Chapter 12 Service Stations

Chapter 12 Service Stations

12-1 Environmental Pollution at Service Stations

There are 212 service stations in Trinidad and Tobago at present, all under the control of the National Petroleum Marketing Company (NPMC). Two major kinds of environmental pollution originate at service stations. One is hydrocarbon vapor emitted when the tank receives gasoline from tank lorries. The other is discharge to the environment of spent lubricating oil replaced there.

12-2 Spent Lubricating Oil

Trinidad and Tobago reportedly consumes about 13,000 kiloliters of lubricating oil a year, of which automotive lubricating oil accounts for 8,000 kiloliters and industrial lubricating oil 5,000 kiloliters per year. About 70 percent is domestically supplied; the rest is imported from the U.S.A., Jamaica, etc.

12-2-1 Present Condition of Pollution by Lubricating Oil

NPMC estimates that 40 percent of automotive lubricating oil is replaced by the drivers themselves, 40 percent by repair shops and 20 percent by service stations.

The spent lubricating oil replaced by the drivers themselves is utilized by them, as a substitute for insecticides for banana trees or for killing mosquito larvae after being diluted with kerosene for example, and is not recovered by the petroleum industry. Very little automotive lubricating oil is recovered by repair shops and service station. Automobiles running in Trinidad and Tobago are generally old and therefore consume much lubricating oil. In most cases lubricating oil is added to the engines rather than replaced.

12-2-2 Recovery of Spent Automotive Lubricating Oil

A 200-liter drum is placed at a number of service stations to store recovered spent lubricating oil. In many cases the drum becomes full in about six months. Repair shops are mostly very small and oil is rarely recovered. The lubricating oil recovered at service stations is supposed to be brought to Pointe-a-Pierre Refinery for re-processing. Actually, however, very little is brought to

Pointe-a-Pierre Refinery.

NPMC presently delivers 10 to 20 drums full of spent oil to the refinery every three months. Pointe-a-Pierre Refinery adds the returned spent oil to the crude oil to be distilled. So little oil is recovered that the spent oil is virtually not recovered. The refinery intends to treat as much spent lubricating oil as is brought in.

12-2-3 Future Prospect of Lubricating Oil Recovery

NPMC has embarked on a campaign to encourage people to replace oil at service stations. However, the campaign understandably has not met with the expected response from the consumers, under a circumstance where about 80 percent is replaced either by the drivers themselves or by repair shops.

NPMC has a plan for recycling the spent lubricating oil. NPMC now has difficulty estimating the amount of lubricating oil that will be recycled and is unable to proceed further with this plan.

12-3 Present Status of Petroleum Pollution at Service Stations

The study team conducted environmental measurements of hydrocarbons at three service stations selected by NPMC on Friday, August 12 in the presence of the staff of NPMC and counterparts from the Ministry of Energy and Energy Industries. At the same time, the study team observed the drums for storing the recovered spent oil. The results of measurements were as follows:

ppm

1. Corner of Park Street and Richman Street
   Two meters downwind when a car was refueled; Kitagawa detecting tubes were employed.
   First measurement: not detected
   Second measurement: 200
   Third measurement: 100
   One 200-liter drum for spent lubricating oil is in place.

2. Johnston Service Station
   Two meters downwind when a car was refueled; Kitagawa detecting tubes were employed.

First measurement:	200
Second measurement:	100
Third measurement:	100

One 200-liter drum for spent lubricating oil is in place. There is a small pit for recovered lubricating oil. The pit is filled with sand and is not effective for separation of oil and water. It is actually useless.

3. Poontip Service Station

Two meters downwind when a car was refueled; Kitagawa detecting tubes were employed.

First measurement:	200
Second measurement:	300

One 200-liter drum for spent lubricating oil is in place.

These three are first-class service stations in Trinidad and Tobago.

The results of the measurements may be evaluated as follows. The measured concentrations of hydrocarbon vapor are all low. The odor is not conspicuously felt. The observed conditions of hydrocarbon emission are even better than average conditions of service stations in Japan. This is presumably because, in Trinidad and Tobago, one refueling is only five to 10 TT$ equivalent of gasoline and refueling is done in a matter of one to two minutes. There is not really enough time for a large amount of vapor to be released to the atmosphere. The service stations do not really contribute much to air pollution.

The service stations are doing nothing but providing a conventional 200-liter drum. New drums are being manufactured for this purpose. They are designed to be emptied only by vacuum cars to prevent stealing. These drums have not been delivered to the service stations, according to NPMC.

12-4 Conclusion

Not as much spent lubricating oil is released to the environment as may be imagined from total consumption. Much automotive lubricating oil is burned in use or utilized by the consumers. The effect on environmental pollution is not as serious as other forms of petroleum pollution. The hydrocarbon vapor released to the atmosphere is not as serious a problem as other types of petroleum pollution. Although the spent lubricating oil does not present an imminent threat to the environment, it is recommended that spent lubricating oil be recovered and utilized effectively in an environmentally benign manner.

Chapter 13 Petroleum Wastes

Chapter 13 Petroleum Wastes

13-1 Petroleum Waste Disposal Management

13-1-1 Present Situation

(1) Outline

There is no regulation or standard on waste disposal in Trinidad and Tobago at this moment. Wastes are disposed of into earthen pits and in landfill areas. Oily sludges are dumped into earthen pits but cannot be dumped in landfill areas; however, the sand containing spilled oil can be disposed of in landfill areas. Toxic and hazardous materials are also disposed of in landfill areas since there is no treating facility in Trinidad and Tobago. Basically, landfill operations follow the "Marine debris action plan for the Caribbean".

The present situation of petroleum wastes disposal management in Point-a-Pierre Refinery, the onshore oil fields and the main storages are explained below.

1) Pointe-a-Pierre Refinery

The petroleum wastes in the refinery consist of oily sludges from equipment and tanks, those from waste water treatment facilities, solid wastes and spent catalysts. No detailed data are available about quantities and characteristics of these wastes.

(a) Oily sludge from equipment

Oily sludges generated in maintenance and cleaning work are disposed of into one of seven earthen pits. When a pit becomes full, it is buried and a new pit is dug.

Inspection and cleaning by opening process equipment is done every three years. Oily sludge from equipment is dumped into pits in the refinery.

Tanks are opened and maintained comprehensively every ten to fifteen years. However, when the service of a tank is changed, or some defects are found by inspection, or the level of bottom sludge has risen to just one foot below the suction nozzle, the tank is opened and cleaned. Oily sludges from tanks are also dumped into pits in the refinery.

(b) Oily sludge from waste water treatment facilities

When the bottom sludge accumulates to an intolerably high level, the API and other separators are cleaned. Oily sludges from the API and other separators are dumped into pits in the refinery.

(c) Solid wastes

Pieces of steel and glass, and kitchen garbage are dumped in landfill areas. There is no plant for recycling them now.

(d) Spent catalysts

Spent catalysts have been buried in the refinery area. During the last ten years, the quantity of spent catalysts has been reduced remarkably. Some of the spent catalysts are regenerated by the catalyst suppliers. The regenerated catalysts are being traded in the Latin American area.

(e) Middle layer emulsion in slop tank

The skimmed oil (oil: 46%, water: 53%, solid: 1%) from the API separators is pumped to the slop tanks where the slop is supposed to separate into three layers: oil, emulsion and water. The water is withdrawn from the tank and sent to the waste water treatment facilities. The oil is sent to a simple distillation column. Light ends of the oil are topped and the rest is blended in fuel oil. The emulsion in the middle layer is sent to another tank. The emulsion is very stable. The quantity of emulsion which has been accumulated for the past 40 years has reached 74,000 barrels and is still increasing. Recently, a project to treat this emulsion has been started.

2) Onshore oil field and main storage

There is a characteristic difference between the wastes generated in the refinery and those in the oil fields or main storages. The former contain toxic materials while the latter contain sand and silt. The petroleum wastes generated in the onshore oilfields and main storages are oily sludges. They come from the tanks and waste water treatment facilities. The total generation of wastes from the onshore oil fields and main storages is about 25,000 barrels per year.

(a) Oily sludge from tanks

Tanks are cleaned once a year. About 70 percent of the 25,000 barrels, or 17,500 barrels, are oily sludges from tanks. Sludges are raked out manually and dumped into pits dug adjacent to the tanks. The density and composition of the sludges are typically as follows:

Density, kg/m^3	1,329
Hydrocarbons, %	18.9

Chlorine, mg/kg	2,130
Sediments, wt%	46.4
Water, wt%	34.7

(b) Oily sludge from API separators and tanks

When the level of bottom sludge of earthen pits and skimmer pits reaches a certain predetermined level, the API and other separators are cleaned. About 30 percent of the 25,000 barrels, or 7,500 barrels, are oily sludges raked out from tanks. The density and composition of the oily sludge are shown below.

Density, kg/m^3	1,730
Hydrocarbons, %	14.2
Chlorine, mg/kg	65
Sediments, wt%	65
Water, wt%	20.8

(2) Ongoing Program

1) Waste disposal management program

A new program for managing waste disposal is underway. The main pillars of the program are as follows:

1. Minimization
2. Recycling
3. Reuse
4. Disposal after treatment.

The following treatment methods are being considered:

1. Bio-remediation
2. Centrifugal separation
3. Incineration.

Bio-remediation is being planned within the context of landfarming. The landfarming is based on TEXACO technology. This concept consists of treating oily sludges by natural bacteria within a five-acre rectangular area on the ground. Four landfarming areas are planned. One is planned to be located in the refinery and others will be in the onshore oil fields.

Centrifugal separation aims to minimize wastes. After separation, the sludges are solidified with cement and disposed of. Incineration means to burn the wastes in a kiln. The idea is to lease a kiln of VESTA Technology Ltd. for a certain period of time.

2) Spent lubricating oil recovery from service stations

A test program is underway. Spent lubricating oils from 25 service stations are collected and stored in a slop tank in Pointe-a-Pierre Refinery. They are blended in the crude oil and treated with it as if they were a crude oil component. The amount of the spent lubricating oil treated in the refinery is 5 to 10 barrels per month. The refinery plans to extend this treatment program to all service stations by 1997. Trinidad and Tobago produces 57,000 barrels of lubricating oil per year and imports 24,600 barrels per year.

