Table Ⅱ－5－1 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (COLUMN AND DRUM) (1/3)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
V1	Evaporator	Cappcity : 11.3㎥ Dimension : 2,010㎜φ× 6,397㎜ H	1	with insulation and no tray
C1A	Heckman No.1A	Cappcity : 43.5㎥ Dimension : 2,025㎜φ×13,510㎜ H	1	with 21 trays and no insulation;not in use
C1B	Heckman No.1B	Cappcity : 43.5㎥ Dimension : 2,025㎜φ×13,510㎜ H	1	with 21 trays and insulation
C2	Heckman No.2	Cappcity : 25.4㎥ Dimension : 1,800㎜φ×10,000㎜ H	1	with 16 trays and insulation
C3	Heckman No.3 (Kerosine Stripper)	Cappcity : 5.6㎥ Dimension : 1,000㎜φ× 7,090㎜ H	1	with 10 trays and insulation
C4	Residue Stripper	Cappcity : 4.8㎥ Dimension : 1,000㎜φ× 6,130㎜ H	1	with 6 trays and insulation

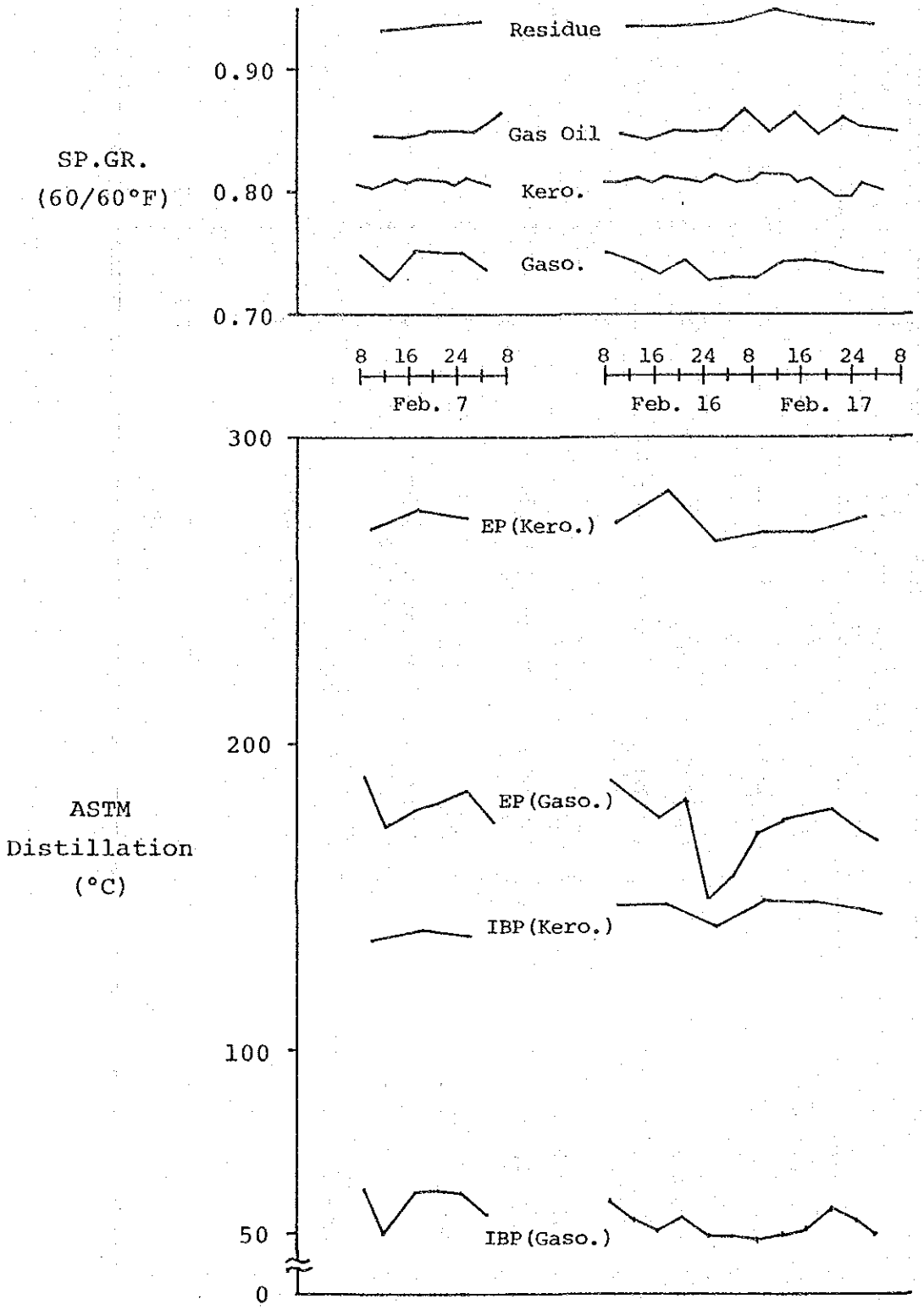
Table Ⅱ－5－1 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (COLUMN AND DRUM) (2/3)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
C 5	Solar Stripper	Cappcity : 4.8㎥ Dimension : 1,000㎜φ × 6,130㎜ H	1	with 6 trays and insulation
V 2	Separator No. 1 (for Gasoline)	Cappcity : 4.7㎥ Dimension : 1,135㎜φ × 4,670㎜ H	1	
V 3	Separator No. 2 (for Gasoline)	Cappcity : 1.5㎥ Dimension : 613㎜φ × 4,930㎜ H	1	
V 4	Separator No. 3 (for Gasoline)	Cappcity : 0.5㎥ Dimension : 380㎜φ × 4,540㎜ H	1	
V 5	Separator No. 4 (for Gasoline)	Cappcity : 0.4㎥ Dimension : 337㎜φ × 4,400㎜ H	1	
V 6	Separator No. 5 (for Kerosine)	Cappcity : 0.4㎥ Dimension : 337㎜φ × 4,385㎜ H	1	

