



No. 09

THE FEASIBILITY STUDY REPORT ON THE LUBRICATING OIL
REFINERY PROJECT IN THE KINGDOM OF THAILAND (ANNEX)

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ON
THE LUBRICATING OIL
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IN
THE KINGDOM OF THAILAND

(ANNEX)

DECEMBER

1984

DECEMBER, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY



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**THE FEASIBILITY STUDY REPORT
ON
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REFINERY PROJECT
IN
THE KINGDOM OF THAILAND**

(ANNEX)

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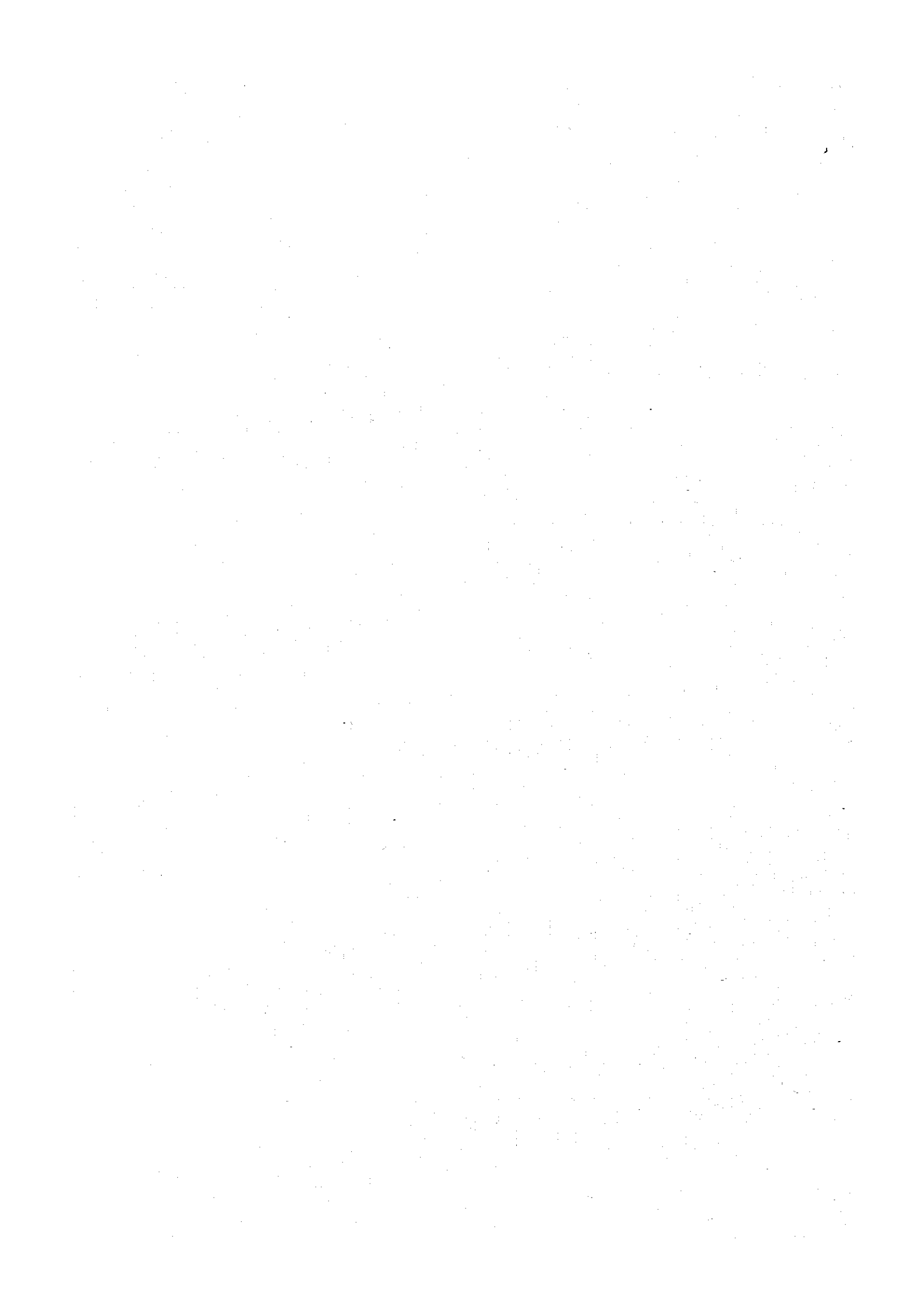
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ANNEX II-1

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1 Vehicles (Transportation on Road)

Data of vehicles is shown in Table AII-1-1(1) to (6).

2 Transportation

2-1 Railway

NUMBER OF DIESEL LOCOMOTIVES AND LUBE OIL CONSUMPTION IN THAILAND IN 1983 AND 1993

	<u>Number of Diesel Locomotives</u>	<u>Engine Oil (kl)</u>	<u>Grease³⁾ (kl)</u>	<u>Total (kl)</u>
1983	272 ¹⁾	1,590 ¹⁾	0.03 ¹⁾	1,590.03
1993	504 ²⁾	2,945	0.05	2,945.05

Notes: 1) Source: State Railway of Thailand

2) Average annual growth rate is estimated as follows which is the same of estimated growth rate of GDP. (Hereafter referred to as growth rate of GDP)

1983 - 1986 6%
1987 - 1993 6.5%

3) Unit of grease is ton, but the consultant estimate that ton is equal to kl.

2-2 River Transportation by Self Propelled Vessels

NUMBER OF VESSELS AND LUBE OIL CONSUMPTION

	<u>Number of Vessels</u>	<u>Engine Oil (kl)</u>	<u>Industrial Oil (kl)</u>	<u>Total (kl)</u>
1983	10,508 ¹⁾	53 ³⁾	43	57
1993	12,809	63	5	68

Notes: 1) Source: Calculated from Kaiji Kokusai Kyoryoku Center (hereafter referred to as KKKC) data in 1981.

2) Average annual growth rate is assumed to be 2% by the consultant.

3) Units lube oil consumption are estimated as follows from the experiences in Japan.
Engine oil consumption 5 lit/unit.year
Gear oil consumption 0.4 lit/unit.year
(Industrial oil)

2-3 River Transportation Except Self Propelled Units

(1) Tonnage of Vessels in 1981

144,500 ton

Source: KKKC

(2) Preconditions of Base Oil Consumption in 1981

1. Distance of navigation (Source: KKKC)

The Cho Phrayo River: Gulf of Thailand-Nakon Sawan
380 km

The Nan River: Nakon Sawan-Uttaradit 370km

One navigation is estimated by the consultant as follows: $(380\text{km}+270\text{km})/3=217\text{km}$

2. Horse power of total vessels (Source: KKKC)

Horse power of total vessels is 144,500sp which is same as the tonnage.

3. Navigation hours per one voyage is as follows:

$217\text{km} / (5\text{kn} \times 1.852\text{km}) \times 2 = 46.8\text{hours}$ (two ways)

5kn is the speed of vessel.

4. Number of Voyages

4days for loadings and unloading of goods.

$365\text{days}/(4+2)\text{days} \times 50\%=30\text{voyages}$

50% is the operating ratio.

5. Lube oil consumption by unit

0.35cc/HP.hr

Estimated by the consultant from the experience in Japan.

(3) Lube Oil Consumption in 1981

$$0.35\text{cc/HP.hr} \times 144,500\text{HP} \times 46.8\text{hr} \times 30 \text{ voyages} = 71\text{kl}$$

Hereafter, lube oil consumptions of barge and ship are calculated by the same say.

Engine oil $71\text{kl} \times 80\% = 57\text{kl}$
Marine cylinder oil $71\text{kl} \times 20\% = 14\text{kl}$
(Industrial oil)

80% and 20% are estimated by the consultant from vessel size which was estimated by KKCC.

(4) Lube Oil Consumption in 1983 and 1993

	<u>Total Tonnages</u>	<u>Engine Oil</u>	<u>Marine Cylinder Oil (Industrial Oil)</u>	<u>Total (kl)</u>
1981	144,500	57	14	71
1983	150,338	59	15	74
1993	183,261	72	18	90

Note: Average annual growth rate is estimated to be 2% by the consultant.

2-4 Coastal Transportation Except Petroleum

(1) Preconditions of Lube Oil Consumption in 1981

1. Distance of one navigation

Bangkok - Sattaheep	200 km
Bangkok - Song Khla	355 km

2. Horse power of total vessels to Sattaheep and Song Khla

Total DWT for coastal transportation 447,000 DWT
(Source: KKKC)

Total tonnage is segregated by both populations.

To Sattaheep $447,000\text{DWT} \times 37\% = 165,390\text{DWT} = 165,390\text{HP}$
To Song Khla $447,000\text{DWT} \times 63\% = 281,610\text{DWT} = 281,610\text{HP}$

3. Navigation and loading and unloading days

To Sattaheep

Navigation	$200\text{km} / (5\text{kn} \times 1.852\text{km}) \times 2 = 43\text{hr} = 2\text{days}$
Loading and unloading	<u>3days</u>
Total	5days

To Song Khla

Navigation	$355\text{km} / (5\text{kn} \times 1.852\text{km}) \times 2 = 77\text{hr} = 4\text{days}$
Loading and unloading	<u>3days</u>
Total	7days

Note: 5kn is the speed of vessel.

4. Number of voyages

To Sattaheep

$$365\text{days}/5\text{days} \times 50\% = 36.5\text{voyages}$$

To Song Khla

$$365\text{days}/7\text{days} \times 50\% = 26.1\text{voyages}$$

Note: 50% is operating ratio

5. Lube oil consumption by unit

0.35cc/HP.hr

Estimated by the consultant from the experience in Japan.

(2) Lube Oil Consumption in 1981

To Sattaheep	91kl
To Song Khla	<u>198kl</u>
Total	289kl

	<u>in 1981</u> (kl)	<u>in 1983</u> (kl)
Engine oil	$289 \times 34\% = 98$	$98 \times (1.04)^2 = 106$
Marine cylinder oil (Industrial Oil)	$289 \times 66\% = 191$	$191 \times (1.04)^2 = 207$

Note: The rate of 34% and 66% are estimated based on ship size.

(3) Lube Oil Consumption in 1983 and 1993

Average annual growth rate is estimated 4% by the consultant.

	<u>Tonnage (1,000 ton)</u>	<u>Engine Oil (kl)</u>	<u>Marine Cylinder Oil (Industrial Oil (kl)</u>	<u>Total (kl)</u>
1981	447	98	191	289
1983	483	106	207	313
1993	715	157	306	463

2-5 Crude Oil Import

(1) Lube Oil Consumption for Crude Oil Import in 1982

Lube oil consumption for crude import in 1982 is shown in Table AII-1-2.

(2) Lube Oil Consumption (Supplied by Thailand) for Crude Oil Import in 1983 and 1993.