13-2 Major Findings

13-2-1 Environmental Pollution by Petroleum Wastes

Characteristics and quantities of the petroleum wastes from the refinery and onshore oilfields and tank farms are reviewed above. These wastes are disposed of in earthen pits and buried. Such a practice does not seem to be regarded as a threat to the environment, because these pits are located sufficiently far from residential areas and there is more land to dig pits. If such a practice should continue, however, pollution of far more serious nature could result. There is a likelihood of soil contaminations, contamination of underground water, and oil in the pits overflowing to rivers or even to the sea in case of heavy rains.

13-2-2 Lack of Data about of Petroleum Wastes

Data and information on varieties, characteristics and quantities of wastes are necessary for planning their disposal. There are insufficient data about wastes from the onshore oilfields, tank farms, and refinery. Systematic data collection is necessary.

13-3 Future Prospects

13-3-1 Reduction of Tank Sludge

When tanks for crude oil and heavy oil in a refinery are cleaned, normally the quantity of oily bottom sludge is reduced by recovering oil contained in the sludge. This can be done in the preparation stage by heating tanks and/or introducing solvents into tanks. Under a circumstance in which it is necessary to withdraw sludge without enough prior recovery of oil, the oil can be recovered from the withdrawn sludge by employing a decanter.

13-3-2 Disposal of the Middle Layer Emulsion in a Slop Tank

It is generally accepted that the cheapest way to treat an emulsion which contains more than 10 percent water is to incinerate it without treatment. This reports recommends incineration of such emulsions.

13-3-3 Treatment of Oil-contaminated Soil

Cases of soil contamination by oil may be broadly broken down into two types by source. One is caused by oil diffusing from earthen pits where oily sludges from tanks and API separators are disposed of. The other is caused by leakage from petroleum pipes and facilities. Treatment of oil-contaminated soil by landfarming is being planned at present. The treatment would take too long, because the plan depends upon natural bacteria. More efficient methods of landfarming using effective bio-remediation agents should be studied.

13-3-4 Treatment of Scum from Pressurized-air Flotation Separator

The results of the study indicate that dissolved air flotation with coagulation is needed in Pointe-a-Pierre Refinery and Bernstein Main Storage. This method would produce a large amount of scum, an additional oily waste. The only proper way to dispose of the scum would be to incinerate it after dehydrating it to reduce the volume. The ash can be solidified by cement and used for reclamation.

13-3-5 Treatment of Spent Lubricating Oil in the Refinery

Spent lubricating oil ranging in volume from 5 to 10 barrels per month is fed to one of the crude oil distillation units. Such an operation would become difficult when the spent lubricating oil to be treated increases, because of the additives and similar substances contained in the lubricating oil, which could possibly poison the catalysts. If such is the case, it would be better to burn the spent lubricating oil in an incinerator as auxiliary fuel.

13-4 Concept of Petroleum Waste Treatment Center

13-4-1 Background

In Japan, oil-containing wastes must be incinerated. Disposal of such wastes in an open dumping area or as landfill is prohibited by law. In Trinidad and Tobago, the present practice of dumping them into open pits or using them for landfilling is also not justifiable. In addition to the variety of oily wastes presently generated, a large amount of scum would be routinely produced. This is the background behind the concept of the Petroleum Waste Treatment Centers which incinerate the oily wastes, including the middle-layer emulsion as an auxiliary fuel, thereby contributing to protection of the environment.

13-4-2 Location of the Petroleum Waste Treatment Centers

In consideration of the transportation cost of wastes, one of the centers is located in Pointe-a-Pierre Refinery and the other is in Bernstein Main Storage.

13-4-3 Outline of Petroleum Waste Treatment Center

(1) Waste Treatment Center in Pointe-a-Pierre Refinery

1) Wastes to be Treated

The center would treat the very stable emulsions accumulated in the slop tanks, the waste from waste water treatment systems and solid oily sludges from tanks.

2) Configuration of Facilities at the Center

The scums generated by the dissolved air flotation with coagulation is dehydrated by a vacuum filter. The cake thus obtained is fed to the incinerator. The middle-layer emulsion is rid of free water and fed to the incinerator. Other oil-stained wastes are also burned by this incinerator. The ash from the incinerator is disposed of as it is or dumped for landfilling after being solidified with cement.

3) Scale of the Center

The conceptual flow and material balance of the waste treatment center are shown in Chapter 21, "Conceptual Design." Reference should be made to Figure 21-1. The incinerator will burn 14 tons per day of the scum cake from the dissolved air flotation with coagulation and five tons per day of the emulsion. The ash from the incinerator is about 1.3 tons per day.

(2) Wastes Treatment Center in Bernstein Main Storage

1) Wastes to be Treated

Very stable emulsions accumulated in slop tanks, wastes from waste water treatment facilities and solid oily wastes are treated.

2) Configuration of Facilities at the Center

The scum from the dissolved air flotation with coagulation is stored in a pit, then dehydrated by a vacuum filter and fed to the incinerator. The emulsion is burned as it is as an auxiliary fuel. Other oil-stained wastes are also incinerated. The ash from the incinerator is disposed of as it is or dumped for landfilling after being solidified with cement.

3) Scale of the Center

The conceptual flow and material balance of the waste treatment center are shown in Chapter 21, "Conceptual Design." Reference should be made to Figure 21-2. The incinerator burns 55 tons per day of scum cake from the dissolved air flotation with coagulation and 11 tons per day of emulsion. The ash from the incinerator is about five tons per day.

13-5 Conclusion

The present practice of dumping the wastes in pits and burying them without any treatment should be banned as soon as possible to prevent environmental pollution. Some of the petroleum wastes contain much oil. When dissolved air flotation with coagulation is introduced to the waste water treatment system, a large volume of scum is produced. The scum has to be incinerated. The tough emulsion that accumulates in the slop tanks should also be incinerated. Incineration would be the most economical way of disposing of such an emulsion. This is the background against which the Waste Treatment Centers have been conceived. The purpose is dual; effective recovery of oil from the wastes and prevention of pollution by petroleum.

As recommended by the study team, Trinidad Cement Limited is studying the possibility of burning in their kilns the emulsion as fuel and feeding the scums from the dissolved air flotation with coagulation as a feed supplement. If one or both of them are found to be feasible, this would contribute to effective utilization of the unused resources and reduction of the incinerator capacity.

Chapter 14 Soil Contamination

Chapter 14 Soil Contamination

14-1 Soil Contamination by Petroleum

14-1-1 Present Condition of Soil Contamination

(1) Soil Contamination by Petroleum Wastes

As stated in Chapter 13, the petroleum wastes generated at Pointe-a-Pierre Refinery and onshore oilfield tank farms are often dumped in open earthen pits. The earthen pits are afterward reclaimed, leaving the wastes buried underground. Such a practice is not clearly classified as a potential threat of pollution to the environment, because those pits are located remote from residential areas and there is plenty of more vacant land to dig pits.

(2) Soil Contamination by Oil Leakage from Pipelines

The other cause of soil contamination is leakage of oil from pipes or valves. Leakage takes place from pipelines in the refinery, in the tank farms and between the refinery and the tank farms. The amount of oil actually leaking is not great, because leakage is repaired as quickly as it is found. However, oil-contaminated soil is left untreated. Soils obviously contaminated by leakage of oil are seen in the refinery, onshore oil fields and tank farms.

14-1-2 Future Prospects

If the practice of disposing of petroleum wastes in open pits is allowed to continue and contaminated soils by leaking oil from pipelines and others remain untreated, more serious cases of secondary pollution could result. Such cases could cause contamination of underground water and overflowing of the pits in the case of heavy downpour, which would wash the petroleum wastes to the rivers as far as the sea.

To forestall such occurrences, it would be practical not to dump the oily wastes in open earthen pits but to incinerate them after recovering as much oil from them as possible. In an intermediate period before such a provision is made, a concept of landfarming now being promoted by Petrotrin should be positively promoted. By this an already commercialized bio-remediation agent is applied to rapid bio-degradation of organic contaminants. To promptly cope with leakages of oil from pipelines, an appropriate agent, the DCR agent mentioned later for example, could be applied as an emergency measure to rapidly confine the spilled oil where it is;

thereafter soils could be treated by landfarming.

14-1-3 Soil Rehabilitation Technology

The study team carried out experiments during the second field survey on a number of legitimate samples using two soil rehabilitation technologies. One of them is a bio-remediation technology using Oppenheimer Formula. The other is a rehabilitation technology using Dispersion by Chemical Reaction (DCR) system.

(1) Oppenheimer Formula

The Oppenheimer Formula is a bio-remediation agent capable of degrading certain organic contaminants, mineral oils in particular, with the active ingredient being an enzymatic mixture of active natural hydrocarbon-oxidizing single-celled organisms. The enzymes and cells are impregnated in an inert preparation of a naturally occurring clay. The mixture has no adverse chemical effect. This formula was invented by Dr. Carl H. Oppenheimer, of University of Texas, and registered with the U.S. Environmental Protection Agency.

(2) DCR System

The DCR system was invented and developed by Prof. Boelsing of the Federal Republic of Germany and patented in Europe, Canada, the U.S.A. and Japan.

The composition of the DCR agent is similar to Portland cement. The main component is calcium oxide, CaO. When CaO reacts with water, H_2O, $Ca(OH)_2$ is formed in an exothermic reaction. $Ca(OH)_2$ becomes very fine particles which have surface area about one million times as large as that of CaO and hence becomes able to absorb a large amount of oil. The DCR agent is a white powder coated with (a) fatty acid(s) which control(s) the exothermic reaction.

14-2 Soil Rehabilitation Tests

14-2-1 Purpose of Tests

The study team conducted soil rehabilitation tests during the second field survey. The purpose of the tests is to evaluate the effects of the two methods on samples of oil-contaminated soils. The tests continued over a period of three weeks. During the test period the samples were closely observed for changes every week. The contents of oil in water used to extract oil from the soil samples were measured before and after the test.

14-2-2 Samples for Tests

Samples were taken from three points at the following locations. The quantity of each sample was about 500 milliliters.