Table Ⅱ－5－1 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (COLUMN AND DRUM) (3/3)

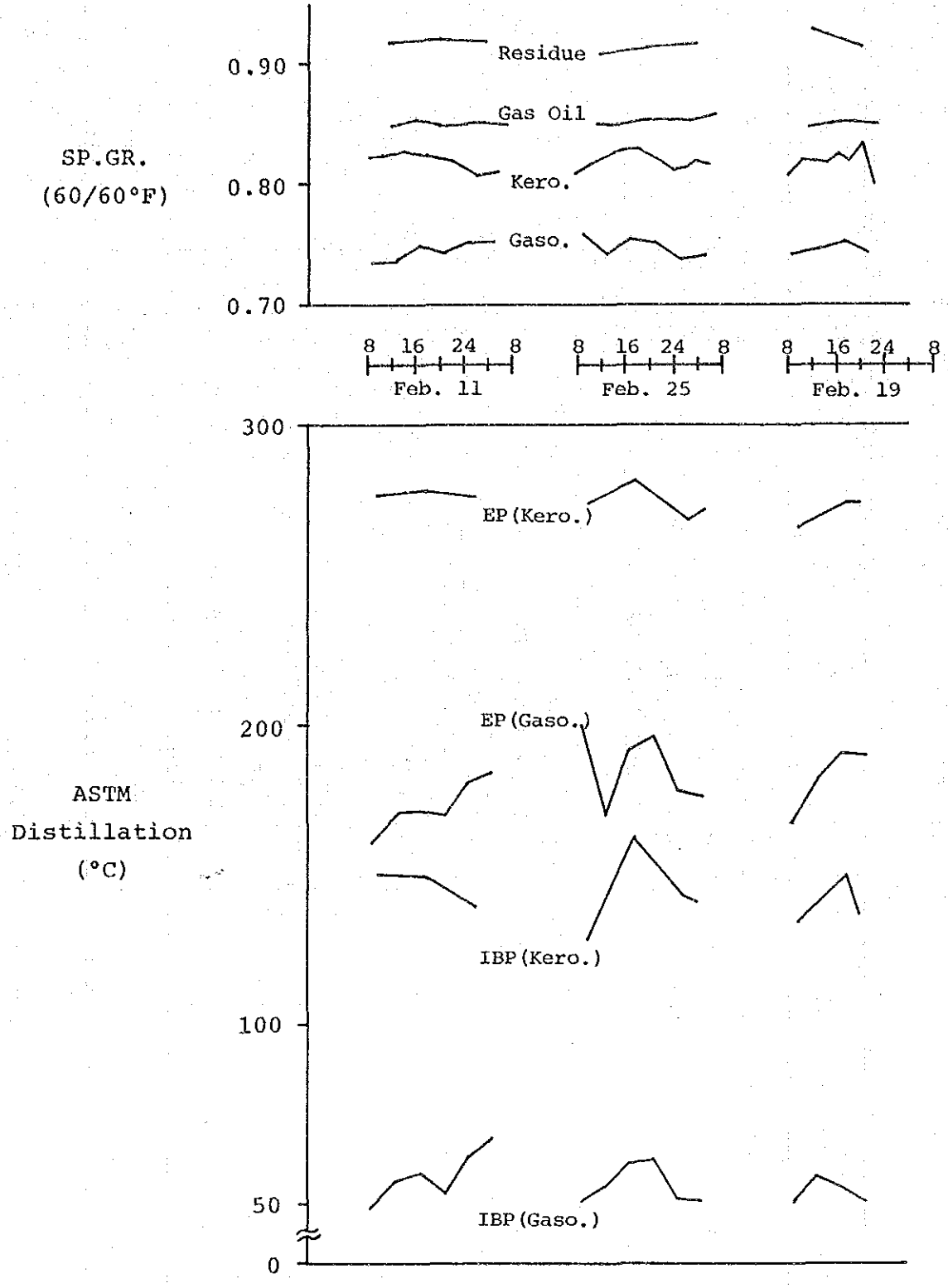
ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
V 7	Separator No. 6 (for Solar)	Capacity : 0.4 ㎥ Dimension : 337㎜φ× 4,400㎜ H	1	
V 8	Separator No. 7 (for PH Solar)	Capacity : 0.4 ㎥ Dimension : 337㎜φ× 4,400㎜ H	1	
V 9	Separator No. 8 (for Gasoline)	Capacity : 1.5 ㎥ Dimension : 613㎜φ× 4,930㎜ H	1	
－	Caustic Make up Drum	Capacity : 1.0 ㎥ Dimension : 1,150㎜φ× 980㎜ H	1	
－	Caustic Wash Settler	Capacity : 3.5 ㎥ Dimension : 1,186㎜φ× 3,000㎜ H	1	

Figure II-5-3(a) STREAM PRODUCT DATA OF LEDOK CRUDE



(Note) Prepared from the operation data in the Refinery Plant, PPT. MIGAS, Cepu.

Figure II-5-3(b) STREAM PRODUCT DATA OF KAWENGAN CRUDE



(Note) Prepared from the operation data in the Refinery Plant, PPT. MIGAS, Cepu.

Table Ⅱ－5－2 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (FURNACE) (1/2)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
