in their natural habitat representatives of all species and genera of native flora and fauna, including migratory birds, in sufficient numbers and over areas extensive enough to assure them from becoming extinct through any agency within man's control …' and to 'protect and preserve scenery of extraordinary beauty, unusual and striking geologic formations, regions and natural objects of aesthetic, historic or scenic value, and areas characterized by primitive conditions in those cases covered by this convention'.

Conservation of habitats through national parks, nature monuments, national reserves is being undertaken. Protection of species inside or outside reserves, especially migratory birds has been pursued through cooperative ventures.

2. *The Convention Concerning the Protection of World Cultural and Natural Heritage (The World Heritage Convention), adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) 1972*

Objective of the convention is to protect natural and cultural areas of 'outstanding universal value'.

3. *The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)*

This convention regulates the international trade in wild animals and plants which are listed in three Appendices to the convention.

4. *The convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR). 1971 'Wetlands Convention'*

Aim 'to stem the progressive encroachment on and the loss of wetlands now and in the future'. Article 2(1) defines wetland as: 'areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including marine water the depth of which at low tide does not exceed six metres'. (Included areas: mangrove swamps, peat bogs, water meadows, coastal beaches, coastal waters, tidal flats, mountain lakes and tropical river swamps).

5. *Convention on the Conservation of Migratory Species of Wild Animals, 1979*

6. *Convention on the Conservation of European Wildlife and Natural Habitats, 1979*

7. *African Convention on the Conservation of Nature and Natural Resources, 1968*

8. *The Convention for the Protection of Birds useful to Agriculture*

9. *The International Convention for the Protection of Birds*

10. *The Benelux Convention on the Hunting and Protection of Birds*

11. *Directive of the Council of the European Economic Community on the Conservation of Wild Birds*

12. *Treaty for Amazonian Co-operation (Brasilia, July 3, 1978)*

Aims at promoting the harmonization and development of the Amazonian territories and achieving the preservation of the environment and conservation and national utilization of the natural resources of those territories.

13. *Declaration of San Francisco de Quito (March 1989)*

14. *The Amazon Declaration (Manaus, May 6, 1989)*

15. *UNESCO. Man in the Biosphere*