	Sample name
Earthen pit at Penal:	A1, A2, A3
Dump site at Bernstein Main Storage:	B1, B2, B3
Earthen pit in Pointe-a-Pierre Refinery:	C1, C2, C3

14-2-3 Test Schedule

The tests were done according to the following schedule:

Visual observation
+ Oil content measurement

Agent	Sample Name	Feb. 25	Mar. 04	Mar. 11	Mar. 15
Oppenheimer Formula	A1	# +	#	#	# +
	A2	# +	#	#	# +
	A3	# +	#	#	# +
	B1	# +	#	#	# +
	B2	# +	#	#	# +
	B3	# +	#	#	# +
	C1	# +	#	#	# +
	C2	# +	#	#	# +
	C3	# +	#	#	# +

Agent	Sample Name	Feb. 25	Mar. 04	Mar. 11	Mar. 15
DCR system	A1-1*	#			# +
	A1-2*	#			# +
	A1-3*	#			# +
	B1-1*	#			# +
	B1-2*	#			# +
	B1-3*	#			# +
	C1-1*	#			# +
	C1-2*	#			# +
	C3-3*	#			# +

Note: The samples with asterisks were tested with varying dosages as shown below.

A1-1* Sample/DCR agent = 100g/ 100g

A1-2*	Sample/DCR agent =	100g/ 66g
A1-3*	Sample/DCR agent =	100g/ 33g
B1-1*	Sample/DCR agent =	100g/ 100g
B1-2*	Sample/DCR agent =	100g/ 66g
B1-3*	Sample/DCR agent =	100g/ 33g
C1-1*	Sample/DCR agent =	100g/ 100g
C1-2*	Sample/DCR agent =	100g/ 66g
C3-3*	Sample/DCR agent =	100g/ 33g

14-2-4 Procedure for Tests

(1) Test Procedure for Oppenheimer Formula (OF Agent)

1. Put 2g of the OF agent into a 1,000ml beaker and add 800ml of distilled water.
2. Add 0.8ml of a compound liquid fertilizer (N:P:K=10:3:3).
3. Aerate the sample by an air pump for 3 hours.
4. During the aeration, put 500ml of each soil sample into a 1,000ml beaker and mix each soil sample (A1, A2, A3, B1, B2, B3, C1, C2, C3). Take 20g soil from each sample (original soil sample).
5. After 3 hours of aeration, add 200ml of sawdust into the bio-solution and mix.
6. Add 20ml of the bio-solution to each soil sample and mix.
7. Transfer each soil sample to a vat (200 x 300 x 30mm) and spread it.
8. Two days later, add 60g of a slow-acting fertilizer (organic fertilizer) to each sample and mix.
9. Visually observe each sample one week later, two weeks later and three weeks later. And take 20g soil from each sample three weeks later (treated soil sample).
10. Measure oil content in water after extracting oil by water from the original soil samples and the treated soil samples.

(2) Test Procedure for DCR System (DCR agent)

1. Take 20g each from well-mixed original soil samples (A1, B1, C1) to be used for measurement of oil content.
2. Take three 100g soil samples from Sample A1. Put each 100g soil sample into a 1,000ml beaker and add 100g, 66g, 33g of the DCR agent to each of the three beakers, respectively.
3. Add 5ml water into a beaker to which has been added 100g of the DCR agent, and vigorously mix the soil with the DCR agent for 2 minutes using a hand-mixer.

4. Observe the exothermic reaction.
5. Repeat steps 3 and 4 with a beaker to which has been added 66g of the DCR agent.
6. Repeat step 5 with a beaker to which has been added 33g of the DCR agent.
7. Repeat steps 3 to 6 for Samples B1 and C1.
8. Visually observe each sample one week, two weeks and three weeks afterward. Take 20g of soil from each sample three weeks later (treated soil sample).
9. Extract oil with water from the treated oil samples and the original control soil samples. Measure oil content in the water used for extracting oil.

14-2-5 Test Results

(1) Test Results of Oppenheimer Formula

By visual observation, a sign of change was noticed after two weeks from the start. Certain edges of the soil lumps, especially Samples B2, C2, C3, changed color to yellow. Other soil samples did not exhibit any change in color even after 18 days. All the samples became less sticky and lumps of the sample became more brittle. These changes indicated that the oil content had decreased.

The results of measurement of oil content in the water used for extracting oil from the original soil samples and from treated soil samples are shown below. The oil content in the water after extracting oil from the soil were measured instead of the total oil content in soil. The oil content was measured by the n-hexane extraction method specified in the Japanese Industrial Standard (JIS). Table 14-1 shows the results of such tests.

Table 14-1 Test of the Effect of OF Agent

(Unit: ppm)

Sample	Oil Content in Water Sample of Feb. 25 (Original control sample)	Oil Content in Water Sample of Mar. 15 (Treated Sample)
A1	36	8
A2	28	11
A3	35	19
B1	80	32
B2	130	13
B3	11	16

Sample	Oil Content in Water Sample of Feb. 25 (Original control sample)	Oil Content in Water Sample of Mar. 15 (Treated Sample)
C1	146	72
C2	61	21
C3	99	43

Source: Study team

(2) Test Results of DCR System

As soon as water was added to a beaker containing a soil sample and the DCR agent and mixed by a hand-mixer, heat was generated by the exothermic reaction and water was quickly evaporated. The soil eventually became fine powder. The powder did not smell of oil.

Tests were carried out at three addition rates of the DCR agent. Even at the lowest addition rate, (Sample/DCR agent = 100g/33g), satisfactory results were obtained, as evaluated by visual observation and smell.

It may be considered that the powdered soil does not easily release oil. To confirm this, the oil contents in water after extracting oil from the treated soil samples were measured by the n-hexane extraction method. Table 14-2 shows the results of this test.

Table 14-2 Test Results of DCR System

Oil content in water (ppm)

Sample	Oil Content in Water Sample of Feb. 25 (Original control sample)	Oil Content in Water Sample of Mar. 15 (Treated sample)
A1-1/ A1-2/ A1-3	36	27 /13 /16
B1-1/ B1-2/ B1-3	80	24 /29 /26
C1-1/ C1-2/ C1-3	146	28 /25 /35

Source: Study team

14-3 Major Findings by Soil Rehabilitation Tests

14-3-1 Tests of Oppenheimer Formula (OF agent)

Unlike other methods, bio-treatment is inherently slow; therefore, it is difficult to confirm by visual observation its effects on oil-contaminated soil. However, it could be surmised in these series of tests that the oil contents of the sample soils were reduced to 20 to 50 percent of the original content in about three weeks, on the basis of the oil content of water used for extracting oil from the samples. In a natural environment, such degrees of reduction can only be expected over much longer periods, say six months or a year or even longer. Therefore, the quickness of the effects of Oppenheimer Formula may be considered to have been demonstrated.

However, the rather low oil content of the original control samples could be interpreted as suggesting that the oil in the soil samples had already been subjected to bio-degradation which took place over long periods of time during which the wastes resided there, by naturally occurring bacteria thriving in the earthen pits or dump sites. It is not established therefore that high reduction rates similar to those achieved by these experiments are obtainable by the OF agent for soils containing oil at high content.

14-3-2 Tests of DCR System (DCR agent)

One of the merits of the DCR agent is its ability to quickly convert oil-contaminated soils into harmless white powders. In the beaker tests, the soil samples containing little moisture were instantaneously converted and those containing more moisture were converted in a matter of a few minutes. When the addition rate of the DCR agent was reduced, the treated soils showed a slightly brown color and the odor of petroleum was conspicuously perceived.

The oil contents of the water after extracting oil from the treated soil were measured to be about 25 ppm in all cases. The measured oil content probably includes fatty acid(s) extracted from the DCR agent; the fact that the measured oil content remains constant irrespective of the oil contents of the soil samples may be taken to indicate that oil is firmly affixed to the treated soil.

14-4 Major Issues on Soil Rehabilitation

One of the major issues in soil rehabilitation is the cost of the agent used. It would cost much less to dispose of oil-contaminated soils by dumping them into earthen pits and to reclaim the pits after leaving them for quite a long time than to use any agent. Whether or not the government exercises tough policies toward environmental pollution problems holds the key to the issue of soil rehabilitation.

Information on the costs of the agents used in the experiments would be of value.

14-4-1 Oppenheimer Formula (OF Agent)

In order to treat about 10 cubic meters of oil-contaminated soil, one kilogram of the OF agent is required. The price of the OF agent is 1,250 TT Dollars per kilogram. In addition, other costs such as transportation cost of the agent, the cost of the nutrients for bacteria, that of watering to give moisture to the bacteria and that of mixing soils to supply oxygen to bacteria should be considered.

14-4-2 DCR System (DCR Agent)

As shown by the results of the tests, use of the DCR agent produced satisfactory results even at a reduced addition rate of 33g to 100g of soil. It may be supposed, subject to confirmation by an actual test, that the addition rate could be reduced as low as to 10g to 100g soil, or 1 kilogram to 10 kilograms soil. The price of the DCR agent is 3 TT Dollars per kilogram. The cost of mixing soils with the agent should be accounted for.

14-5 Conclusion

If the present practice of disposing of petroleum wastes by dumping them in open earthen pits is allowed to continue and contamination caused by leakage from pipelines is left unattended, such secondary pollution as contamination of the underground water and overflowing of the oil from the pits to the rivers as far down as the sea in case of heavy rains would be the likely consequences. To prevent such oil contamination, it would be most practical to incinerate the oily waste after recovering as much oil from it as possible.

In a transition period before the concept of a Waste Treatment Center equipped with incinerators is realized, application of landfarming using commercialized bio-remediation agents such as Oppenheimer Formula should be seriously considered. As a means of promptly coping with soil contamination by oil leakage from pipelines, the DCR agent could be effectively applied to confine oil in the soil in case of emergency. The soil should be treated afterward by landfarming.

It is very important in bio-remediation that the bacteria be well taken care of by being given a comfortable environment where they can thrive and multiply well. A comfortable environment means that the soils should have adequate supplies of nutrients, moisture, and oxygen. This can definitely be regarded as farming.

In application of the DCR system it should always be kept in mind that the maximum effects should be drawn from a minimum of the agent. In case that oil-contaminated soil is soaked in water, the DCR agent should be applied to soil after water and floating oil have been thoroughly removed by a vacuum truck. The supplier of the DCR system claims that oil, once treated by this system, will not be leached by water. However, such a possibility cannot be completely ruled out. Therefore, as mentioned above, it would give a more reliable result if the DCR-treated soil is treated further by the landfarming. Alternatively, the DCR-treated soil can be better utilized as auxiliary fuel for incinerators.