F1/A/B/C	Crude Charge Heater	Furnace Box type, Natural draft 3,880㎜ W× 6,800㎜ L× 7,405㎜ H (excluding stack and ground) Tube Size 4in × 6,000㎜ Number (Sch 80) 47 pieces (Sch 40) 48 pieces Materials Upper : CS Lower : 0.5% Mo Burner (Mixed burning sysrem) Oil burner 1 nozzle (Steam atomizing) Gas burner 4 nozzle	3	

Table Ⅱ－5－2 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (FURNACE) (2/2)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
F 2	Reboiler Heater	Furnace Box type,Natural draft 3,880㎜ W× 6,800㎜ L× 7,405㎜ H (excluding stack and ground) Tube Size 4in × 6,000㎜ Number (Sch 80) 47 pieces (Sch 40) 48 pieces Materials Upper : CS Lower : 0.5% Mo Burner (Mixed burning sysrem) Oil burner 1 nozzle (Steam atomizing) Gas burner 4 nozzle	1	

Heating tubes are all made of carbon steel, and have 95 pieces of tubes 4 in x 6 m (Sch. 40 on the upper, and Sch 80 on the lower section). Thermometers for tube skin temperature, furnace internal temperature and stack temperature were installed in 1977, and their readings were loccally indicated by a multi-dots recorder located at the side of the furnaces.