	<u>1983</u>	<u>1993</u>
Import Crude Oil (10 ³ kl)	9,226	13,669
Import Crude Oil for which Thailand Supplies Cons. Lube Oil (10 ³ kl)	9,101 ²⁾	2,974 ³⁾
Marine Cylinder Oil (kl) ⁴⁾	192.0	14.4
Other Industrial Oil ⁵⁾	2.0	0.1
Grease (kl) ⁶⁾	0.2	0.01
Total (kl)	<u>194.2</u>	<u>14.51</u>

Note: 1) Source: Table AII-1-2.

2) Import crude oil except China for which Thailand supplies consumed lube oil.

3) Import crude oil except China and Middle East for which Thailand supplies consumed lube oil.

4) Estimated by Table AII-1-3.

4) and 5) are industrial oil.

5) 6) Estimated 1% on marine cylinder oil is other industrial oil and 0.1% is grease.

2-6 Crude Oil Transportation from Sri Racha to MOR

MOR receives import crude oil in Sri Racha tank yard, then the crude oil is transported to MOR by small tanker.

	<u>Crude Oil (10³kl)</u>	<u>Marine Engine Oil (Industrial Oil) (kl)</u>
(1982	2,852 ¹⁾	83 ¹⁾
1983	2,852 ²⁾	8
1993	3,371 ²⁾	9

Notes: 1) Source: OIL AND THAILAND 1982

2) Estimated from CRUDE OIL TOPPING CAPACITY
(Source: NEA)

3) Tanker size 25,000DWT, Horse power 17,600sp
Speed 5kn, Distance 65nm; Unit lube oil
consumption is 1.16cc/HP.hr.

2-7 Petroleum Products Import (Fuel, Lube Oil and Base Oil)

Fuel means LPG, gasoline, jet fuel, kerosene, diesel oil
and fuel oil (except lube oil, wax and others).

(1) The Import products for which consumed lube oil
supplied by Thailand in 1982 are shown in Table AII-1-4.

(2) The consumed lube oil which is supplied by Thailand
for products import in 1982 is shown in Table AII-1-5.

(3) Lube Oil Consumption (Supplied by Thailand) for Product
Import in 1982 and 1993

	1982	1983	1993
Import Products (10 ³ kl) ¹⁾	2,476	2,645	4,883
Marine Cylinder Oil (kl) ⁴⁾ (Industrial Oil)	51.1 ²⁾	54.6	53.2 ³⁾
Other Industrial Oil ⁴⁾ (Industrial Oil)	0.5	0.5	0.5
Grease (kl)	0.05	0.05	0.05
Total	51.65	55.15	53.75

Notes: 1) Source: Table AII-1-3. Fuel Import (1)+
Lube oil (4) + Base Oil import.

2) Source: Table AII-1-4.

Consumed lube oil supplied by Thailand is
to be assumed by the consultant as follows:

in 1983	Middle East	100%
	China	0%
	Other Countries	50%

3) Consumed lube oil supplied by Thailand is as follows:

in 1993	Middle East	0%
	China	0%
	Other Countries	50%

4) Industrial Oil

2-8 Petroleum Products (Fuel) Transportation from Sri Racha to Bangkok

(1) Precondition to be Assumed by the Consultant

1. Import fuel: MOR - Received in his depots.
TORC and Esso
1/2 Received in their depots.
1/2 Received in their refineries.
2. TORC and Esso transport 85% of import fuel which is received in their refineries and produced products from Sri Racha to Bangkok by sea.
3. Total DWT: 1,452 (answer of Company A),
Horse power: 1,452sp
Carring capacity: 1,400kl, Speed: 5kn,
Distance (from Sri Racha to Bangkok): 70nm,
Unit lube oil consumption in average: 0.255cc/HP.hr
(By the experience in Japan)

(2) Transportation Volume of Fuel from Sri Racha to Bangkok

(Unit: 1,000 kl)

	Fuel Import (1)	TORC and Esso Fuel Import (2)	(2)x1/2 (3)	TORC and Esso Fuel Production (4)	(3)+(4) (5)	(5)x85% (6)
1982	2,314	1,556	778	6,066 ¹⁾	6,844	5,817
1983	2,467	1,659	830	6,066	6,896	5,862
1984	2,518	1,694	847	6,066	6,913	5,876
1985	2,043	1,366	683	6,495	7,178	6,101
1986	1,572	1,045	523	6,925	7,448	6,331
1987	1,555	1,064	532	7,553	8,085	6,872
1988	2,183	1,493	747	7,553	8,300	7,055
1989	2,843	1,945	973	7,553	8,526	7,247
1990	1,316	971	486	9,824	10,310	8,764
1991	2,045	1,509	755	9,824	10,579	8,992
1992	3,403	2,511	1,256	9,824	11,080	9,418
1993	4,883	3,603	1,802	9,824	11,626	9,882

Notes: (1) Source: 3) of Table AII-1-5.

(2) Fuel oil import by TORC and Esso is Their corresponded to their CRUDE OIL TOPPING CAPACITY to be assumed. (Source: EMP)

(3) 1/2 of import fuel is received in refineries, another 50% is received in their depots.

(4) 1) Source: "OIL AND THAILAND 1982"
After 1983, these are corresponded to CRUDE OIL TOPPING CAPACITY to be assumed.
(Source: EMP)

(6) 85% of imported and produced products of TORC and Esso is transferred from Sri Racha to Bangkok by sea, which is surveyed by the consultant.

(3) Lube Oil Consumption in 1983 and 1993

(Unit: 1,000 kl)

	Transport ¹⁾ Product	Engine ²⁾ Oil	Marine Cyl-2) inder Oil (Industrial Oil)	Grease ³⁾	Total
1983	5,817	21.5	21.5	0.04	43.04
1993	9,882	36.0	36.0	0.07	72.07

Notes: 1) Source: Above Table.

2) 50% of lube oil consumption is engine oil and another 50% is marine cylinder oil, assumed by the consultant due to transportation vessel sizes.

3) It is assumed that 0.01% of lube oil consumption is grease consumption.

Reference: Base oil plant is not decided, so lube oil consumption for base oil transportation from the base oil plant to the blending plant can not be estimated, but it is very small.

CONCLUSION "2" TRANSPORTATION

LUBRICATING OIL CONSUMPTION (1)
TRANSPORTATION

	Answer for Questionnaire		1983		Average Growth Rate (1983-1993)				
	Lubricating Oil Consumption (kl)	Production	Engine Oil	Lubricating Oil Consumption (kl)					
	Production	Engine Oil	Industrial Oil	Grease	Total	Growth Rate of GDP			
2-1 Railway	272 cars	1,590	0.03	1,590.03	272 Cars	1,590.0	0.03	1,590.03	2
2-2 River Trans-Propelled	N.A.	N.A.	10,508 vessels	53.0	4.0	57.0	-	57.0	2
2-3 River Trans-Ex. Propelled	N.A.	N.A.	150,338 tonnages	59.0	15.0	74.0	-	74.0	2
2-4 Coastal Trans-Ex. Petroleum	N.A.	N.A.	483,000 tonnages	106.0	207.0	313.0	-	313.0	4
2-5 Crude Import	N.A.	N.A.	9,226,000 kl	-	194.0	194.2	0.20	194.2	
2-6 Crude Trans. for MOR	N.A.	N.A.	2,852,000 kl	-	8.0	8.0	-	8.0	
2-7 Petroleum Prod. Import	N.A.	N.A.	2,645,000 kl	-	55.1	55.15	0.05	55.15	
2-8 Petroleum-Prod. Trans. Sri Racha to Bangkok	N.A.	N.A.	5,817,000 kl	21.5	21.5	43.04	0.04	43.04	
Total				1,829.5	504.6	2,334.4	0.32	2,334.4	

Notes: 1) MOR receives import crude oil in Sri Racha tank yard then transports to MOR.
2) N.A.: not available.

CONCLUSION "2" TRANSPORTATION

LUBRICATING OIL CONSUMPTION (2)
TRANSPORTATION

		1993				
		Lubricating Oil Consumption (kl)				
Production	Engine Oil	Industrial Grease	Total			
2-1	Railway	504 cars	2,945.0	-	0.05	2,945.05
2-2	River Trans. Propelled	12,809 vessels	63.0	5.0	-	68.0
2-3	River Trans. Ex. Propelled	183,261 tonnages	72.0	18.0	-	90.0
2-4	Coastal Trans. Ex. Petroleum	715,000 tonnages	157.0	306.0	-	463.0
2-5	Crude Import	2,974,000 kl	-	14.5	0.01	14.51
2-6	Crude Trans. for MOR	3,371,000 kl	-	9.0	-	9.0
2-7	Petroleum Prod. Import	4,883,000 kl	-	53.7	0.05	53.75
2-8	Petroleum Prod. Trans. Sri Racha to Bangkok	9,882,000 kl	36.0	36.0	0.07	72.07
			3,273.0	442.2	0.18	3,715.4

3 Agriculture, Fishery, Forest and Cold Storage

3-1 Agriculture

(1) Agriculture Machinery in Use and Average Growth Rate:
See Table AII-1-6

(2) Estimated Number of Agriculture Machineries From 1983
To 1993:

See Table AII-1-7

(3) Estimated Lube Oil Consumption By Agriculture
Machineries:

See Table AII-1-8

3-2 Fishery

(1) Fish Captured

Estimated quantity of fish captured for the following
period in Thailand is shown below.

	(Unit: ton/year)				
<u>Fish Captured</u>	<u>1982</u>	<u>1983</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>
Marine	1,861,000	1,800,000	1,500,000	1,560,000	1,560,000
- In Thai Territorial Waters	1,761,000	1,700,000	1,400,000	1,450,000	1,450,000
- Out of Thai Territorial Waters	100,000	100,000	100,000	110,000	110,000
Inland	134,000	159,000	197,000	200,000	200,000
Total	1,995,000	1,959,000	1,697,000	1,760,000	1,760,000
Quantity of Fish Captured					

Source: Ministry of Agriculture and Cooperatives, Department
of Fisheries

(2) Lube Oil Consumption

Lube oil consumption for fish captured in Thailand is not available, so the Consultant estimate by using Japanese data (source: the Japanese Government and Japanese company).

Total lube oil consumption: 4.51kl/1,000 ton

Breakdown 3.157 kl/1,000 ton Engine oil (70%)
1.353 kl/1,000 ton Marine cylinder oil (30%)
(Industrial oil)

(3) Lube Oil Consumption in 1983 and 1993

	<u>Fish Captured (1,000 ton)</u>	<u>Engine Oil (kl)</u>	<u>Marine Cylinder Oil (Industrial Oil) (kl)</u>	<u>Total</u>
1983	1,959	6,185	2,650	8,835
1993	1,760	5,557	2,381	7,938

3-3 Forest

(1) Wood Production and Lube Oil Consumption

	(Unit: m ³)	
	<u>1982</u>	<u>1983</u>
Teak	58,076	56,843
Others	1,711,282	1,517,856
Total	1,769,358	1,574,699

Lube oil consumption: engine oil 141 lit/year in 1982.