Chapter 15 Accidental Oil Pollution

Chapter 15 Accidental Oil Pollution

15-1 Facilities Vulnerable to Accidental Oil Pollutions

15-1-1 Petrotrin's Cases

Petrotrin's reports and statistics of accidents describe various types of oil pollution associated with accidents. The most frequent are oil spills from pipelines such as flow lines and trunk lines. The spills are mostly from pinholes resulting from corrosion or disconnections of screw-type nipples and elbows, caused mainly by damage to screw-threads by corrosion. Some are caused by stolen fittings. Next come overflows from tanks caused by errors in valve operation and sudden stops of pumps by drops in voltage. There are some cases of oil leakage from small cleavages on the tank bottom plate.

In a tank accident in the refinery, 6,200 barrels of heavy oil was reportedly spilled to the sea from cracks resulting from uneven settlement of a tank. This is the single largest oil accident in Trinidad and Tobago. Another large accident is overflow from oily pits in a heavy rain. Although such accidents are not frequent, they presumably have happened more than are officially reported.

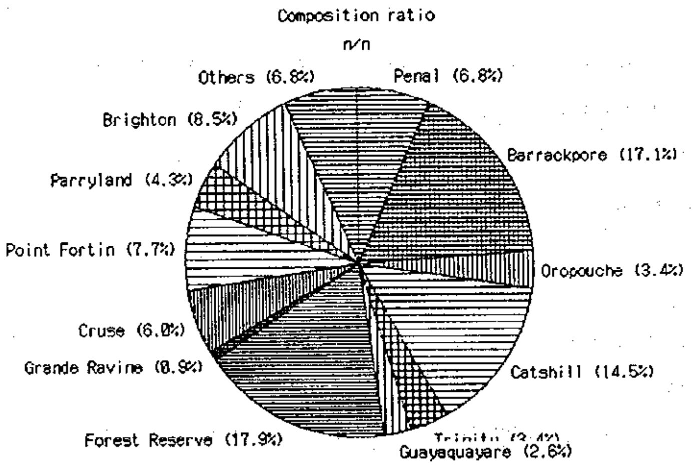
In an accident in an onshore oilfield, the gaskets on the stuffing boxes of certain Christmas trees and BOPs (Blow Out Preventers) at a well head ruptured. Another example is overflow from an intermediate tank on a marine platform. Petrotrin's accident statistics are shown in Figure 15-1.

15-1-2 Accidents with Serious Oil Pollution

Oil spills on rivers and the sea generally inflict serious damage on the environment. Once oil is spilled to the sea, it disperses very rapidly and spreads. There are difficulties peculiar to marine oil pollution, not encountered onshore.

Field	Nos. of Incidents				Volume of Oil spills(bbls)			
	1991	1992	1993	Total	1991	1992	1993	Total
Penal	4	2	2	8	125	38	31	194
Barrackpore	9	6	5	20	311	407	92	810
Oropouche	2	1	1	4	25	80	10	115
Catshill	2	3	12	17	30	50	245	325
Trinity	2	1	1	4	60	12	20	92
Guayaquayare	1	2	0	3	100	45	0	145
Forest Reserve	7	7	7	21	150	190	420	760
Grande Ravine	0	0	1	1	0	0	15	15
Cruse	0	7	0	7	0	222	0	222
Point Fortin	5	1	3	9	95	10	42	147
Parryland	0	2	3	5	0	40	65	105
Brighton	2	3	5	10	75	170	202	447
Others	3	2	3	8	95	54	49	198
Total	37	37	43	117	1066	1318	1191	3575

Note: Oil spill incidents below 10 bbls are crossed off this list.



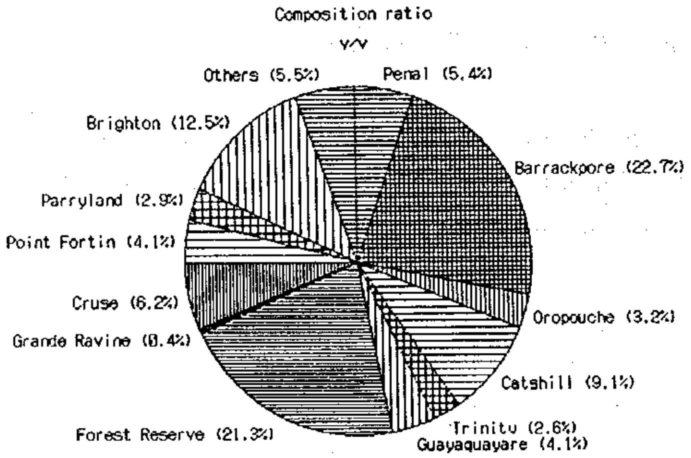


Figure 15-1 Oil Spills by Field

Table 15-1 Oil Spills on Production Fields in Recent Years (1/9)

PETROTRIN Western Disrict (Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
91/01/15	P/Seco	Flowline	Leaked due to corrosion.	30.00	28.00	2.00
91/03/07	P/Fortin	2" Line	Stolen.	20.00	18.00	2.00
91/03/19	P/Fortin	2" Casing valve	Left open.	15.00	13.00	2.00
91/03/19	F/Reserve	100 lb Tank	Overflowed.	15.00	15.00	0.00
91/04/27	F/Reserve	Dogleg Tank	Oil escape.	30.00	0.00	30.00
91/04/29	P/Fortin	Flowline	Stolen.	15.00	12.00	3.00
91/04/30	P/Fortin	2" Line	Stolen.	20.00	18.00	2.00
91/05/21	B'Ton	Bulk Tank	Overflowed(Marine platform #1).	40.00	0.00	40.00
91/05/26	F/Reserve	BOP on Wellhead	Gasket blown.	15.00	0.00	15.00
91/06/11	P/Seco	Storage Tank	Overflowed.	16.00	15.00	1.00
91/06/14	F/Reserve	Manifold	Cut.	10.00	10.00	0.00
91/08/12	P/Fortin	2" Flowline	Leaked due to corrosion.	25.00	25.00	0.00
91/08/17	F/Reserve	Header	FR gassed out Header.	10.00	9.00	1.00
91/09/05	F/Reserve	Bulk Tank	Leaked.	20.00	20.00	0.00
91/10/04	B'Ton	Bulk storage Tank	Burst.	35.00	12.00	23.00
91/10/21	F/Reserve	6" Storage line	Leaked.	50.00	48.00	2.00
91/01～91/12	Miscellaneous	No. of Spills :	24	86.00	35.00	51.00
		Total No. of Spills :	40	452.00	278.00	174.00

Source: Oil Pollution Report 1991～1993, Production Department, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (2/9)

PETROTRIN Western Disrict (Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
92/01/15	F/Reserve	4" Storage line	Leaked.	15.00	14.00	1.00
92/01/20	B'Ton	Transfer Pump	Malfunctioned.	35.00	0.00	35.00
92/02/19	F/Reserve	Storage Line	Leaked.	40.00	38.00	2.00
92/03/15	F/Reserve	Tanks	Overflowed.	30.00	30.00	0.00
92/03/29	B'Ton	250 bbl Tanks	Overflowed.	35.00	35.00	0.00
92/06/02	Cruse	Flowline	Leaked.	25.00	25.00	0.00
92/06/13	Cruse	Flowline	Leaked.	20.00	20.00	0.00
92/06/28	F/Reserve	1000 bbl Tank	Overflowed.	20.00	20.00	0.00
92/07/05	P/Seco	500 bbl Tank	Overflowed.	20.00	19.50	0.50
92/07/19	F/Reserve	Manifold	Gassed out.	60.00	57.00	3.00
92/07/23	Cruse	500 bbl Tank	Overflowed.	50.00	50.00	0.00
92/08/21	P'Land	Tank	Bleed line found open.	20.00	20.00	0.00
92/08/26	P'Land	Flowline	5 JTS 2" flowline stolen.	20.00	15.00	5.00
92/09/12	Cruse	Wash Tank	Bleed valve open.	30.00	30.00	0.00
92/09/20	Cruse	Tank	Punctured.	32.00	12.00	20.00
92/10/08	P/Fortin	Tanks	Overflowed.	10.00	10.00	0.00
92/10/14	F/Reserve	Casing of FR	Casing blew.	15.00	12.00	3.00
92/10/27	Cruse	Wellhead	Mist spray of oil/gas/mud.	25.00	10.00	15.00
92/10/28	Cruse	Elbows on Flowline	Oil/sand/mud sprayed. through 3 cut elbows.	40.00	35.00	5.00
92/11/20	F/Reserve	Tank	Header opened in error.	10.00	10.00	0.00
92/11/20	B'Ton	Tank	Low voltage-Pump failed to causing tank to overflowed.	100.00	90.00	10.00
92/12/08	P/Seco	Flowline	Bursted 2" flowline.	34.00	32.00	2.00
92/01～92/12	Miscellaneous	No. of Spills :	36	90.00	40.50	49.50
		Total No. of Spills :	58	756.00	610.00	146.00

Source: Oil Pollution Report 1991～1993, Production Department, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (3/9)