However a French-made multi-dots recorder was removed in 1983 because of poor supply of its spare parts. According to the past data, the furnace internal temperature was appr. 500°C and skin temperature on the heating tube appr. 450°C, and stack temperature appr. 220°C.

To judge whether the present operations of these furnaces are appropriate for the tube coking and their deteriorations or not, the allowable radiation rates in radiation section and the oil velocities in the tube should be checked.

However the allowable radiation rates cannot be checked because the heating tubes are not provided on the radiation section of the side walls but are provided for convection only. (Fig. II-5-4)

Consequently it was checked in accordance with the following 3 criteria whether the oil velocities in the tube are in an appropriate range or not.

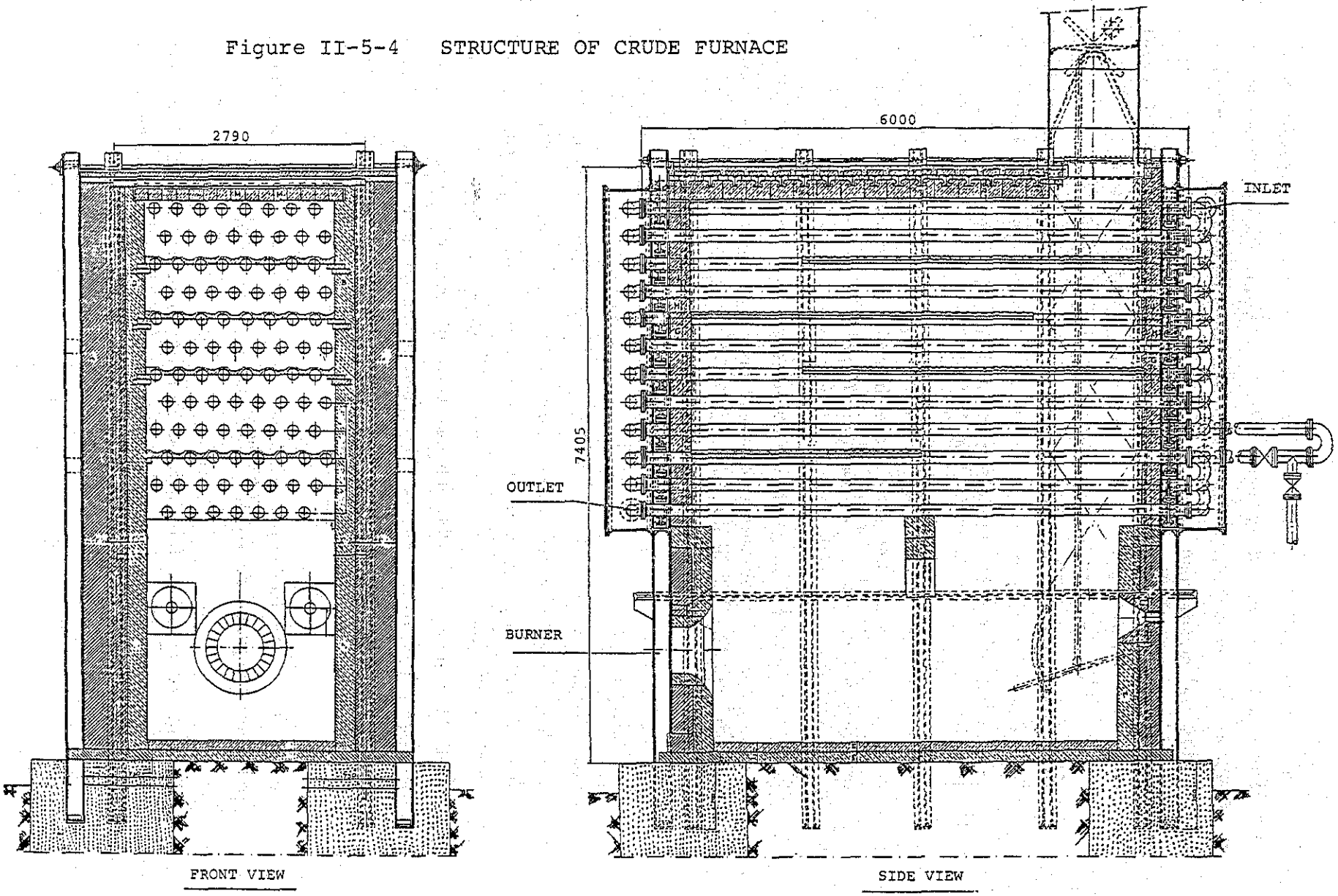
- Bell, H.S., Pipe Heaters, "American Petroleum Refining", 3rd ed., P.155, 1945