Source: Ministry of Agriculture and Cooperatives, Thailand.

(2) Lube Oil Consumption in 1983 and 1993

	<u>(1982)</u>	<u>1983</u>	<u>1993</u>
Forest Production(m ³)	(1,769,358)	1,574,699	1,574,699
Engine Oil Consumption(kl)	(0.141)	0.125	0.125

The wood production decreased from 1,769,358m³ of 1982 to 1,574,699m³ of 1983, thus the Consultant estimates that average annual growth rate is zero from 1983 to 1993.

3-4 Cold Storage

	<u>Company A</u>	<u>1983</u>	<u>1993</u>
Cold Storage Capacity (ton)	3,500 1)		
(m ³)	3,000 1)	7,814 2)	9,556 3)
Lube Oil Consumption (kl) (Industrial Oil)	24 1)	63	76

Note: 1) Answer of Company A

2) Cold storage capacity in Thailand is estimated by Ministry of Agriculture and Cooperatives.

	<u>1982</u>	<u>1983</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>
Capacity (m ³)	7,546	7,814	8,205	9,025	9,228

3) Cold storage capacity in 1993 is estimated from above figure.

CONCLUSION OF "3" AGRICULTURE, FISHERY, FOREST AND COLD STORAGE

LUBRICATING OIL CONSUMPTION (1)
 AGRICULTURE, FISHERY, FOREST AND COLD STORAGE

	Answer for Questionnaire		1 9 8 3		Average Growth Rate (1983-1993)
	Production (1983)	Lubricating Oil Consumption (kl)	Engine Oil	Industrial Grease Total	
3-1 Agriculture	N/A.		6,688.0	3,947.0	10,635.0
3-2 Fishery	1,959,000 ton	-	6,688.0	2,650.0	9,338.0
3-3 Forest	1,769,000 ^{*)} m ³	141 lit./y	0.125	-	0.125
3-4 Cold Storage	3,000,000 m ³	8 lit./y	-	63.0	63.0
Total			12,873.1	6,660.0	19,533.1

Note: *) 1982

CONCLUSION OF "3" AGRICULTURE, FISHERY, FOREST AND COLD STORAGE

LUBRICATING OIL CONSUMPTION (2)
 AGRICULTURE, FISHERY, FOREST AND COLD STORAGE

		1 9 9 3		
		Lubricating Oil Consumption (kl)		
Production		Engine Oil	Industrial Grease	Total Oil
3-1 Agriculture	-	14,690	9,414	- 24,304
3-2 Fishery	1,760,000 ton	5,557	2,381	- 7,938
3-3 Forest	1,575,000 m ³	0.125	-	- 0.125
3-4 Cold Storage	9,556,000 m ³	-	76	- 76
Total		20,447.1	11,871.0	- 32,318.1

4 Construction

Construction Cost and Lube Oil Consumption

	Unit Lube ³⁾ Oil Consumption (lit./ million Bahts)	1978	1981	1983	1993
Consumption Expense (million Bahts)		13,583 ¹⁾	16,660 ¹⁾	19,074 ²⁾	37,522 ²⁾
Total Lube Oil Consumption	0.08457			1,613	3,173
Breakdown					
Engine Oil	0.02114			403	793
Industrial Oil	0.06343			1,210	2,380

Notes: 1) Source: NESDB

2) Growth rate is estimated as 7% which is the same growth rate between 1978 and 1981.

3) Unit lube oil consumption is estimated from the experience in Japan.

CONCLUSION OF "4" CONSTRUCTION

LUBRICATING OIL CONSUMPTION (1)
CONSTRUCTION

	Answer for Questionnaire		1983		Average Growth Rate (1983-1993)
	Production	Lubricating Oil Consumption (kl)	Production	Lubricating Oil Consumption (kl)	
	Engine Oil	Industrial Grease	Engine Oil	Industrial Grease	
	Oil	Oil	Oil	Oil	
	Total	Total	Total	Total	
4 Construction	N.A.	19,704 million b ^{*)}	403.0	1,210.0	1,613.0
					7

Notes: *) barrels

CONCLUSION OF "4" CONSTRUCTION

LUBRICATING OIL CONSUMPTION (2)
CONSTRUCTION

		1993	
		Lubricating Oil Consumption (kl)	
Production	Engine Oil	Industrial Oil	Grease Total
4 Construction	37,522,000 barrels	793.0	2,380.0
			-
			3,173.0

5 Electric Power Generation

5-1 Electric Power Generation of Electricity Generation Authority of Thailand (EGAT)

(1) Forecast of Electric Power Generation of EGAT

ELECTRIC POWER GENERATOR
(INSTALLED CAPACITY & FUTURE CAPACITY)

(Unit: MW)

	Hydro Power	Thermal	Gas Turbine	Gas Turbine Combined Cycle	Diesel	Total
EGAT April 1982	1,380	1,927.5	745		34.6	4,087.1
EGAT 1983	1,380.6	1,927.5	745		33.6	4,086.7
EGAT 1985	1,496.9	2,477.5	265	720	33.6	4,993.0
EGAT 1990	1,988.9	3,477.5	265	720	33.6	6,485.0
EGAT 1995	2,502.7	4,302.5	265	720	33.6	7,823.8
EGAT 1995	3,522.7	5,805.0	130	720	33.6	10,211.3

Source: EGAT

(2) Lube Oil Consumption in 1983 and 1993

	1983	1993
Power Generator Capacity (MW)	4,954.93 ³⁾ +33.6 ²⁾	9,145.53 ³⁾ +33.6 ²⁾
Total	4,993	9,179.1
Engine Oil (kl)	5 (4,854 lit ¹⁾)	5 ⁴⁾
Industrial Oil (kl)	298 (297,710 lit ¹⁾)	550 ⁴⁾
Total (kl)	303 (302,564 lit ¹⁾)	555 ⁴⁾

Notes: 1),2),3) Source: EGAT

- 2) Power generation capacity (MW) of diesel is no change from 1982 to 1995.
- 3) Other power generation capacity (MW) except diesel is hydro, thermal, gas turbine, gas turbinéd combined cycle. These are increasing every year.
- 4) Calculated from the expected capacity of electric power generation.

5-2 Electric Power Generation of Provincial Electricity Authority (PEA)

(1) Forecast of Electricity Power Generation of PEA

ELECTRIC POWER GENERATOR
(INSTALLED CAPACITY & FUTURE CAPACITY)

(Unit: MW)

	<u>Hydro Power</u>	<u>Thermal</u>	<u>Gas Turbine</u>	<u>Combined Cycle</u>	<u>Diesel</u>	<u>Total</u>
April	-	-	-	-	29.5	29.5
PEA 1982	-	-	-	-	20.083	20.083
PEA 1983	-	-	-	-	20.083	20.083
PEA 1985	-	-	-	-	20.083	20.083
PEA 1990	-	-	-	-	20.083	20.083
PEA 1995	-	-	-	-	20.083	20.083

Source: PEA

(2) Lube Oil Consumption in 1983 and 1993

	<u>Diesel Engine Oil (kl)</u>
1983	2521)
1993	252

Note: The growth rate of electricity power generation is zero percent.

1) Source: PEA

CONCLUSION OF "5" ELECTRIC POWER GENERATION

LUBRICATING OIL CONSUMPTION (1)
ELECTRIC POWER GENERATION

	Answer for Questionnaire			1983			Average Growth Rate (1983-1993)
	Production	Engine Oil Consumption (kl)	Industrial Grease Total	Production	Engine Oil Consumption (kl)	Industrial Grease Total	
S-1 ECAT	4,993 MW	4,054 lit.	297,710 lit.	4,993 MW	5.0	298.0	303.0
S-2 PEA	20,083 MW	251,656 lit.	-	20,083 MW	252.0	-	252.0
Total				257.0	298.0	-	555.0

CONCLUSION OF "5" ELECTRIC POWER GENERATION

LUBRICATING OIL CONSUMPTION (2)
ELECTRIC POWER GENERATION

1 9 9 3					
Lubricating Oil Consumption (kl)					
Production	Engine Oil	Industrial Oil	Grease	Total	
S-1 EGAT	9,179 MW	5.0	550.0	-	555.0
S-2 PBA	20,083 MW	252.0	-	-	252.0
Total		257.0	550.0	-	807.0

6 Manufacturing

6-1 Refinery

(1) Lube Oil Consumption Ratio of 3 Refineries

Production ¹⁾ Total in 1982 (1,000 kl)	Total Production Ratio (as AR ⁶)=1.00)	Light Production in 1982 (1,000 kl)	Light Production Ratio (as AR ⁶) 1.00)	Lube Oil Consumption Ratio (as AR ⁶)=1.00)
Refinery A 2,726	1.00	1,532	1.00	1.00
Refinery B 3,363	1.23 ²⁾	2,745	2.79 ³⁾	1.63 ⁴⁾
Refinery C 2,704	0.99	1,847	1.21	0.87 ⁵⁾

Notes: 1) Source: OIL AND THAILAND 1982

4) The lube oil consumption ratio of Refinery B (as Refinery A=1.00) is calculate as follow.

$$[(2) + 3) - 2] 0.7$$

5) The lube oil consumption ratio of Refinery C (as Refinery A=1.0) is estimated from CRUDE TOPPING CAPACITY (Source: EMP).

6) AR is Refinery A.

(2) Lube Oil Consumption in 3 refineries in 1983 and 1993

	Refinery A*1 Lube Oil Consumption (kl)		Refinery B*1 Lube Oil Consumption (kl)		Refinery C*1 Lube Oil Consumption (kl)		Total (kl)	
	1983 ¹⁾	1993	1983 ²⁾	1993	1983 ²⁾	1993	1983	1993
Engine Oil	1.8	2.1	2.9	5.4	1.6	2.1	6.3	9.6
Industrial Oil	30.3	35.8	49.4	91.2	26.5	34.7	106.2	161.7
Total	32.1	37.9	52.3	96.6	28.1	36.8	112.5	171.3

Notes: 1) Answer of Refinery A

2) 1) x Lube oil consumption ratio (as Refinery A 1.00)

*1 Lube oil consumption of each year for 3 refineries is corresponded to CRUDE OIL TOPPING CAPACITY (source: EMP).

		1983	1993	Capacity Increase Ratio Between 1983/1993
Topping Capacity (1,000 bbl)	Ref.A	20,075	23,725	1.1818
	Ref.B	23,725	43,800	1.8462
	Ref.C	17,520	22,995	1.3125
		61,320	90,520	1.4762

The lube oil consumption for increase topping capacity of every year is a half.