PETROTRIN Western Disrict (Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
93/01/09	P/Fortin	2" Test line	Leaked.	20.00	20.00	0.00
93/01/13	P'Land	Line to pit	Check valve malfunction.	30.00	28.00	2.00
93/01/27	B'Ton	2" Discharge hose	Pump discharge hose burst spilling oil into the sea.	60.00	0.00	60.00
93/01/29	P/Seco	Storage line	Develop leaks while pumping.	10.25	9.00	1.25
93/02/11	F/Reserve	4" Discharge line	Leaked.	10.00	0.00	10.00
93/03/02	P'Land	2" Bleed line	Bleed line was found opened.	25.00	23.00	2.00
93/04/27	P/Fortin	4" Gate valve	Valve was discovered opened.	10.00	8.00	2.00
93/05/20	F/Reserve	2" Bleed	Bleed on tank was found opened and bleeding oil to drain.	50.00	48.00	2.00
93/06/23	B'Ton	6" Flowline	Oil seepage through holes in rotten section of line.	60.00	0.00	60.00
93/07/03	F/Reserve	Tanks	Overflowed.	15.00	15.00	0.00
93/08/13	B'Ton	4" Storage line	Leaks discovered on storage line causing oil to spill into sea.	20.00	0.00	20.00
93/08/14	B'Ton	3" and 6" line	Leaks discovered on lines causing oil to spill into sea.	30.00	0.00	30.00
93/08/26	P/Seco	2" Flowline	Leaked.	10.00	0.00	10.00
93/08/30	F/Reserve	Tanks	Automatic pumping system failed causing tanks to overflow.	160.00	160.00	0.00
93/09/02	B'Ton	6" line	Corroded line.	32.00	0.00	32.00
93/10/02	F/Reserve	Tank	Corroded line.	150.00	150.00	0.00
93/10/12	F/Reserve	Storage line	Union on storage line stripped.	20.00	19.00	1.00
93/11/15	G/Ravine	Joints	Corroded joints.	15.00	14.00	1.00
93/11/16	P'Land	Casing	Oil spill on location due to casing left venting.	10.00	5.00	5.00
93/12/16	P/Fortin	Joint	Oil spilled from joint gasket during pumping operations.	12.00	8.00	4.00
93/12/19	F/Reserve	4" Storage line	Leaked.	15.00	14.00	1.00
93/01～93/12	Miscellaneous	No. of Spills :	20	53.85	26.75	27.10
		Total No. of Spills :	41	818.10	547.75	270.35

Source: Oil Pollution Report 1991～1993, Production Department, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (4/9)

PETROTRIN Eastern Disrict (Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
91/01/17	Penal	Main storage tank	Hole developed in base of tank.	80.00	80.00	0.00
91/02/16	G'Yare	Bleed valve on tank	Stuck in open position while bleeding.	100.00	98.00	2.00
91/02/22	B'Pore	500 bbl bulk tank	Hole developed in base of tank.	21.00	20.50	0.50
91/03/17	B'Pore	Wash tank	Dog leg bled oil which overflowed drain.	140.00	139.00	1.00
91/03/22	B'Pore	MR-372 Starter	RAG placed under starter and ignited.	10.00	10.00	0.00
91/04/04	Trinity	Old well in forest	Sporadic emission from old well.	50.00	50.00	0.00
91/04/15	B'Pore	Line to pit	Oil leaked thru. valve, pit overflowed.	30.00	30.00	0.00
91/04/22	B'Pore	3" Pump line	Leak developed on line.	10.00	8.00	2.00
91/07/08	B'Pore	4" Pump line	Leak developed on line-corroded.	30.00	28.00	2.00
91/07/24	B'Pore	2" Flowline	Leak developed on line.	10.00	9.50	0.50
91/08/02	B'Pore	CSG valve	Crude oil escaped from vented CSG valve.	35.00	33.00	2.00
91/09/06	Oropouche	Stuffing box	Developed leak.	10.00	9.50	0.50
91/09/15	MD Sifaria	500 bbl tank	Tank overflowed while recycling from 250 bbl tank.	49.00	47.00	2.00
91/09/20	B'Pore	Test tank	R/Valve on test lift & tank o/flow.	25.00	20.00	5.00
91/09/29	Oropouche	3" Pump line	Line developed leak.	15.00	15.00	0.00
91/10/01	Catshill	6" Pump line	Line developed leak.	20.00	19.00	1.00
91/10/05	Catshill	6" Pump line	Line developed leak.	10.00	9.70	0.30
91/10/06	Penal	Tank Vent pipe	Lightning struck above and was ignited.	10.00	10.00	0.00
91/11/11	Penal	4" Pump line	Line developed leak.	20.00	20.00	0.00
91/11/17	Triity	Tank	Tank overflowed.	10.00	10.00	0.00
91/12/10	Penal	Stuffing box of Pump	S/Box blew, oil sprayed on nearby surroundings.	15.00	15.00	0.00
91/01~91/12	Miscellaneous	No. of Spills :	127	216.70	162.90	53.80
		Total No. of Spills :	148	916.70	844.10	70.60

Source: Oil Pollution Report 1991~1993, Production Department, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (5/9)

PETROTRIN Eastern Disrict (Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
92/02/18	Penal	Tank	Leak developed at base tank.	25.00	25.00	0.00
92/03/11	Trinity	2" Flowline	Line developed a leak.	12.00	11.50	0.50
92/03/25	B'Pore	Tank	Sake overflowed.	10.00	9.50	0.50
92/05/25	Catshill	2" Flowline	Line developed a leak.	10.00	8.00	2.00
92/05/31	B'Pore	Pit	Pit & WTR Hydrant net open. oil flowed over to Dam.	300.00	300.00	0.00
92/07/06	G'Yare	Tank line	From previous spills, residue oil washed into river.	25.00	25.00	0.00
92/07/08	Penal	2" Flowline	Line developed a leak.	13.00	12.00	1.00
92/08/26	B'Pore	Pit	Oil seeped from abandoned waste oil pit.	12.00	10.00	2.00
92/09/17	B'Pore	Tanks	Bulk test tanks overflowed.	25.00	18.00	7.00
92/09/21	Cashill	6" Pump line	Line developed a leak.	20.00	18.00	2.00
92/10/09	B'Pore	Valve on pump discharge	Found open.	10.00	8.00	2.00
92/10/15	Oropouche	Pump line	Line developed a leak. Oil flowed into Canals in canefield.	80.00	78.00	2.00
92/10/18	B'Pore	Tank	Overflowed. Oil contained in drains and pits.	50.00	50.00	0.00
92/11/21	G'Yare	Tank	Overflowed. Slug on cond.& water from NGC caused crude to spill over.	20.00	16.00	4.00
92/11/24	Catshill	6" Pump line	Lined developed a leak.	20.00	18.00	2.00
92/01～92/12	Miscellaneous	No. of Spills :	121	232.60	172.40	60.20
		Total No. of Spills :	136	864.60	779.40	85.20

Source: Oil Pollution Report 1991～1993, Production Department, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (6/9)

PETROTRIN Eastern Disrict (Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
93/01/19	Catshill	CO-39 Casing	Casing kicked causing oil to spill on location area & pollution pit area.	20.00	20.00	0.00
93/01/19	B'Pore	Bleed valve on tank	Tank overflowed due to open valve.	12.00	6.00	6.00
93/02/08	Catshill	CO-10 Casing	Casing blew causing oil to spill on location, Pit and nearby vegetation.	15.00	15.00	0.00
93/02/15	B'Pore	Wilson STN Bleed valve	Valve was open causing oil to flow from pit into Waste Dam next to G/S.	35.00	35.00	0.00
93/02/18	B'Pore	Bleed valve on tank	xxxx open causing oil to flow into Pit and to Waste Dam.	15.00	15.00	0.00
93/05/19	Catshill	6" Flowline	Line developed a leak.	10.00	9.00	1.00
93/05/26	Catshill	2" Bleed valve	Found partially open. Oil contained in pit and cellars.	35.00	35.00	0.00
93/06/07	Catshill	6" Pump line	Line developed a leak.	50.00	50.00	0.00
93/07/05	Catshill	2" Flowline	Line developed a leak.	15.00	15.00	0.00
93/07/08	Catshill	6" Pumpaway line	Line developed a leak.	15.00	14.50	0.50
93/07/17	B'Pore	3" Flowline	Line developed a leak on Union.	20.00	19.00	1.00
93/08/27	Catshill	Test line on manifold	Line developed a leak.	10.00	0.00	10.00
93/09/14	Oropouche	4" Pumpline	Line developed a leak.	10.00	9.80	0.20
93/09/20	Catshill	Test line on manifold	Between CO-94 manifold and CO-88, 99 locked.	10.00	9.00	1.00
93/09/30	Catshill	Test line on manifold	Line developed a leak.	30.00	30.00	0.00
93/10/30	Inniss	Valve on manifold	Valve found open.	28.00	5.00	23.00
93/11/17	Penal	4" Pumpline	Line developed a leak.	10.00	9.50	0.50
93/11/25	B'Pore	Tank	Tank overflowed.	10.00	10.00	0.00
93/12/14	Catshill	6" Trunkline	Line developed a leak on corroded	10.00	10.00	0.00
93/12/15	Trinity	4" Pumpline	4" Union was stripped out.	20.00	20.00	0.00
93/12/24	Penal	F-122 Stuffing box	Box leaked spilling oil into cellar, pit and well site.	21.00	20.00	1.00
93/12/28	Catshill	6" Pumpline	Line leaked.	25.00	23.00	2.00
93/01～93/12	Miscellaneous	No. of Spills :	121	475.50	399.50	76.00
		Total No. of Spills :	143	901.50	779.30	122.20

Source: Oil Pollution Report 1991～1993, Production Department, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (7/9)

(Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
90/01/09	F/Reserve	8" Oil line	Leaked. TTPCL STN. Fyzabad.	50.00	25.00	25.00
90/01/12	Trinity	3" Oil line	Leaked. Pump line wayleave.	100.00	97.00	3.00
90/03/10	Penal	8" Oil line	Developed leak due to bush fire.	10.00	6.00	4.00
90/04/03	Penal	8" Oil line	Leaked. Well #153-F/Reserve.	50.00	46.00	4.00
90/05/04	Trinity	3" Oil line	Leaked. South of Edward TR.	150.00	79.00	71.00
90/05/07	F/Reserve	8" Oil line	Leaked due to external corrosion. Trinmar to F/Reserve.	20.00	0.00	20.00
90/05/20	G'Yare	8" Oil line	Leaked. Spilled into river. Sandy river.	158.00	58.00	100.00
90/05/25	Trinity	3" Trunk line	Leaked into corroded section. Trinity pump.	198.00	178.00	20.00
90/06/13	F/Reserve	8" Oil line	Leaked. FR-1522.	23.00	15.00	8.00
90/07/26	Oropouche	4" Oil line	Developed leak. Woodland manifold.	15.00	13.00	2.00
90/07/26	Oropouche	4" Oil line	Leaked. Manifold.	15.00	13.00	2.00
90/07/28	B'Pore	8" Oil line	Developed pin hole leak	25.00	0.00	25.00
90/08/17	S/F'que	8" Oil line F/R-PAP	Developed leak	10.00	6.00	4.00
90/09/25	F/Reserve	Oil line	Leaked due to external corrosion	70.00	66.00	4.00
90/01~90/12	Miscellaneous	No. of Spills :	48	378.50	314.40	64.10
		Total No. of Spills :	62	1,272.00	916.40	355.60