- Nelson, W.L., Tubestill Heaters, "Petroleum Refinery Engineering", 4th ed., P.608, 1958

- Berman, H.L., Fired Heaters-III, "Chemical Engineering", P.136, Aug. 14, 1978

Please refer to Appendix II-5-1 summarizing the check results. According to Bell's criteria, the minimum oil velocities for a turbulent flow have been maintained with close margins. However according to Nelson's and Berman's criteria, it was found the oil velocities greatly underran the lower limit of the allowable velocities.

Figure II-5-4 STRUCTURE OF CRUDE FURNACE



The Center itself had realized the problem earlier, and, according to the Center's renovation survey report "Modification of Cepu refinery as the educational medium" dated June, 1983, a proposal was presented to modify the arrangement of the two furnaces from the parallel one to a series one, and this change however cannot achieve the minimum allowable oil velocities.

According to the Center's maintenance record, "History File of Furnace" the cases of coking of tubes and their deteriorations were reported at three times among the 4 reports presented from 1968 to 1975.

Moreover these reports stated that the coking of tubes and their deteriorations were becoming more intensive year by year, and the establishment of appropriate operation conditions was urgently needed.

In all the furnaces, oil-gas mixed burnings were adopted, and the burners are composed of a oil-burner of steam spray type and a gas burner having 4 nozzles around the oil burner.

No peeping holes are provided on the side walls, and a peeping hole at the burner's side was moreover modified to be upward inclined so as to give a sight on the underside of the tube coils, and nearly no sight on the flames and to prevent observations of the flame shapes. Also for the fuel oil and fuel gas systems, any instrumentations, to indicate fuel consumptions for each of the furnaces, were not provided, and any sampling devices for combustion gas were not installed. (No experiences on Orsat Analysis). Any confirmation cannot be made on the furnace O_2 control and efficiencies and therefore the present situation cannot make much contributions to oil trainee practice .

In addition, any back-fires has not been experienced, and the effluent gas from the stack showed no smoke and was fully clear.

Contents of consumed fuel and gas including fuels for the reboiler shows an actual fuel ratio (oil/gas) of appr. 8/1, and the combustion is controlled by regulating the flow of the major fuel or oil.

The instrumentation system is a common type of regulating the flow of fuel oil by detecting the outlet temperature of crude oil from the furnace, for example, in the case of a reboiler furnace, and, for a crude furnace, an more advanced type or a control system combining TRC with a feed-forward system controlling the fuel oil flow by detecting the crude oil flow into the furnace.

d) Heat exchangers, condensers and coolers

Equipment lists of heat exchangers, condensers, and coolers, (hereinafter to be called "heat exchangers") are summarized in Table II-5-3 in terms of the equipment numbers in the flowsheet in Fig. II-5-2.