6-2 Viscose Rayon

(1) Viscose Rayon Production in 1983, Answer of Company A:
17,000 ton

The future average annual growth rate of viscose rayon production in Thailand is estimated zero.

(2) Lube Oil Consumption in 1983 and 1993

	1983 (kl)	1993 (kl)
Industrial Oil	8	8
Grease	1.2	1.2
Total	9.2	9.2

Note: The lube oil consumption in 1983 is the answer of Company A.

6-3 Nylon and Polyester

(1) Nominal (Name Plate) Capacity and Production in Thailand

	<u>Polyester Staple</u>	<u>Polyester Filament</u>	<u>Nylon Filament</u>	<u>Nylon Staple</u>	<u>Total</u>
Nominal Capacity in 1982 (ton/day)					
Teijin	120	30	-	-	150
Thai Melon	60	20	-	-	80
Toray Nylon Thai	-	20	15	-	35
Asia Fiber	-	-	15	-	15
Hantex	-	7	12	-	19
Oriental Fiber	-	-	-	45	45
Total	180	77	42	45	344
Production in 1982 (ton/year)					(113,520 ¹⁾)
	48,958	19,726	13,634	82,318	

Note: 1) 344 ton/day x 330 days = 113,520 ton/year (Nominal Capacity)

Source: Japan Chemical Fiber Association

Average annual growth rate is 8.9% which is estimated from EMP data of the raw textile growth rate between 1982 (1,385 MMSY) and 2001 (6,992 MMSY).

(2) Production and Lube Oil Consumption, Answer of Company A

Production in 1983	
Nylon Filament Yarn	6,866 ton/year
<u>Polyester Filament Yarn</u>	<u>7,682 ton/year</u>
Total	14,548 ton/year

Lube oil consumption in 1983

Industrial Oil	23,374 lit ¹⁾ / 14,548 ton/year	= 1.61 lit/ton
Grease	234 lit ¹⁾ / 14,548 ton/year	= 0.016 lit/ton
<u>Total</u>	<u>23,608 lit</u>	

Source: 1) Answer of Company A

(3) Production and Lubricating Oil Consumption in Thailand in 1983 and 1993

	<u>Nylon and Polyester Production¹⁾</u> (ton)	<u>Industrial Oil²⁾</u> (kl)	<u>Grease²⁾</u> (kl)	<u>Total</u> (kl)
1983	89,644	139	1.4	140.4
1993	210,282	257	2.6	259.6

Notes: 1) The consultant estimates production in 1983 and 1993 based on the data of Japanese Chemical and Fibre Association 82,318 ton in 1982, and growth rate 8.9% which is raw textile growth rate estimated by EMP.

2) Answer of Company A

1. The lube oil consumption for increased production of each year is a half.

2. The consultant assumes when production is increased 1.5 times (50% up) of 1983 production, a new plant is installed. The year of newly installation the lube oil consumption is 100%.

6-4 Textile Fabric

(1) Textile Machineries in Thailand

Number of textile machineries is shown in Table AII-1-9.

Average annual growth rate of spinning is 10.2% from 1971 to 1981, and that of weaving is 5.3%, but the Consultant estimates those growth rates of 8.9% as is estimated by EMP.

(2) Unit Lube Oil Consumption

Unit lube oil consumption of spinning and waring are show in Table AII-1-10.

(3) Number of Machines and Lube Oil Consumption in Thailand in 1983 and 1993

	Number of ¹⁾ Machineries Units	Engine ²⁾ Oil (kl)	Industrial ²⁾ Oil (kl)	Grease ²⁾ (kl)	Total (kl)
in 1983					
Spinning	1,572,748	-	60	12	72
Weaving	57,338	8	177	1.7	186.7
Total		8	237	13.7	258.7
in 1993					
Spinning	1,712,726	-	140	28	168
Weaving	62,441	19	415	4	438
Total		19	555	32	606

Notes: 1) Estimated from Table AII-1-9.

2) Estimated from Table AII-1-10.

The lube oil consumption for increase number of machineries for each year is 100%, not a half, because the textile industry is gathering small machines.

6-5 Fertilizer (Excepting New Fertilizer Plant Based on Natural Gas)

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production: 252,050 ton

Lubricating Oil Consumption and Unit Consumption

Engine Oil	3,947 lit./252,050 ton = 0.0157 kl/ 1,000 ton
Industrial Oil	24,112 lit./252,050 ton = 0.0957 kl/ 1,000 ton
Grease	2,084 lit./252,000 ton = 0.0083 kl/ 1,000 ton

30,143 lit.

(2) Thai Production

Production in 1983: 290,000 ton

(Source: Company B)

Average annual growth rate is the same with Thai GDP growth rate.

(3) Production and Lubricating Oil Consumption in Thailand in 1983 and 1993

	Compound Fertilizer (1,000 ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	290	5	28	2.4	35.4
1993	368	5	32	2.8	39.8

Notes: (1) The lube oil consumption for increased production of each year is a half.

(2) New fertilizer project will be completed in October 1986, thus the production of existing plant will not be increased after 1987.

6-6 Sugar

(1) Process Sugar Production and Lube Oil Consumption in 1983, Answer of Company A.

Production

White Sugar	34,042.45 ton
Refined Sugar	39,852.80 ton
Raw Sugar	73,864.03 ton
Total	147,759.28 ton

Lube Oil consumption and unit consumption

Engine Oil	6,279.5 lit./147,759.28 ton = 0.042 kl/1,000 ton
Industrial Oil	53,922.0 lit./147,759.28 ton = 0.365 kl/1,000 ton
Grease	1,745.5 lit./147,759.28 ton = 0.012 kl/1,000 ton
Total	61,947.0 lit.

(2) Sugar Production and Lube Oil Consumption in Thailand
Between 1983 and 1993

PROCESS SUGAR PRODUCTION AND LUBE OIL CONSUMPTION

	Process Sugar Production (1,000 ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1982	2,768 ¹⁾	116.3	1,010.3	33.2	1,159.8
83	2,666	114.2	991.7	32.6	1,138.5
84	2,568	112.1	973.8	32.0	1,117.9
85	2,473	110.1	956.5	31.4	1,098.1
86	2,382 ¹⁾	108.2	939.9	30.9	1,079.0
87	2,525	111.2	966.0	31.8	1,109.0
88	2,676	114.4	993.6	32.7	1,140.7
89	2,837	117.8	1,023.0	33.7	1,174.5
1990	3,007	121.4	1,054.0	34.7	1,210.1
91	3,187 ¹⁾	125.2	1,086.9	35.8	1,247.9
92	3,378	129.2	1,121.8	36.9	1,287.9
93	3,581	133.5	1,158.8	38.1	1,330.4

Note: 1) Source: EMP

Production other than the above is estimated
by the Consultant based on EMP data.

The lube oil consumption for increased or decreased
production of every year is a half.

6-7 Rubber

(1) Tires and Inner Tubes Production and Lube Oil Consumption in 1983, Answer of Company A

Production

	<u>Tires</u>	<u> Tubes</u>
Vehicle (Standard Type)	61,784	43,973
Vehicle (Radial Type)	181,250	
Pick up	292,241	167,321
Bus & Truck	139,079	121,265
Tractor (Front Wheel)	11,597	12,402
Tractor (Rear Wheel)	14,145	12,068
Grades	12,011	13,142
Total	712,107	370,171
	Total	1,082,278

Lube Oil Consumption and Unit Consumption

		<u>Unit Lube Oil Consumption</u>
Engine Oil	627 lit.	0.58 lit./1,000 tires and tubes
Industrial Oil	16,326 lit.	15.08 lit./1,000 tires and tubes
<u>Grease</u>	<u>3,420 lit.</u>	
	20,373 lit.	

(2) Production of Tires and Tubes and Average Annual Growth Rate in Thailand

TYRES AND TUBES PRODUCTION, 1976-1980

	Passenger Car Tyres	Truck and Bus Tyres	Tractor Tyres	Tubes & inner rubber	Total tyres	(Units)
						Total
1976	463,922	826,050	42,289	1,332,261	803,780	2,136,041
1977	573,065	1,101,416	60,868	1,735,349	1,004,727	2,740,076
1978	708,680	1,285,822	64,498	2,059,000	1,118,864	3,177,864
1979	575,766	1,219,551	49,379	1,844,696	1,213,285	3,057,981
1980	517,007	1,151,409	49,414	1,718,830	1,345,420	3,064,250
1983						3,650,000
1988						6,536,000

Average annual growth rate based on Bank of Thailand data between 1976 and 1980 is 9.4% in total. But the Consultant estimates growth rate of tires and tubes as 6% of the growth rate of vehicles.

(3) Production of Tires and Tubes and Lube Oil Consumption in Thailand in 1983 and 1993

PRODUCTION OF TIRES AND TUBES

	Production of Tires and Tubes (1,000 units)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	3,650	2.1	51	10.6	63.7
1993	6,536	3.2	76	14.2	93.4

6-8 Plywood

(1) Production of Plywood and Lube Oil Consumption, Answer of Ministry of Agriculture and Cooperatives of Thailand

Kind of Plywood	1982	1983	1985	1990	1995
Plywood (sheet)	2,014,323	2,497,232	2,800,000	3,600,000	4,000,000
Hard board (sheet)	3,241,157	4,088,500	4,500,000	5,500,000	7,000,000
Total	5,255,480	6,585,732	7,300,000	9,100,000	11,000,000
Lube Oil (lit.)	43,724	51,945	54,500	59,950	64,900
Grease (lit.)	2,012	2,160	2,200	2,300	2,390
Total	45,736	54,105	56,700	62,250	67,290

(2) Production of Plywood and Lube Oil Consumption in Thailand Between 1983 and 1993

	Production (1,000 sheets)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	6,586 ¹⁾	51.9 ¹⁾	2.2 ¹⁾	54.1 ¹⁾
1984	6,943	53.2	2.2	55.4
1985	7,300 ¹⁾	54.5 ¹⁾	2.2 ¹⁾	56.7 ²⁾
1986	7,629	55.6	2.2	57.8
1987	7,973	56.6	2.2	58.9
1988	8,332	57.7	2.3	60.0
1989	8,708	58.9	2.3	61.2
1990	9,100 ¹⁾	60.0 ¹⁾	2.3 ¹⁾	62.3 ¹⁾
1991	9,452	60.0	2.3	63.2
1992	9,817	61.9	2.3	64.2
1993	10,197	62.9	2.4	65.3

Note: 1) Data of production and lube oil consumption is mentioned in above figure.

Source: Ministry of Agriculture and Cooperatives of Thailand

6-9 Cement

(1) Production of Cement and Lube Oil Consumption in 1983,
Answer of Company A

Production:

Mixed Cement	3,264,000 ton
Portland Cement (X)	1,359,000 ton
Portland Cement (Y)	124,000 ton
Total	4,747,000 ton

Lube oil consumption and unit consumption:

Engine Oil	85,422 lit./4,747,000 ton = 0.0180 kl/1,000 ton
Industrial Oil	168,138 lit./4,747,000 ton = 0.0354 kl/1,000 ton
Grease	3,767 lit./4,747,000 ton = 0.00079 kl/1,000 ton
Total	257,327 lit.