Source: Oil Pollution Report 1990~1992, Engineering Service, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (8/9)

(Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
91/01/25	P/Fortin	P/F-F/R 8" Line	Leak was observed.	16.00	15.00	1.00
91/02/08	G'Yare	8" GY-BP Oil line	Developed a leak. Edward trace.	60.00	1.00	59.00
91/02/25	Penal	12" Oil line F/R-PAP	Oil leaked while charging spool-line plg duck pond river.	377.00	347.00	30.00
91/03/26	Oropouche	4" Line M/Fold	Oil observed near line. Woodland.	45.00	41.00	4.00
91/04/08	G'Yare	8" GY-BP Oil line	Oil was lost and soaked into dry soil.	30.00	8.00	22.00
91/04/11	Trinity	3" Pump line-Trinity	Line developed a leak. Evaporation and Absorption.	75.00	0.00	75.00
91/08/15	B'Pore	6" Oil line	Oil leaked into nearby drains.	37.00	34.00	3.00
91/08/26	Penal	8" Oil line	Oil leaked into surrounding areas. Evaporation, Absorption, nearby streams.	300.00	91.00	209.00
91/09/12	F/Reserve	12" Oil line	Oil line developed leak. Some to Tulsa Dam	150.00	117.00	33.00
91/11/19	Brighton	6"/10" Oil line	Oil leak was observed.	215.00	210.00	5.00
91/01~91/12	Miscellaneous	No. of Spills :	35	91.00	32.80	58.20
		Total No. of Spills :	45	1,396.00	896.80	499.20

Source: Oil Pollution Report 1990~1992, Engineering Service, PETROTRIN

Table 15-1 Oil Spills on Production Fields in Recent Years (9/9)

(Unit: bbls)

Incident Date	Field	Facility	Description	Final amount spilled	Final amount recovered	Amount loss
92/01/13	Penal	6" EX Catshill line	Oil leak. R.Douglas RD.	38.70	38.00	0.70
92/04/22	G'Yare	8" Line G'Yare-B'Pore	Oil leak was observed. Edward Trace.	38.00	36.00	2.00
92/04/22	G'Yare	8" Oil line	Oil leak was observed. Penal R.R.	14.00	12.00	2.00
92/05/05	Penal	6" EX Catshill line	Oil leak was observed. Roch. D.RD.	10.00	9.00	1.00
92/05/06	Penal	6" Catshill line	Oil leak was observed. Roch. D.RD.	239.00	229.00	10.00
92/05/15	Penal	6" EX catshill line	Oil leak was observed. Roch. D.RD.	22.00	17.00	5.00
92/05/19	Pt.Fortin	8" Line Pt.Fortin-F/R	Oil leak was observed. Cruse E.	60.00	46.00	14.00
92/06/10	Pt.Fortin	8" Line Pt.Fortin-F/R	Oil leak was observed. Cruse E.	420.00	408.00	12.00
92/07/13	B'Pore	2 7/8 KPA Trunk line	Oil leak was observed. G.P. RD P-A-P.	30.00	25.00	5.00
92/07/15	TPL P-A-P	12" Oil line.	Oil escaped due to heavy rain during. slip blanking operation. Security RD.P-A-P.	186.00	171.00	15.00
92/08/06	Penal	W.D. Oil line	While cutting dead station-oil flowed out.	11.00	10.00	1.00
92/09/17	Oropouche	12" Line F/R to P-A-P	Oil leak was observed. Centered TR. Pluck RD.	363.00	353.00	10.00
92/10/05	F/Reserve	12" Line F/R to P-A-P	Oil leak was observed. Dome field.	36.00	26.00	10.00
92/11/06	F/Reserve	12" Line F/R to P-A-P	Oil leak was observed. West of Dome field.	292.00	287.00	5.00
92/01～92/12	Miscellaneous	No. of Spills :	37	87.80	31.50	56.30
		Total No. of Spills :	51	1,847.50	1,698.50	149.00

Source: Oil Pollution Report 1990～1992, Engineering Service, PETROTRIN

The two accidents which have caused the largest oil spills so far are a tanker accident and a tank accident. In the tanker accident, oil leaked from cracks in the hull caused by a collision, stranding or submergence. In the tank accident, oil overflowed or leaked from cleavages developed on the tank bottom plate. One ship ran into a pier and a piping broke due to an operational error during loading or unloading. An accident on a large trunk line could be serious, because it could lead to spillage of a large amount of oil.

Overflow from oily pits which hold sludge is serious, because it happens many times and the overflowing oil flows to the sea via rivers, contaminating the environment along the way.

15-1-3 Large-scale Oil Spill Accidents in the World

Table 15-2 shows large-scale oil spills which have happened recently in the world. Cases that led to serious accidents are mostly tanker accidents. Others are oil spills from tanks in the coastal industrial zones.

15-2 Major Issues with Petrotrin

In the operation of Petrotrin, there are situations that could lead to accidental pollution, specifically as follows:

1. The locations and the structures of the drainage trenches could allow storm water to flow to the process water streams. As a result, the API separators are overloaded and cannot perform as they should after rainfall.

2. Oil is drained with water from crude oil tanks. The oil is discharged with waste water to the Gulf of Paria via public rivers. The waste water contains oil in the form of a very stable emulsion that is not easily separable into oil and water.

3. Precipitation is about 1,800 millimeters per year. It pours frequently. When the API separators, oil-catches or rivers are flooded, floating oil is swept away to the sea.

Table 5-2 Recent Large-scale Oil Spills in the World

No.	Date (year/month)	Location	Source to Oil spill	Volume of Oil Spill
1	1967/03	Southern coast in England	The Torrey・Canyon (61,000G/T)	Crude oil about 93,000 kl
2	1970/02	Chedabucto Bay in Nova Scotia Canada	The Arrow (11,000G/T)	C Fuel oil about 10,000kl
3	1971/11	Off Niigata in Japan	The Juliana (11,000G/T)	Crude oil about 7,200kl
4	1974/12	Mizusima Bay in Japann	Heavy Fuel oil Tank (9,500kl)	Heavy Fuel oil about 7,500kl
5	1976/12	Off Massachusetts in the East U.S.A	The Argo・Merchant (19,000G/T)	C Fuel oil about 29,000kl
6	1978/03	Off Bretagne in the West France	The Amoco・Cadiz (110,000G/T)	Crude oil about 240,000kl
7	1989/03	North Pacific Coast in Alaska U.S.A	The Exxon・Valdez (95,000G/T)	Crude oil about 40,000kl
8	1992/09	North End in Malacca Str.	The Nagasaki・Spirit (52,787G/T)	Crude oil about 13,000 t
9	1992/12	Off La Coruna in northwest coast Spain	The Aegean・Sea (53,964G/T)	Crude oil about 73,000 t
10	1993/01	Off Sumburgh Cape in Shetland	The Braer (44,989G/T)	Crude oil about 85,000 t
11	1993/01	Off North End of Sumatra Is.	The Maersk・Navigator (142,488G/T)	Crude oil about 25,000 t
12	1994/03	Inlet of Bosphorus Str. from Black Sea	The Nassia (66,822G/T)	Crude oil about 20,000 t

4. In areas of onshore oilfields and tank farms, small rivers run in all directions. Moreover, rushing streams suddenly appear in heavy rains, because of the short lengths of river basins to the sea. This rapidly washes the floating oil down to the sea.

5. All rivers in the study area empty themselves in the Gulf of Paria. The Gulf of Paria itself forms a semi-closed water system and the geographical conditions allow oil to flow to the Gulf of Paria.

6. Petroleum facilities such as tanks and pipelines have become obsolete and tend to be insufficiently maintained.

7. Employees are not motivated enough to prevent oil pollution and preserve good environment.

8. Laws and regulations relevant to oil pollution prevention are yet to be instituted.

The combined effects of these causes are causing chronic pollution.

15-3 Prevention of Accidental Oil Pollution

To better cope with accidental oil pollution, levels of equipment design, operation and maintenance should be improved. Geographical features, climatic and oceanographic conditions, people's awareness of the importance of pollution prevention, and government policies all have important bearings on the prevention of accidental pollution. In view of the limited availability of economic and human resources, countermeasures against accidental pollution should be planned in a long-term perspective and priority projects should be properly sorted out. The hardware should be modified as necessary to stop oil spills and not allow discharges to rivers as far as the Gulf of Paria. All the concerned facilities should be maintained well enough to ensure reliable operation. Apart from such hardware improvements, consciousness by all those concerned of the importance of prevention of oil pollution should always be emphasized. This concerns both management and field workers. The government needs to establish regulations and announce firm will to enforce them for the cause of environmental protection.

15-4 Measures for Preventing Accidental Pollution

Oil spills that could reach the sea via rivers could result in serious pollution problems. The following discussions focus on countermeasures against such accidents.

15-4-1 Permanent Measures in Onshore Oil Fields and Tank Farms

Oil floating on oil separators and oily sludge in pits in onshore oil fields, tank farms, and Pointe-a-Pierre Refinery frequently overflow to rivers and the sea after heavy downpours. The following primary measures will be necessary against such accidents.

1. Storm water should not be allowed to enter the process waste water system. It is necessary for this purpose to completely separate storm water from oily process water. Installation of higher dikes around oil separators and overhead or underground pipings for process waste water are necessary.

2. The inside walls of oily sludge pits should be coated to prevent permeation of oil. The pits should also be roofed.

3. Floating oil in oil separators should be recovered by pumps with an automatic level controlling system.

Secondary permanent measures include installation of oil retaining walls, dikes, spill walls, oil detectors, and shutoff valves with on-off indicators in the trench system.

15-4-2 Oil Spill Cleanup Operations

(1) Equipment and Materials for Removal of Oil Spills

There is a tendency throughout the world to require by law oil companies to be equipped with the following.