In the flowsheet the heat exchangers already removed are 3 unit or F4C, E6A, and E10; while 19A and 19B correspond to 12A and 12B in the equipment lists.

Furthermore heat exchangers not used at present because of the leaky tubes are 6 unit, or E1A, E4B, E6B, E6C, E12 and E14A.

Except for the equipments alredy removed, the heat exchangers are classified into the following:

Functional Grouping	Quantity	Structural Breakdown	
(1) Heaters	3	Multi-tubular, Verical	3
(2) Coolers	20	Coil type (Box Cooler)	6
		Multi-tubular, Vertical	12
		Ditto, Horizontal	2
(3) Condensers	9	Multi-tubular, Vertical	9
Total	32	Multi-tubular, Vertical	24

Table Ⅱ－5－3 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (HEAT EXCHANGER, CONDENSER AND COOLER) (1/6)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
E1A/B	Crude Charge Heat Exchanger	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 125㎡	2	F1A is not in use because of tube leakage, Drawing : TJU No. 0531
E1C	Crude Charge Heat Exchanger	Shell & tube, Vertical and floating head type (Once-through) Surface area : 95㎡	1	Drawing : TJU No.74, 200
E2A/B/C	Light Gasoline Condenser	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 129㎡	3	Drawing : TJU No. 0532, TJU No. 0533
E3	Light Gasoline Condenser	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 129㎡	1	

Table Ⅱ－5－3 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (HEAT EXCHANGER, CONDENSER AND COOLER) (2/6)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
E4A	Light Gasoline Condenser	Shell & tube, Vertical and floating head type (Once-through) Surface area : 79㎡	1	Drawing : TJU No. 0547
E4B	Light Gasoline Condenser	Shell & tube, Vertical and floating head typet (Once-through) Surface area : 60㎡	1	Drawing : TJU No. 0037
E5	Heavy Gasoline Cooler	Shell & tube, Vertical and floating head typet (Once-through) Surface area : 60㎡	1	
E6B	Light Gasoline Condenser	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 135㎡	1	not in use because of tube leakage, Drawing : TJU No. 0534

Table Ⅱ－5－3 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (HEAT EXCHANGER, CONDENSER AND COOLER) (3/6)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
E6C	Light Gasoline Condenser	Shell & tube, Vertical and floating head type (Once-through) Surface area : 49 ㎡	1	not in use because of tube leakage, Drawing : No. 465
E7	Heavy Gasoline Cooler	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 135 ㎡	1	Drawing : TJU No. 0534
E8A／B	Residue Cooler	Box cooler Surface area : 154 ㎡	2	Drawing : TJEPU/FBNo. A2
E9	Light Gasoline Condenser	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 79 ㎡	1	Drawing : TJU No. 0535

Table Ⅱ－5－3 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (HEAT EXCHANGER, CONDENSER AND COOLER) (4/6)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
E 11	Heavy Gasoline Cooler	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 111 ㎡	1	
E 12	Heavy Gasoline Cooler	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 102 ㎡	1	not in use because of tube leakage
E 12A／B	PH Solar cooler	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 73 ㎡	2	Drawing : TJU No. 0539
E 13A	Kerosine Cooler	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 73 ㎡	1	Drawing : TJU No. 0537

Table Ⅱ－5－3 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (HEAT EXCHANGER, CONDENSER AND COOLER) (5/6)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
E 13B	Kerosine Cooler	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 102 ㎡	1	
E 14A	Gas Oil Cooler (Solar Cooler)	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 59 ㎡	1	not in use because of tube leakage Drawing : TJU No. 0536
E 14B	Gas Oil Cooler (Solar Cooler)	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 102 ㎡	1	
E 15A	Gas Oil Cooler (Solar Cooler)	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 102 ㎡	1	

Table Ⅱ－5－3 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (HEAT EXCHANGER, CONDENSER AND COOLER) (6/6)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
E15B	Gas Oil Cooler (Solar Cooler)	Shell & tube, Vertical and fixed tube sheet-type (Once-through) Surface area : 102 ㎡	1	
E16A／B	Light Gasoline Cooler	Shell & tube, Horizontal and floating head typet Surface area : 95 ㎡	2	Drawing : TJU No. 0543

In addition to the abovementioned, there is a much simple air cooler for PH Solar, in which pipe bent in coils only is placed on the ground.