(2) Cement Production in Thailand Between 1982 and 2001

	<u>1982</u>	<u>1986</u>	<u>1991</u>	<u>1996</u>	<u>2001</u>
Cement (million ton)	6.66	8.53	11.52	15.57	21.03

(Source: EMP)

(3) Production of Cement and Lube Oil Consumption in Thailand Between 1983 and 1993

PRODUCTION AND LUBE OIL CONSUMPTION

	Production ¹⁾ (million ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	7.09	124	244	6	374
1993	13.00	183	360	8	551

Note: 1) The production in each year is estimated based on EMP data.

1. The lubricating oil consumption for increased production in each year is a half.
2. The year of newly installation, the lube oil consumption is 100%.

6-10 Plate Glass

(1) Production of Plate Glass and Lube Oil Consumption, Answer of Company A

Production in 1983:

Sheet Glass: 5,000 cases/day

4 kg/case x 5,000 cases = 225,000 kg/day

= 74,250 ton/year

(Operation days: 330)

(2) Lube Oil Consumption in 1983

	<u>lit</u>	<u>Unit kl/1,000 ton</u>
Engine Oil	1,764	0.0238
Industrial Oil	3,873	0.0522
Grease	2,006	0.0270
Total	7,643	

(3) Plate Glass production in Thailand

	<u>1982</u>	<u>1986</u>	<u>1991</u>	<u>1996</u>	<u>2001</u>
Plate Glass (1,000 ton)	85	102	139	188	255

(Source: EMP)

(4) Production of Plate Glass and Lube Oil Consumption in Thailand in 1983 and 1993

	<u>Plate glass Production¹⁾ (1,000 ton)</u>	<u>Engine²⁾ Oil (kl)</u>	<u>Industrial²⁾ Oil (kl)</u>	<u>Grease²⁾ (kl)</u>	<u>Total (kl)</u>
1983	69	2.1	4.6	2.4	9.1
1993	157	3.7	8.2	4.2	16.1

Notes: 1) The production of each year is estimated based on EMP data.

2) The lube oil consumption for increased production is not a half, because the lube oil consumption is very small.

6-11 Caustic Soda

(1) Production of Caustic Soda and Lube Oil Consumption in 1983, Answer of A Company

Production in 1983:

NaOH 60,739 ton

Caustic Soda Production in Thailand is same as Company A.

(2) Lube Oil consumption

Engine Oil 14,400 liter

(3) Forecast of Caustic Soda Production

New petrochemical project is completed in July 1987, thus the caustic soda production by existing plant will not be increased after 1988.

(4) Average Annual Growth Rate

	<u>1970</u>	<u>1980</u>	
NaOH Production in Thailand	32,745	62,130	Growth Rate 6.6% p.a. (1970-1980)

Source: Bangkok and Japan Trading Center.

(5) Lube Oil Consumption in 1983 and 1984

	<u>NaOH Production (ton)</u>	<u>Industrial Oil (kl)</u>
1983	60,739	14.4
1993	78,433	18.6

Note: The lube oil consumption is not a half for increasing product, because the lube oil consumption is very small.

6-12 Gas (O₂, N₂)

(1) Production of Oxygen and Nitrogen Gas and Lube Oil Consumption in 1983; Answer of A Company

Production

Liquid Oxygen	6,704,000 SM ³
<u>Nitrogen</u>	<u>3,270,000 SM³</u>
Total	9,974,000 SM ³

Lube Oil Consumption

Engine Oil	50 lit.
<u>Industrial Oil</u>	<u>12,400 lit.</u>
Total	12,450 lit.

(2) Gas (O₂, N₂) Production in Thailand

There are 6 similar kind of companies (source: Siam Directory), therefore the consultant estimates that Thai production is 5 times of Company A's production to be considered plant size.

Production in 1983

$$9,974,000 \text{ SM}^3 \times 5 = 49,870 \times 10^3 \text{ SM}^3$$

Lube Oil Consumption in 1983

$$\begin{aligned} \text{Engine Oil} & 50 \text{ lit.} \times 5 = 250 \text{ lit.} = 0.3 \text{ kl} \\ \text{Industrial Oil} & 1,243 \text{ lit.} \times 5 = 6,215 \text{ lit.} = 6.2 \text{ kl} \end{aligned}$$

(3) Average Annual Growth Rate

Average annual growth rate is estimated as follows which is the same of estimated growth rate of GDP.

(4) Production and Lube Oil Consumption in 1983 and 1993

	<u>Production of Gases (1,000 SM³)</u>	<u>Engine Oil (kl)</u>	<u>Industrial Oil (kl)</u>	<u>Total (kl)</u>
1983	49,870	0.3	62	62.3
1993	92,301	0.4	92	92.4

Note: The lube oil consumption for increasing production in each year is a half. The year of newly installation the lube oil consumption is 100%.

6-13 Steel and Iron (Electric Furnace Products)

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production: 147,934.98 ton

Lube oil consumption and Unit Consumption

Engine Oil	19,049.00 lit./147,934.98 ton	= 0.1288 kl/1,000 ton
Industrial Oil	15,753.65 lit./147,934.98 ton	= 0.1065 kl/1,000 ton
Grease	55,728 lit./147,934.38 ton	= 0.3767 kl/1,000 ton
Total	90,530.65	

(2) Thai Electric Furnace Production

Name of Company	Annual Production Capacity	Production Past Record		
		1977	1978	1979
The Bangkok Iron Steel Works Co., Ltd.	120,000 MT	47,400	48,700	39,200
Bangkok Steel Industries Ltd.	90,000 MT	44,000	70,000	70,000
G.S. Steel Co., Ltd.	140,000 MT	95,000	100,000	117,000
The Siam Iron & Steel Co., Ltd.	135,000 MT	96,200	127,500	127,000
Thai India Steel Co., Ltd.	42,000 MT	N.A.	16,000	21,000
Thai Pattana Casting Steel Co., Ltd.		N.A.	N.A.	8,000
Total	527,000	282,600	362,200	382,200

Average annual growth rate was 16% between 1977 and 1979.

The consultant estimates the growth rate in 1979 as 16%, then the growth rate has been going down 1% every year, and after 1988 the growth rate will be constant of as 7%.

(3) Lube Oil Consumption in 1983 and 1993

	Electric Furnace Products Production (1,000 ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	634	65	53	192	310
1993	1,367	122	100	371	593

Note: Lube Oil Consumption is a half for increased production. The year of newly installation the lube oil consumption is 100%.

6-14 Parts

(1) Production and Lube Oil Consumption in 1983, Answer of Company A and Company B

1. Answer of A company

Products: Vehicle part

Lube Oil Consumption: Engine Oil 4.5 kl

There are 12 similar companies (Source: Siam Directory).

2. Answer of Company B

Products: Pipes and Fittings 2,600 ton

Lube Oil Consumption: Engine Oil 0.3 kl

Industrial Oil 13.5 kl

There are 16 similar companies (Source: Siam Directory).

3. Total of Lube Oil Consumption

	<u>Engine Oil</u>	<u>Industrial Oil</u>
Vehicle Parts	$4.5 \times 12 = 54 \text{kl}$	-
Pipes and Fittings	$0.3 \times 16 = 5 \text{kl}$	$13.5 \times 16 = 216 \text{kl}$

(2) Average Annual Growth Rate

Average annual growth rate is estimated as the same of estimated growth rate of GDP.

(3) Lube Oil Consumption in 1983 and 1993

	<u>Engine Oil (kl)</u>	<u>Industrial Oil (kl)</u>	<u>Total (kl)</u>
1983	59	216	275
1993	109	399	508

Note: Parts shops are very small, so the consultant estimates lube oil consumption for increased production is not a half.

6-15 Plastic Polymer

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production:

PVC Resin	43,171 ton
<u>PVC Compound</u>	<u>20,044 ton</u>
Total	63,215 ton

Lube oil consumption:

Industrial Oil	9,053 liter
----------------	-------------

(2) Plastic Polymers Production in Thailand

	<u>1980¹⁾</u>	<u>1983²⁾</u>	<u>1993²⁾</u>
PVC Resin (ton)	48,000		
<u>PVC Compound (ton)</u>	<u>24,000</u>		
Total (ton)	62,000	73,843	136,670

Notes: 1) Source: Industrial Finance Corporation Thailand (IFCT)

2) The Consultant estimates the production by the growth rate of production is same to Thai GDP growth rates.

3. Lubricating Oil Consumption in 1983 and 1993

	<u>Plastic Polymer Production (ton)</u>	<u>Industrial Oil (kl)</u>
1983	73,843	10.6
1993	136,670	19.6

Note: Lube Oil consumption for increased production is not a half, because lube oil consumption is very small.

6-16 Paper

(1) Production and Lube Oil Consumption in 1983, Answer of Companies A, B, and C

	<u>Paper Production (ton)</u>	<u>Engine Oil (lit.)</u>	<u>Industrial Oil (lit.)</u>	<u>Grease (lit.)</u>	<u>Total (lit.)</u>
Company A (Refined paper)	12,109.69	3,277	57,653	1,171	62,101
Company B (Tissue paper)	9,000	697	5,686	220	6,603
Company C (Board)	49,500		43,100		43,100
Total	70,609.69	3,974	106,439	1,391	111,804

(2) Paper Production in Thailand

	<u>1982</u>	<u>1986</u>	<u>1991</u>	<u>1996</u>	<u>2001</u>
Paper (1,000 ton)	362	748	1,102	1,624	2,392

(Source: EMP)

(3) Lube Oil Consumption in 1983 and 1993

	<u>Paper Production (1,000 ton)</u>	<u>Engine Oil (kl)</u>	<u>Industrial Oil (kl)</u>	<u>Grease (kl)</u>	<u>Total (kl)</u>
1983	434	22	600	8	630
1993	1,287	55	1,447	20	1,522

Note: Lube Oil Consumption is a half for increased production of every year, the year of newly installation the lube oil consumption is 100%.

6-17 Liquid CO₂ and Dry Ice

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

PRODUCTION AND LUBE OIL CONSUMPTION

	<u>Production</u>	<u>Lube Oil Consumption (Industrial Oil)</u>
Liquid CO ₂	2,900 ton	
Dry Ice	225 ton	
Total	3,125 ton	2.2 kl

(2) Liquid CO₂ and Dry Ice Production in Thailand

There are two companies producing liquid CO₂ and dry ice (Source: Siam Directory).

The Consultant estimates that Thai Production is 3 times of Company A's production due to the capacity.

$$3,125 \text{ ton} \times 3 = 9,375 \text{ ton in 1982}$$

(3) Average Annual Growth Rate

The consultant estimates the growth rates which is the same of estimated Thai GDP growth rate.