1. Oil fences
2. Oil fence deploying boat
3. Oil recovery boat
4. Oil dispersant
5. Oil adsorbent
6. Oil gelling agent

1) Oil Fence

(a) Storage of Petroleum

Storage capacity (kiloliters)	Length (meters)
10,000 to less than 100,000	1,080
100,000 to less than 1,000,000	1,620
more than 1,000,000	2,160

(b) Tanker

Corresponding to total tons (eight ranks) 200 meters to 3,000 meters

(c) Shipment Pier

(Length of the largest ship to be moored) times 1.5 meters

2) Oil Fence Deploying Boat

Number of boats that can be deployed along a fixed length of oil fence within one hour

3) Oil Recovery Boat

More than one boat, in the case that the quantity of petroleum to be stored or handled is more than 1,000,000 kiloliters.

4) Oil Dispersant X (kl)

5) Oil Adsorbent Y (t)

6) Oil Gelling Agent Z (kl)

Estimated oil spill U (kl) = 20X + 50Y +15Z

Routine exercises are necessary to enable the personnel and materials to be rallied within the fixed time at the designated location, their sizes depending upon the scale of the spill.

(2) Oil Spill Cleanup

Equipment and materials for removal of oil spills in Japan conceive oil spill occurring on inland seas, where comparatively mild conditions prevail. Because the Gulf of Paria is a semi-closed sea with moderate marine conditions, the measures employed in Japan may be worth studying. In Japan, the measures for marine environmental protection are based primarily on the policy of the local government presiding over the concerned district; the measures basically aim to recover 80 percent of spilled oil by mechanical means and treat the remaining 20 percent by oil dispersants or oil adsorbents. The standard oil spill cleanup processes are as follows.

1. Containment of spilled oil by oil fences
2. Recovery of spilled oil by oil recovery boat (Target: 80%)
3. Recovery of spilled oil by oil adsorbents (Target: 10%)
4. Cleanup by oil dispersants to within a tolerable limit (Target: 10%)

Oil fences are not applicable to containing spilled oil on the rough sea. In such cases oil dispersion must be resorted to; containment by fences and recovery by boat should be considered as backup secondary measures.

1) Use of Oil Fences

An oil spill can occur under any conditions, either favorable or most unfavorable conditions, -- climatic, oceanographic, or geographic. The amount of oil can be small or large. Therefore, the cleanup method best suited to each case must be employed. Fences are not always effective and are used for the following purposes.

1. To prevent oil dispersion and confine the spill within the area to be cleaned
2. To gather oil dispersed in a thin film to a thicker oil layer to facilitate recovery

The basic concept is to deploy oil fences as quickly as possible at the initial stage of an oil spill. In order to deploy oil fences effectively, it is important to consider the location and length of the oil fence, shape of the enclosure and procedures. Oil fences are generally secured by anchors to trap the spilled oil. Trapped oil spills sometimes escape under the oil fences by the effect of waves or current. This tendency is more pronounced if the spillage is large and the oil layer is thicker. In such cases the spill is encircled by double or triple fences. Usually, when the current flows at more than 0.3 knots, spilled oils escapes under the bottoms of oil fences. Oil fences usually become out of control at more than 0.5 knots, and oil fences are often broken and swept away. One method of deployment, which reduces the external influences on the oil fences and effectively traps spilled oil, is the "drift deployment" method. In this method, the spilled oil is recovered while a chain of oil fences containing spilled oil is being allowed to drift, which is stabilized by sinkers attached at both ends. In cases where spilled oil widely drifts along the coast, this method is employed.

2) Use of Oil Dispersant

In the case of the oil spill from the Torrey Canyon off the southern coast of England in 1967 and the oil spill from the Juliana off the Japan Sea coast in 1971, large quantities of oil dispersants were employed for the initial cleanup operation. However, the secondary environmental pollution caused by the oil dispersants was hotly argued because of the results of a toxicity test. It was found that the dispersants employed for these accidents exerted harmful effects upon the aquatic ecosystem. As a result of such incidents, the performance of the dispersants has been improved and their toxicity to the organisms has been remarkably reduced. At present, the dispersants employed in Japan are based mainly on paraffinic hydrocarbon solvents and contain about 20 percent surfactants. In Japan, when oil dispersants are employed on inland seas, consent must be obtained from the fishermen's union in the area. This makes prompt cleanup operations at the initial stage of an oil spill difficult. Therefore, in many cases in Japan, the spilled oil is mechanically recovered after preventing diffusion using oil fences, and the thin oil films or floating spilled oil encircled by oil fences are treated by oil dispersants or oil adsorbents. In England, the basic policy for oil spill cleanup is to treat oil spills mainly by oil dispersants. It is said that oil dispersants are more effective if used at the initial stage of a spill when the volatile matter remains in the spilled oil and the oil viscosity is low. This is the reason why mobility of the cleanup squad is emphasized at the initial stage of oil spills. The aerial application of oil dispersants by airplane is one means of quickly responding to the spills. Therefore, the application of oil dispersants by boat plays a supplementary role. The aerial application of oil dispersants by helicopter was first carried out in the Juliana accident of 1971 in Japan. However, the aerial application of oil dispersants was not established at that time. The guidelines for using them were enacted afterwards. Since then, aerial application in coastal areas has been based on these guidelines and remarkable achievements have been made. The airplane duster is equipped with tanks on the fuselage and dispensers on the legs. Tank capacity is 180 to 300 liters. Actual dispensing takes 1.5 to 3 minutes, flying at 50 to 60 kilometers an hour at a low altitude of 5 to 15 meters.

3) Oil Adsorbent

Oil adsorbents are generally used to recover oil remaining after the oil contained by oil fences has been collected by oil recovery devices. The role of oil adsorbents is supplementary. The application of oil adsorbents in the first stage helps prevent dispersion of oil and facilitates subsequent operations. If the oil film is too thin to recover by oil recovery devices, oil adsorbents should be applied from the beginning. In addition, oil adsorbents are effective in narrow waterways or in complicated areas where oil recovery boats cannot navigate. When weather conditions make recovery of used oil adsorbents difficult, oil adsorbents should not be employed. The following two principles facilitate recovery of used adsorbents.

1. Recovery equipment
   Since oil adsorbents are employed under various circumstances, it is necessary to prepare long and short poles attached with a hook to recover used oil adsorbents and big plastic bags or half-cut drums to receive used oil adsorbents.

2. Working boats
   It is necessary to use working boats to dispense and recover oil adsorbents. For dispensing small boats are adequate; but for recovery, sufficient room is required in the boat to for half-cut drums.

Furthermore, it is important that a proper method for disposing of recovered used oil adsorbents be established. Oil adsorbents are selected according to the purpose of the application. The quantity of oil adsorbents to be used depends mainly on surface tension between oil and adsorbents, effective surface area of adsorbents and viscosity of oil. Oil adsorbents must be lipophilic enough to resist leaching of oil after adsorbing the oil and being soaked in water for an extended period of time. Synthetic polymers such as polyurethane, polystyrene, polypropylene, etc. are highly lipophilic and adsorb a large amount of oil. They are therefore used as adsorbents. They can also be regenerated after use and re-used again. The recovered oil is burned. Synthetic polymers are reclaimed or incinerated after pressing the oil out. Incineration is preferable to disposal.

15-4-3 Prediction of Oil Spill Dispersion

Once an oil spill occurs in a coastal area, it is necessary to quickly predict the direction of dispersion. Since the late 1980s, studies on the behavior of oil spills and simulations of dispersion have made rapid progress in the U.S.A. in particular. Good models for predicting behavior of spilled oil have been developed and used in practice. Such a model should be useful in predicting oil spill dispersion off the coast of Trinidad and Tobago. It is important that factors affecting the behavior and dispersion of oil spills be accumulated in a data base and the model be modified to fit to analyses of accidents.

15-5 Conclusions

In order to prepare for oil spill accidents, it is required to establish an organization that responds to accidents, and to establish an emergency task force that accumulates technical knowhow for removal, treatment and disposal of oil. It is also necessary to establish communication networks, to store a reasonable quantity of equipment and materials to adequately cope with oil spills, and to set up facilities for treating the recovered oil. Oil spill accidents in the Gulf of Paria, a semi-closed water system, should be the first priority. Case studies of oil recovery operations in the Gulf of Paria under varied assumed conditions should be done. To study accidents on larger scales such as tank or tanker accidents, it is desirable to utilize a predictive model for oil spill dispersion. It is also important to build networks of mutual cooperation among the countries in this area for coping with large-scale oil spill accidents.

Chapter 16 Upgrading Project

Chapter 16 Upgrading Project

Trintoc has formulated a program for upgrading and modernizing Pointe-a-Pierre Refinery to increase the production of higher-valued lighter products targeted for the international market by increasing the conversion capability. They commenced implementing this plan supported by a loan from the Inter-American Development Bank (IADB). Petrotrin, the successor to Trintoc, inherited the plan, and expects to complete it by the end of 1995.

The entire program, which is partly relevant to environmental improvement, and its expected merits are outlined below.

16-1 Outline of the Entire Upgrading Plan

The upgrading plan contemplates construction and revamping of process units, and modification of facilities related to environmental control. The entire upgrading plan includes the following items.

16-1-1 Construction and Revamping of Process Units

(1) Gas Oil Hydrotreating Unit (No. 2 HTU)

The existing gas oil hydrotreating unit (No. 2 HTU), now idle, will be put it to service again, but as a mild hydrocracking unit. The capacity however will be reduced from 88,000 to 55,000 bpsd.

(2) Installation of a New Sulfur Recovery Unit

A new 183-tons-per-day sulfur recovery unit will be installed. A tail gas treater, a molten sulfur transportation facility, and sulfur solidification and storage facilities will also be constructed together with the sulfur recovery unit.

(3) Installation of a New Hydrogen Unit

A 30 MMscfd hydrogen unit will be constructed to supply hydrogen, mainly to the No. 2 HTU to be revamped.

(4) Visbreaking Unit

This unit is constructed to increase the conversion capacity of the refinery. The capacity will be 32 Mbpsd.

(5) FCC Unit

This unit is expanded from the present 26 Mbpsd to 30 Mbpsd to increase the conversion capacity of the refinery.

(6) Modernization of Refinery Instrumentation

The existing outmoded analog pneumatic instrumentation will be replaced by a modern Distributed Control System (DCS). A central control room will also be installed.

16-1-2 Improvements in Environmental Conservation

The following projects are planned along with completion of the upgrading project to control environmental pollution.

(1) Improvements in Waste Water Treatment

- Segregation of storm water from the existing sewage systems which lead to the API separators,

- Installation of pumps and associated facilities to efficiently skim slop oil from the existing API separators,

- Rationalization and improvement of the API separators as found necessary through thorough studies on them.

(2) Countermeasures against Emission of Volatile Hydrocarbons

- Installation of inner-floating roofs on petroleum storage tanks for hydrocarbons with vapor pressures exceeding 1.5 psia. Tanks will be sorted out, identified and assigned priorities for installation of inner floating roofs.

(3) Countermeasures against Air-borne Particulates

- Installation of high efficiency cyclones on the FCC unit, to be implemented as part of the FCC revamping,

- Installation of smokeless flares for waste gas firing. Details will be studied.

- Installation of mist eliminators on the sulfuric acid recovery unit. This will be done as part of the revamping of the sulfuric acid plant.

(4) Countermeasures against Sulfur Oxides

- Reduction of sulfur content in the fuels. This will be done along with the revamping of the No. 2 HTU unit,

- Construction of a new sulfur recovery unit.

(5) Countermeasures against Carbon Monoxide

- Introduction of complete combustion technology to the FCC regenerator. This will be done as part of the FCC revamping.

(6) Countermeasures against Offensive Odors

- Refurbishing the sour water stripper at No. 2 HTU and putting it back to service again. This will be done as part of the revamping of No. 2 HTU.

- Installing a sour water collection system for every sour water stream from the crude distillation unit, HTU's, FCC, Visbreaker and Vacuum units. This will be done along with completion of the upgrading project.

- Installing a system to recycle the bottom water from the sour water strippers back to the desalter make-up water line. Details will be studied.

- Installing a spent caustic soda collection and treatment system.

(7) Countermeasures for Noise

- Improving the FCC blower turbine by introducing hydraulic speed control or installing a noise controlled booth for operator protection.

(8) Countermeasures against Soil Contamination

- Construction of a land farming facility.

16-2 Upgrading of the Waste Water Treatment Facility

The basic policy of Pointe-a-Pierre Refinery for upgrading of the waste water treatment facilities is as follows.

1. The most important issue in pollution control at Pointe-a-Pierre Refinery is the

treatment of waste water. Every measure should be evaluated in terms of the anticipated 50 ppm limit to be imposed on the oil and grease content of water discharged to the environment.

2. The measures to be implemented under the IADB loan along with upgrading of refinery processing are designated here as first-phase activities. The first-phase activities aim to reduce the oil content of the refinery effluent water from current levels, about 1,500 ppm, to between 100 and 200 ppm.

3. Installation of secondary treatment facilities is required to reduce the effluent oil content to below 50 ppm. However, these facilities are not included in the present upgrading plan and therefore would have to be installed by Petrotrin, apart from the present upgrading plan.

4. It is essential that the results of the first phase activities be reflected in selection and design of the secondary treatment facilities.

Based on the above proposed policy, items 16-2-1 to 16-2-11 are included in first-phase activities.

16-2-1 Improvement of Simpson Catch

(1) Maintenance Items

- Installation of a new oil retention baffle to contain oil during high tide and floods,

- Refurbishing the existing air-driven reciprocating pumps to ensure reliability of operation, and connecting them to the slop tanks of the new Oil Stocks API separator to transfer slop oil.

(2) Upgrading Items

- Installation of a self-adjusting floating skimmer (buoyancy chamber) equipped with booms and timer-pumping control,

- Installation of a set of pumps/motors/hoses to recover oil from the skimmers,

- Installation of slop tanks (31 m^3 x 2) and necessary piping to receive and bleed the recovered oil,

- Installation of pipes to return the bleed water from slop tanks to the oil catch, and installation of pumps and pipes to transfer the recovered oil to the new API separator and slop system installed at the Oil Stock,

- Installation of electrical and instrumentation system necessary for the control of skimmer pumps.

16-2-2 Improvement of No. 3 and No. 5 Pump Houses

(1) No. 3 Pump House

- Installation of pipes to deliver oil, which is bled when starting the pumps, to the oil pit,

- Connection of the pump bed drain to the oily pit,

- Connection of drain leaking from the pumps to the drain header.

(2) No. 5 Pump House

- Revamp of the existing slop oil pits,

- Installation of a set of pumps/motors at slop oil pits. Installation of pipes to the new API separator at the Oil Stock Sump.

16-2-3 Installation of a New API Separator at Oil Stock Main Sump

- Installation of a closed bleed system to the following 43 tanks in the West and North Areas:

Gas oil	7
Kerosene	5
Gasoline products	13
Gasoline components	10
Fuel oil	1
Wild naphtha	5
Slop	2
Total	43

- Installation of a new channel to by-pass the storm water now flowing to the existing Main Sump, and increasing the cross sectional areas as necessary,

- Removal of the existing Oil Stock Main Sump and installation of a new API separator. The capacity of this new API oil separator should correspond to the capacities of the oil pits at Nos. 3 and 5 Pump Houses plus the capacity of the closed tank bleed water system. The outlet water of this API separator is connected to the Simpson Catch and water channels. Slop tanks for recovered oil are to be installed as necessary. Specifications of the new API separator will be:

Capacity, cubic meters:	147.6
Number of channels:	3
Dimensions, meters:	Width 3.2 x Height 1.7 x Length 23.6.

- Installation of pumps and motors with automatic level controlling devices to transfer the recovered oil to the slop tanks. The pumps will be equipped with necessary electrical and instrumentation facilities.

- Installation of two 75 cubic-meter slop tanks for receiving recovered oil,

- Installation of pipes to connect the slop tanks to the existing slop system.

16-2-4 Point "J" Oil Catch

- Installation of a set of pumps and motors with automatic level controlling devices for transferring slop oil from the Sump to the recovered oil tank for the new Oil Stock API separator.

16-2-5 East Area Guard Basin

- Installation of a floating rotary-drum type skimmer equipped with a boom and automatic timer-controlling system at the guard basin,

- Installation of two 31 cubic-meter slop tanks for oil recovery,

- Installation of a pump with automatic level controlling device for transferring recovered oil at the oil recovery pit. Installation of pipes to the slop tanks.

16-2-6 No. 3 API Separator

(1) Maintenance Items

- Refurbishing the existing steam-driven reciprocating pump to ensure reliability. The pump will become a stand-by spare.

(2) Upgrading Items

- Installation of a pump with automatic level controlling device for oil recovery,

- Installation of pipes for transferring the recovered oil to the No. 4 API separator.

16-2-7 No. 2 API Separator

- Increasing the cross-sectional area of the storm water by-pass channel as necessary,

- Installation of two 31 cubic-meter slop tanks for receiving the recovered oil,

- Installation of instrumentation for automatic level control at the oil recovery pump,

- Installation of pipes to transfer the slop oil to the No. 31 tank (South Area slop tank).

16-2-8 No. 2 API Separator Guard Basin

- Installation of a floating-type oil skimmer equipped with a boom and a timer controller,

- Installation of a set of pumps/motors/hoses to recover oil from the skimmer,

- Installation of pipes for transferring the recovered oil to the No. 2 API separator slop tank,

- Installation of instrumentation for automatic level control at the oil recovery pump,

- Refurbishing the existing steam-driven reciprocating pump to be used as a stand-by spare.

16-2-9 No. 1 API Separator

- Segregation of the waste water streams containing caustic soda discharged from the processing units at the North Area, or neutralizing them at their sources (further study needed),

- Installation of two 31 cubic-meter slop tanks for receiving recovered oil,
- Installation of instrumentation for automatic level control at the oil recovery pump,
- Installation of pipes for transferring the recovered slop oil to the No. 31 tank (South Area slop tank).

16-2-10 Water Channel for No. 1 API Separator Outlet

- Installation of a boom for collecting the surface oil,
- Installation of a floating-type oil skimmer equipped with a timer and instrumentation,
- Installation of slop tanks for receiving recovered oil.

16-2-11 No. 4 API Separator

- Refurbishing the existing steam-driven reciprocation pump to use as a stand-by spare,
- Installation of instrumentation for automatic level control at the oil recovery pump.

16-3 Effect of Improvements on Waste Water Treatment

As stated in the basic policy, these items explained above are intended to improve the function of the waste water treating facilities to decrease the oil content in the refinery effluent, now exceeding 1,000 ppm, to about 150 ppm. After they are completed, and if given good maintenance, it will perhaps be possible to achieve the 100 to 200 ppm target.

However, the objective of this study is to obtain 50 ppm oil content in the refinery effluent. As explained in Chapter 11, this target is not achievable without secondary treatment consisting of dissolved air-flotation and auxiliary treatment.

The waste water treatment system to be proposed for the refinery will, on the basis of the results of the experiments described in Chapter 19, consist of buffer tanks, API/CPI separators, dissolved air flotation with coagulation and a guard basin. It is essential that, for good operation of the facilities, the flow rates be maintained to within their design rates with a minimum of fluctuation. Therefore, complete segregation of the storm water from oily waste waters is the basic prerequisite.

The upgrading project include a plan for storm water segregation. However, this plan is limited mainly to the tank yards in the West Area, constituting only a small fraction of what should be done in the entire refinery premises to segregate all storm water from the oily waste water.

To control oil and grease concentration in all the refinery effluent waters at less than 50 ppm, segregation of the oily waste water from the chemical waste water is first required as pointed out in Chapter 11. These waters should then be segregated from the storm water using a piping system installed above ground, and treated by the proposed secondary waste water treatment system under well controlled flow conditions. This is considered to be the only practical way to achieve the 50 ppm target. All the existing waste water treating facilities, including those installed and improved in the upgrading project, are to be diverted to the treatment of storm water.

It would take long to realize all the proposed modifications including preparation of the necessary funds. It will however be a matter of serious concern not only to Trinidad and Tobago but to adjacent countries if Trinidad and Tobago has to continue discharging waste water containing more than 1,000 ppm oil to the sea. Under such a circumstance, the present upgrading project, incomplete as it is capable only of achieving about 150 ppm oil in water, is meaningful and worth implementing as an intermediate measure.

When the recommendations of this study have been implemented, all modifications which are included in the present upgrading project will be used for treatment of storm water. Even non-oily water effluents need a system for treatment as a guard against unexpected situations. In this sense, the systems provided by the present upgrading project will be effectively utilized in the future.