(4) Lubricating Oil Consumption in 1983 and 1993

	Liquid CO ₂ & Dry Ice Production (1,000 ton)	Industrial Oil (kl)
1983	10.0	7.0
1993	18.5	13.0

Notes: (1) Lube oil consumption for increased production is not a half because lube oil consumption is very small.

(2) Liquid CO₂ and dry ice production capacity is big, so it is not necessary to install new plant within 1993.

6-18 Beverage

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production:

Beer and Soft Drink 180,802 kl

Lube oil consumption

	lit.	Unit consumption (kl/1,000 kl)
Engine Oil	10,023	0.0554
Industrial Oil	5,016	0.0277
Total	15,039	

(2) Beverage Production in Thailand

	<u>1982</u>	<u>1986</u>	<u>1991</u>	<u>1996</u>	<u>2001</u>
Beverage (10 ⁶ ton)	1.05	1.40	2.04	1.96	4.31

(Source: EMP)

The Consultant assumed 1 ton of beverage is same as 1kl.

(3) Lube Oil Consumption

	<u>Beverage Production (1,000 kl)</u>	<u>Engine Oil (kl)</u>	<u>Industrial Oil (kl)</u>	<u>Grease (kl)</u>	<u>Total (kl)</u>
1983	1,128	60.4	30.2	0.8	91.4
1993	2,368	102.7	51.3	1.4	155.4

Notes: Lube oil consumption for increased production of each year is a half. And the year of newly installation of plant is 100%.

CONCLUSION "6" MANUFACTURING

LUBRICATING OIL CONSUMPTION (1)
MANUFACTURING (1)

	Answer for Questionnaire				1 9 8 3				Average Growth Rate (1983-1993)		
	Lubricating Oil Consumption (kl)		Lubricating Oil Consumption (kl)		Lubricating Oil Consumption (kl)		Lubricating Oil Consumption (kl)				
	Production	Engine Oil	Industrial Grease	Total	Production	Engine Oil	Industrial Grease	Total			
6-1 Refinery	Topping Cap. of A Ref. *) 2,726,000kl	1.8	30.3	-	32.1	Topping Capacity 61,320,000kl	6.3	106.2	-	112.5	NEA Data
6-2 Viscose Rayon	17,000 ton	-	8.0	1.2	9.2	17,000 ton	-	8.0	1.2	9.2	0
6-3 Nylon Acid Polyester	14,548 ton	-	23.374	0.234	23.608	89,644 ton	-	139.0	1.4	140.4	8.9
6-4 Textile Fabric		N.A.					8.0	237.0	13.7	258.7	8.9
6-5 Fertilizer	252,050 ton	3.947	24.112	2.084	30.143	290,000 ton	5.0	28.0	2.4	35.4	GDP Growth Rate
6-6 Sugar	147,759 ton	6.2785	53.922	1.7455	61.947	2,666,000 ton	114.2	991.7	32.6	1,138.5	EMP Data
6-7 Rubber	1,082,000 Tires & Tubes	0.627	16.326	3.42	20.373	3,650,000 tires & Tubes	2.1	51.0	10.6	63.7	6
6-8 Plywood	6,586,000 Sheets	-	51.945	2.16	54.105	6,586,000 Sheets	-	51.9	2.2	54.1	Government Data
6-9 Cement	4,747,000 ton	85.422	168.138	3.767	257.327	7,090,000 ton	124.0	244.0	6.0	374.0	EMP Data
6-10 Plate Glass	74,250 ton	1.764	3.873	2.006	7.643	89,000 ton	2.1	4.6	2.4	9.1	EMP Data
6-11 Caustic Soda	60,739 ton	14.400	-	-	14.4	60,739 ton	14.4	-	-	14.4	6.6

Note: *) 1982

CONCLUSION "6" MANUFACTURING

LUBRICATING OIL CONSUMPTION (1)
MANUFACTURING (2)

	Answer for Questionnaire				1 9 8 3			Average Growth Rate (1983-1993)			
	Production	Engine Oil (Ton)	Industrial Grease (Ton)	Total	Production	Engine Oil (Ton)	Lubricating Oil Consumption (kl)				
6-12 Gas (O ₂ , N ₂)	9,974,000 am ³	0.05	12.4	-	12.45	49,870 am ³	0.3	62.0	-	62.3	GDP Growth Rate
6-13 Steel and Iron	147,935,000 ton	19,049	15,754	55,728	90,531	634,000 ton	65.0	53.0	192.0	310.0	16% - 7%
6-14 Parts	Answer of 2 Companies	4.8	13.5	-	18.3	-	59.0	216.0	-	275.0	GDP Growth Rate
6-15 Plaste Polymer	63,215 ton	-	9,053	-	9,053	73,843 ton	-	10.6	-	10.6	GDP Growth Rate
6-16 Paper	70,610,000 ton	3,974	106.44	1.39	111,804	434,000 ton	22.0	600.0	8.0	630.0	EMP Data
6-17 Liquid CO ₂ of Dry Ice	3,125 ton	-	2.2	-	2.2	10,000 ton	-	7.0	-	7.0	GDP Growth Rate
6-18 Beverage	180,802 kl	10,023	5,016	-	15,039	1,128,000 kl	60.4	30.2	0.8	91.4	EMP Data
Total							482.8	2,840.2	273.3	3,596.3	
Plus 10%							591.1	3,124.2	300.6	3,955.9	

CONCLUSION "6" MANUFACTURING

LUBRICATING OIL CONSUMPTION (2)
MANUFACTURING (1)

Production	1 9 9 3			Remarks
	Engine Oil	Industrial Grease	Total	
90,520,000 barrels	9.6	161.7	-	171.3
6-1 Refinery				
17,000 ton	-	8.0	1.2	9.2
6-2 Viscope Rayon				
210,282 ton	-	257.0	2.6	259.6
6-3 Nylon and Polyester				
Textile Fabric	19.0	555.0	32.0	606.0
6-4 Textile Fabric				
368,000 ton	5.0	32.0	2.8	39.8
6-5 Fertilizer				
3,501,000 ton	133.5	1,150.0	38.1	1,330.4
6-6 Sugar				
6,536,000 Tires & Tubes	3.2	76.0	14.2	93.4
6-7 Rubber				
10,197,000 Sheet	-	62.9	2.4	65.3
6-8 Plywood				
13,000,000 ton	183.0	360.0	8.0	551.0
6-9 Cement				
157,000 ton	3.7	8.2	4.2	16.1
6-10 Plate Glass				
78,433 ton	10.6	-	-	18.6
6-11 Caustic Soda				

CONCLUSION "6" MANUFACTURING

LUBRICATING OIL CONSUMPTION (2)
MANUFACTURING (2)

Production	1993 Lubricating Oil Consumption (kl)			Remarks
	Engine Oil	Industrial Oil	Grease Total	
Gas 6-12 (O ₂ , N ₂ , and others)	92,301,000 sm ³	0.4	92.0	- 92.4
6-13 Steel and Iron	1,367,000 ton	122.0	100.0	371.0 593.0 Electric furnace products
6-14 Parts		109.0	399.0	- 508.0 Parts of vehicle, pipes and fittings
6-15 Plastic Polymer	136,670 ton	-	19.6	- 19.6
6-16 Paper	1,287,000 ton	55.0	1,447.0	20.0 1,522.0
6-17 Dry Ice	18,500 ton	-	13.0	- 13.0
6-18 Beverage	2,368,000 ton	102.7	51.3	1.4 155.4
Total		764.7	4,801.5	497.9 6,064.1
Plus 10%		841.2	5,281.7	547.7 6,670.6

7 New Project

7-1 Gas Separation Plant

- (1) Treated Gas 350 SCFD
- (2) Completion Date Nov. 14, 1984
- (3) Production

Production for Gas Separation Project

C ₂	358,000 ton/year
C ₃	223,000 ton/year
LPG (C ₃ , C ₄)	250,000 ton/year (C ₃ 35%)
NGL	83,000 ton/year

(4) Lube Oil Consumption for Gas Separation

Lubricating oil consumption for gas Separation project:

	1984	(Unit: kl) 1985
Engine Oil	12	82.0
Industrial Oil	32	58.46
Grease	0.037	0.13
Total	44.037	140.59

(Source: Constructor)

Note: Lube oil consumption in 1993 is same as in 1985.

7-2 Fertilizer Project

A fertilizer project in Thailand now under planning stage and the expected lube oil consumption by the project are shown in the table below.

	Lube Oil Consumption (lit./1,000ton*)		Expected Capacity in Thailand (ton/day)	Annual Production (297 days/ year)	Lube Oil Consumption (kl)			
	Engine Oil	Industrial Grease			Engine Oil	Industrial Oil	Grease Total	
Ammonia	0.465		900	267,300		124		124
Urea	0.270		1,000	297,000		80		80
Sulfuric Acid	0.150		2,180	647,460		65		65
Phosphoric Acid	0.230		720	213,840		49		49
Phosphate and Compound Fer- tilizer	0.02	0.01	2,130	632,610	13	63		82
Total					13	381	6	400

Notes: * Based on Japanese experience

** Completion date: October 1986

Lube Oil Consumption in 1983 and 1993

	<u>1983</u>	<u>1993</u>
Engine Oil	0	13
Industrial Oil	0	381
Grease	0	6
Total	0	400

7-3 Rock Salt Project

(1) Rock Salt Production

Production: 1,800,000 ton

(2) Completion date: July 1985

(3) Lubricating oil consumption for salt project:

20% on total consumption is engine oil and 5% is grease (estimated by the Consultant from the experience in Japan).

(Unit: kl)

	<u>1983</u>	<u>1993</u>
Engine Oil	0	106
Industrial Oil	0	398
Grease	0	27
Total		531

7-4 Soda Ash Project

(1) Production: 400,000 ton/year

(2) Completion Date: July 1985

(3) Lube Oil Consumption: 139.7 kl

(Unit: kl)

	<u>1983</u>	<u>1993</u>
Engine Oil	0	28
Industrial Oil	0	111
Grease (ton)	0	0.7
Total		139.7

Note: 1) Estimated by the experience in Japan.

7-5 Petrochemical Project

	Lube ¹⁾ Oil Consumption (kl/1,000 ton)		Expected ²⁾ Capacity (ton)	Lube Oil Consumption(kl)		
	Industrial Oil	Grease		Industrial Oil	Grease	Total
Ethylene Propylene	0.082	0.000355	300,000 73,000	25.0	0.01	25.01
LDPE	2.619	-	73,500	192.0	-	192.0
HDPE	0.0614	0.0020	110,000	7.0	0.23	7.23
VCM	0.125		80,000	10.0	-	10.0
EG	0.0089	0.00021	50,000	0.4	0.01	0.41
PP	0.002225	0.0056	70,000	1.6	0.39	1.99
				236.0	0.64	236.64

- Notes: 1) Source: Estimated by the experience in Japan
 2) Completion date: 1987

LUBRICATING OIL CONSUMPTION IN 1983 AND 1993

	(Unit: kl)	
	1983	1993
Industrial Oil	0	236.0
Grease	0	0.64
Total	0	236.64

7-6 Caustic Soda Project

Chlorine projection from caustic soda project meets to chlorine for vinyl chloride production.

Caustic soda production will be 55,000 ton/year, and completion date is in 1987.

Lube oil consumption is same as Section 6-11.

Engine Oil	14,400 liter
NaOH Production	60,739 ton
Unit Lube Oil Consumption	0.237 lit/ton

Lube Oil Consumption in 1983 and 1993

	<u>1983</u>	(Unit: kl) <u>1993</u>
Engine Oil	0	13

CONCLUSION OF "7" NEW PROJECT

LUBRICATING OIL CONSUMPTION (2)
NEW PROJECT

Consumption Date	1 9 9 3 Lubricating Oil Consumption (kl)			Production
	Engine Oil	Industrial Oil	Grease Total	
7-1 Gas Separation Nov. 1984	82.0	58.46	0.13	140.59 C ₂ 358,000 ton, C ₃ 223,000 ton, LPG 250,000 ton, NGL 83,000 ton
7-2 Fertilizer Oct. 1986	13.0	381.0	6.0	400.0 Ammonia 267,300 ton, Urea 297,000 ton, Sulfuric acid 647,460 ton Phosphoric acid 213,840 ton, Ammonium phosphate and Compound fertilizer 632,610 ton
7-3 Rock Salt July 1985	106.0	398.0	27.0	531.0 Rock salt 1,800,000 ton
7-4 Soda Ash July 1985	28.0	111.0	0.7	139.7 Soda ash 400,000 ton
7-5 Petro-chemical 1987	-	236.0	0.64	236.64 Ethylene 300,000 ton, Propylene 73,000 ton, LDPE 73,500 ton, HDPE 110,000 ton, VCM 80,000 ton, EG 50,000 ton, PP 70,000 ton
7-6 Caustic Soda 1987	13.0	-	-	13.0 Caustic soda 53,000 ton
Total	242.0	1,184.46	34.47	1,460.93

OVERALL LUBRICATING OIL CONSUMPTION FOR INDUSTRY

LUBRICATING OIL CONSUMPTION INDUSTRY

Item	Lube Oil Consumption (kl)								
	1983	1983	1983	1983					
	Engine Oil	Industrial Oil	Grease	Total					
1									
2	Transportation	1,829.5	504.6	0.32	2,334.4	3,273.0	442.2	0.18	3,715.4
3	Agriculture, Fishery, Forest, Cold Storage	12,873.1	6,660.0	-	19,533.1	20,447.1	11,871.0	-	32,318.1
4	Construction	403.0	1,210.0	-	1,613.0	793.0	2,380.0	-	3,173.0
5	Electric Power Generation	257.0	298.0	-	555.0	257.0	550.0	-	807.0
6	Manufacturing	531.1	3,124.2	300.6	3,955.9	841.2	5,281.7	547.7	6,670.6
7	New Project	0	0	0	0	242.0	1,184.46	34.47	1,460.93
	Lube Oil	15,893.7	11,796.8	300.92	27,991.4	25,853.3	21,709.4	582.3	48,145.0
	as Base Oil	14,622	10,853	238	25,713	23,785	19,973	461	44,219

Table AII-1-1 DATA OF VEHICLES

Table AII-1-1(1) Passenger Car

a) Past registered number of passenger car

(unit: 1,000)

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
221.8	235.0	240.1	250.9	270.5	290.4	298.4	331.3	362.4	387.3	393.0
1981	1982									
429.0	440.5									

b) Regression equation of number of passenger car

$$30.0665 + 0.00126575 \times \text{GDPR}$$

c) Estimation of number of passenger car

(unit: 1,000)

	1986	1991	1993	1996	2001
Estimated number	549.5	741.0	819.6	937.4	1,188.1

d) Average km per year (km/veh/year)

16,000 km/veh/year

e) Kilometer per liter fuel (km/lit.)

Gasoline 8.0 km/l

Diesel 9.2 km/l

f) Sales record of passenger car (Including Taxi)

1975	1976	1977	1978	1979	1980	1981	1982	1983
12,692	14,458	25,767	23,125	21,785	26,739	27,088	29,352	32,966

g) Interval of oil exchange: 5,000km in 1983 and 7,000km in 1993

Table AII-1-1(2) Truck

a) Past registered number of Truck

(unit: 1,000)

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
135.7	147.2	159.1	179.4	232.4	238.1	285.2	345.5	368.4	417.2	365.8
1981	1982									
413.1	466.7									

b) Regression equation of number of truck

$$-135.5579 + 0.0018571 \times \text{GDP}$$

c) Estimation of number of truck

(unit: 1,000)

	1986	1991	1993	1996	2001
Total	626.5	907.4	1,022.7	1,195.6	1,563.4
Heavy	81.4	118.0	133.0	155.4	203.2
Small	545.1	789.4	889.7	1,040.2	1,360.2

d) Average km per year (km/veh/year)

Heavy truck 80,000
Small truck 18,000

Small truck is used as small bus in Thailand, therefore consultant estimates 100,000 km/veh/year instead of 18,000.

e) Kilometer per liter fuel (km/lit.)

Heavy truck
Diesel 3.2 km/l

Small truck
Gasoline 6.14 km/l
Diesel 7.7 km/l

f) Sales record of truck

	1975	1976	1977	1978	1979	1980	1981	1982	1983
Heavy	4,462	7,277	10,147	7,696	7,297	5,262	6,425	5,355	7,057
Medium	2,241	2,978	4,372	4,042	3,899	3,034	3,535	2,826	4,118
Small	40,206	45,856	58,857	52,525	54,889	51,991	51,287	54,813	73,529
Total	46,909	56,111	13,376	64,263	66,045	60,267	61,247	62,994	84,704

Table AII-1-1(3) Motor Cycle

a) Past registered number of motor cycle

(unit: 1,000)

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
337.6	363.6	376.2	408.2	458.6	479.5	511.5	645.7	714.1	793.3	915.8

1981	1982
1,136.7	1,047.4

b) Regression equation of number of motor cycle

$$-355.4303 + 0.00432586 \times \text{GDPR}$$

c) Estimation of number of motor cycle

(unit: 1,000)

	1986	1991	1993	1996	2001
Estimated number	1,419.9	2,074.2	2,342.7	2,745.5	3,602.2

d) Average km per year (km/veh/year)

12,000 km/veh/year

e) Kilometer per liter fuel (km/lit.)

Gasoline 31.0 km/l

Table AII-1-1(4) Bus

a) Past registered number of buses

(unit: 1,000)

1970	1971	1972	1973	1974	1975	1976	1977	1978
18,715	18,302	20,153	21,573	22,050	22,717	19,603	27,425	28,127
1979	1980	1981						
28,424	29,913	31,402						

Source: Police Registration Department

b) Estimation of number of buses

Number of bus will not be increased in future and Consultant estimates number of buses in 1993 as 30,000 which is the same one in 1981.

c) Average km per year (km/veh/year)

65,000 km

Table AII-1-1(5) Taxi

a) Past registered number of Taxi

1975	1976	1977	1978	1979	1980	1981
15,724	20,902	20,247	18,430	19,191	18,682	N.A.

Include interurban serviced cars and non exceed 7 person commercial cars.

b) Historical data shows that number of Taxi will be constant in future.

c) Estimate of number of Taxis will be constant and 19,000 by 2001.

d) Average km per year (km/veh/year) 120,000 km/veh/year

Table AII-1-1(6) Tricycle

a) Past registered number of Tricycle

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
6,984	2,889	9,960	8,043	8,016	6,419	8,124	8,556	8,635	9,014

1980	1981
9,066	8,679

b) Historical data shows that number of Tri-cycle will be constant in future.

c) Estimated number of Tri-cycle number of Tri-cycle will be constant and 9000 by 2001.

d) Average km per year (km/veh/year) 80,000 km/veh/year.

**Table AII-1-2 CRUDE OIL IMPORT SOURCE
FOR THAILAND**

	1) 1982	2) 1983	3) 1993
Saudi Arabia	5,609	6,058	8,974
Qatar	686	741	1,098
Dubai	103	111	165
Oman	105	113	168
UAE	65	70	104
Malaysia	1,412	1,525	2,259
Brunei	447	483	715
China	116	125	186
	8,543	9,226	13,669

- Notes: 1) Source: OIL AND THAILAND 1982
 2) After 1983, import crude oil is corresponding to CRUDE OIL TOPPING CAPACITY (Sources: NEA's Base Data and EMP - scenario 1 which are collectively referred as NEA.)
 3) CRUDE OIL TOPPING CAPACITY (Source: EMP) has no data for after 1992, thus it is assumed that crude oil import in and after 1993 is as same as in 1992.

Table AII-1-3 ESTIMATED LUBE OIL CONSUMPTION FOR TRANSPORTATION OF IMPORTED CRUDE OIL IN 1982

Export Country	1) Imported Crude Volume ('000kt)	Tanker Size (Dwt)	Specific Gravity of crude	Cargo Capacity (kt)	Engine capacity (ps)	Sailing Speed (kn/hr)	Distance (nm)	Lube Oil Consumption (cc/HP-hr)	Sailing Time for Round trip (hr/voyage)	Number of Voyage per year	Lube Oil Consumption (kt/y)	3)
Saudi Arabia	5,609.4	90,000	0.87	93,100	21,600	13	4,509	0.16	693.7	60.2	144	
Qatar	685.8	90,000	0.84	96,400	21,600	13	4,509	0.16	693.7	7.1	17	
Dubai	103.0	90,000	0.87	93,100	21,600	13	4,293	0.16	660.0	1.1	3	
Oman	105.2	90,000	0.84	96,400	21,600	13	4,186	0.16	644.0	1.1	3	
UAE	65.2	90,000	0.82	97,600	21,600	13	4,368	0.16	697.0	0.7	2	
Malaysia	1,411.7	60,000	0.78	62,000	13,200	13	824	0.16	126.8	23.0	6	
Brunei	447.0	60,000	0.90	60,000	13,200	13	1,072	0.16	165.0	7.5	3	
(China	115.5)											
Total	8,427.3 (8,542.8)											178

Notes: 1) Source: OIL AND TITANIUM 1982

2) Lube oil requirement for crude oil import from China is assumed to be supplied by China.

3) As of 1982, lube oil requirements except China have been fulfilled by Thailand, but after 1993, it is assumed that all of lube oil requirements in Middle East will be supplied by Saudi Arabia.

Table AII-1-4 ESTIMATED LUBE OIL CONSUMPTION FOR TRANSPORTATION OF IMPORTED PETROLEUM PRODUCTS IN 1982

Export Country	1) Imported Fuel ('000kt)	2) Imported Lube Oil & Base Oil ('000kt)	Total ('000kt)	Tanker Size (DWT)	Cargo Capacity (kt)	Engine Capacity (ps)	Shipping Speed (kn/hr)	Shipping Distance (nm)	Lube Oil Consumption (cc/HP.hr)	Sailing Time for Round Trip (hr/voyage)	Number of Voyages Per Year	Lube Oil Consumption (kl/y)
Singapore	1,509	93	1,602	24,000	24,400	17,600	13	844	0.16	130.0	62.0	22.7
Middle East	301	-	301	2,000	2,000	2,000	13	814	0.16	130.0	47.0	2.0
Japan	94	8	102	25,000	24,400	17,600	13	4,519	0.16	693.7	12.8	24.0
(China)	162	26	188	2,000	2,000	2,000	13	3,015	0.16	464.0	15.0	7.6
Philippines	40	-	40	2,000	2,000	2,000	13	633	0.16	97.3	20.0	0.6
Australia	40	14	54	2,000	2,000	2,000	13	5,084	0.16	782.0	27.0	13.2
USA	56	3	59	2,000	2,000	2,000	13	8,967	0.16	1,380.0	30.0	6.8
Netherlands	-	9	9	2,000	2,000	2,000	13	5,320	0.16	-	-	1.3
Total	2,040	127	2,167									78.2
	2,202	153	2,355 (including China)									(Lube Oil supply by Thailand 51.1)

Notes: 1) Source: OIL AND THAILAND. Fuel includes LPG, gasoline, jet fuel, kerosene, diesel oil and fuel oil.

Small imports are omitted. actual total import in 1982 was 2,999,000 kl.

2) Source: Thai Customs

Small lube oil and base oil import sources are omitted. actual total import in 1982 was 162,000 kl.

3) Tanker size for lube oil and base oil from Singapore.

4) Lube oil supply share by Thailand in 1982. (For transportation of imported petro-products for Thailand.)

Origin of cargo	share (%)
From Middle East	100
From China	0
From other countries	50

Table AII-1-5 ESTIMATED LUBE OIL SUPPLY BY THAILAND REQUIRED FOR TRANSPORTATION OF PETRO-PRODUCTS IMPORTED TO THAILAND FROM 1982 THROUGH 1993

(Unit: 1000kl)

	Fuel Oil			Lube Oil & Base Oil			Total Import
	Demand (A)	Domestic Production (B)	Import (1) (C)	Import (2) (D)	Import (1) (E)	Import (2) (F)	
1982	11,136	8,822	2,314	1,241	162	68	1,309
1983	11,289	8,822	2,467	1,323	178	75	1,398
1984	11,443	8,822	2,621	1,350	165	70	1,420
1985	11,600	9,501	2,099	1,036	169	71	1,167
1986	11,759	10,187	1,572	843	171	72	915
1987	12,357	10,802	1,555	884	180	76	910
1988	12,985	10,802	2,183	1,171	189	79	1,250
1989	13,645	10,802	2,843	1,525	198	83	1,608
1990	14,339	13,023	1,316	706	209	88	794
1991	15,068	13,023	2,045	1,097	219	92	1,189
1992	16,426	13,023	3,403	1,825	0	0	1,825
1993	17,906	13,023	4,883	2,619	0	0	2,619

- Notes: 1) Source: Demand for petroleum products derived from GMP
 2) Source: OIL AND THAILAND 1982
 After 1983, estimated domestic production of fuel is corresponded to crude oil topping capacity (Source: NCA).
 3) (A)-(B).
 Actual fuel import was 2,298,000 kl in 1982 (Source: OIL AND THAILAND 1982).
 4) The fuel import for which required lube oil is supplied by Thailand.
 Middle East: 100%, China: 0%, other countries: 50%.
 (2,314 (Total)-331 (Middle East)-162 (China))/2=331=1,241 kl (in 1982)
 After 1983, it is assumed to correspond to fuel import 1).
 5) Lube oil and base oil imports in 1982 are based on the Customs data, and after 1983, it is assumed to correspond to fuel oil demand.
 6) The lube oil and base oil import for which required lube oil is supplied by Thailand.
 7) (D)+(F).
 Total volume of fuel and lube oil (including base oil) import for which required lube oil is assumed to be supplied by Thailand.

Table AII-1-6 AGRICULTURAL MACHINERIES IN USE AND GROWTH RATES

Description	1976	1977	1978	1979	1980	Average Annual Growth Rate (%)	Adjusted Annual Growth Rate (%)
	Power tillers	90,001	113,286	151,504	192,002	230,591	26.5
Mini-tractors	14,575	16,427	23,942	26,984	378,389	125.7	26.9
Large tractors	13,338	17,569	22,826	28,987	33,285	25.7	25.7
Motor rollers	9,882	9,000	8,700	8,200	8,000	-5.2	6.0
Sprayers	1,310,464	1,379,436	1,452,038	1,528,461	1,604,884	5.2	5.2
Diesel engines	56,891	68,219	81,923	89,775	107,730	17.3	17.3
Water pumps	251,288	277,084	317,328	359,306	473,975	17.2	17.2
Cleaning machines	42,342	47,423	53,114	59,488	66,806	12.1	12.1
Corn threshing machines	5,721	6,407	7,175	8,036	9,000	12.0	12.0
Rice threshing machines	3,955	4,430	4,902	5,557	6,224	12.0	12.0
Feed mixing machines	374	419	469	525	588	12.0	12.0
Windmills	1,937	2,169	2,429	2,721	3,047	12.0	12.0
Sugar cane cutters	-	-	-	-	5	19.0	19.0
Rice milling machinery	24,658	24,942	25,170	25,426	25,682	1.0	1.0

Source: Office of Agricultural Economics (OAE), Ministry of Agriculture & Cooperatives.

- Notes: 1. Since the number of mini-tractors in 1980 is doubtfully corrected to 37,238.9 units. Growth rate after such adjustment is 26.9%.
2. The average growth rate of the motor rollers is minus 5.2%, however it is assumed to be 6% as per GDP growth rate in Thailand.
3. The average growth rates of total agriculture machinery is assumed to be 5% till 1983, due to mechanization program which is completed in 1983. Annual growth rate of agricultural production is 3% during Fourth Year Plan, but agricultural machinery growth rate is expected to be more than 3%. Thus it is assumed to be 5%.
4. Water pump, corn threshing, rice threshing and rice milling machines are assumed to use gasoline engines. Total units of such items in 1980 are 514,831 and weighted average annual growth rate is 16.3%.
5. By similar experience in Japan, major tube off demand for agricultural equipment is caused by the items marked "m". Share of the other items, therefore, is assumed to be 20% in the total demand.

Table AII-1-7 ESTIMATED NUMBER OF AGRICULTURAL MACHINERIES FROM 1983 TO 1993

	Power Tillers		Mini-Tractor		Large-Tractor		Diesel Engine		Gasoline Engine	
	Growth Rate (%)	Number of Units	Growth Rate (%)	Number of Units	Growth Rate (%)	Number of Units	Growth Rate (%)	Number of Units	Growth Rate (%)	Number of Units
1983	26.5	466,782	26.9	77,326	25.7	66,100	17.3	173,872	16.3	810,872
1984	22.5	571,808	22.9	95,034	21.7	80,453	13.3	195,997	12.3	910,609
1985	18.3	677,592	18.9	112,995	17.7	94,694	9.1	214,924	8.3	986,190
1986	13.5	769,067	13.9	128,701	12.7	106,720	5.0	225,670	5.0	1,035,499
1987	8.5	834,438	8.9	140,156	7.7	114,937	5.0	236,954	5.0	1,087,274
1988	5.0	876,160	5.0	147,164	5.0	120,684	5.0	248,801	5.0	1,141,638
1989	5.0	919,968	5.0	154,522	5.0	126,718	5.0	261,241	5.0	1,198,720
1990	5.0	965,966	5.0	162,248	5.0	133,054	5.0	274,303	5.0	1,258,650
1991	5.0	1,014,265	5.0	170,361	5.0	139,707	5.0	288,018	5.0	1,321,588
1992	5.0	1,064,978	5.0	178,879	5.0	146,692	5.0	302,419	5.0	1,387,068
1993	5.0	1,118,227	5.0	187,823	5.0	154,027	5.0	317,540	5.0	1,457,051

Notes: Number of units for machineries are estimated from Table AII-1-5.

Table AII-1-8 ESTIMATED LUBE OIL CONSUMPTION BY AGRICULTURAL MACHINERIES IN 1983 AND 1993

	Machinery Units in 1983	3) Unit Lube Oil Consumption lit/Unit		Lube Oil Consumption in 1983 (kl)		Machineries Units in 1993	Lube Oil Consumption in 1993 (kl)	
		Engine Oil	Gear Oil	Engine Oil	Gear Oil		Engine Oil	Gear Oil
Power Tillers	466,702	4.2	2.8	1,960	1,307	1,118,227	4,697	3,131
Mini-Tractor	77,326	16.1	12.8	1,245	990	187,823	3,024	2,404
Large-Tractor	66,108	12.0	15.0	793	992	154,027	1,848	2,310
Diesel engine	173,872	1.6	-	278	-	317,540	508	-
Water Pump	810,872	1.6	-	1,297	-	1,457,051	2,331	-
Sub-total				5,573	3,289		12,408	7,845
				8,862			20,253	
2) Total				6,688	3,947		14,890	9,114
				10,635			24,304	

Notes: 1) Industrial Oil

2) Added 20% of the sub-total as the consumption for other item of machines.

3) Source: The experience of Japan, but adjust to meet Thai condition.

Table AII-1-9 NUMBER OF TEXTILE MACHINES

	Number of Spinning Machine	Number of Weaving Machine	Number of Knitting Machine
1971	538,958	32,332	5,222
1972	637,720	34,589	6,929
1973	773,404	39,503	9,373
1974	838,060	46,140	15,533
1975	1,094,652	48,836	21,700
1976	1,112,248	51,020	29,512
1977	1,129,144	52,168	30,417
1978	1,168,596	54,008	31,617
1979	1,300,844	57,567	34,190
1980	1,298,368	57,511	29,907
1981	1,541,684	58,180	31,555
1982	1,572,748	57,338	32,531

Source: Japan Spinning and Weaving Association

**Table AII-1-10 UNIT LUBE OIL CONSUMPTION
OF SPINNING AND WEAVING**

	Spinning lit/100,000 units	Weaving lit/1,000 units
Engine Oil	-	132
R.S spindle Oil	1,500	
) 3,500	2,841
Industrial Oil	2,000	
Grease	700	27
Total	4,200	3,000

Source: Japanese company