In the abovementioned, the heat exchangers of multi-tubular once-through vertical type occupies 70% of the whole heat exchangers and this is a feature of this plant.

Among there vertical type heat exchangers, 1 unit for heating and 4 units of gasoline condensers/coolers are floating head type heat exchangers and the remainder are fixed tube-sheet type heat exchangers.

Fig. II-5-5 shows the outlines of the heat exchangers of these types.

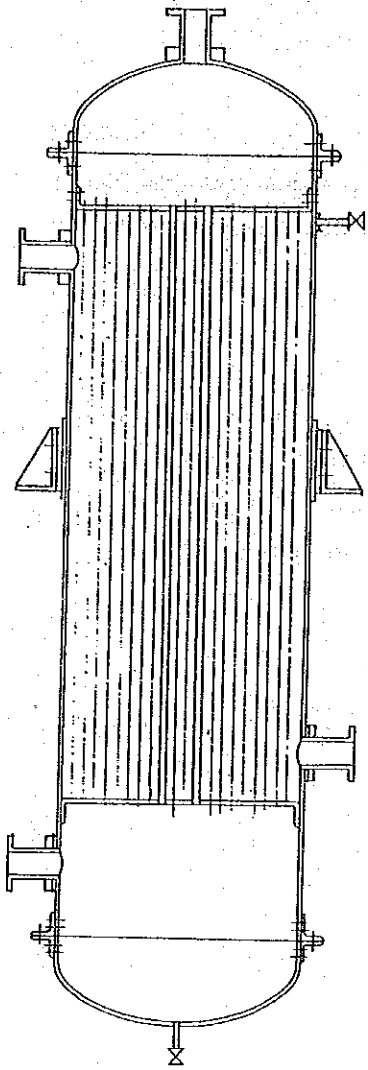
Particulary in the two unit with fixed tube sheet, cleanings are not possible in their shell side while possible in their tube side, and therefore it is estimated that thermal efficiencies may be extremely decreased due to the service for years.

On the other hand, the vertical condensers and coolers are arranged in sequence and in steps from the upstream of the lines from the tower tops and sides, to make the distillates run down into the tanks in the adjacent area by the gravity flows due to the differential head.

As described in the above, the Topping unit was designed to be much compact by using these vertical heat exchangers. On the other hand these arrangements have a layout and structure requiring an extensive modification, if horizontal heat exchangers should be adopted for easy maintenances.

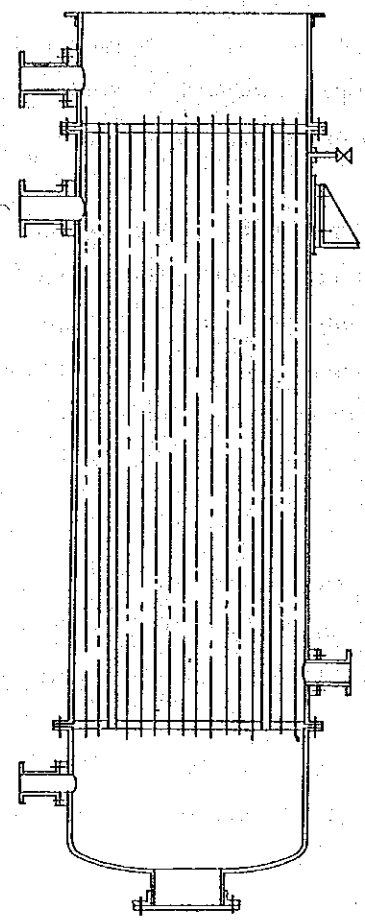
Our checks has proposed the following problems on the Main Equipment List (prepared by Refinery Personnel Development Div.) and Drawings (parepared by General Engineering Personnel Development Div.) and further on the results of the existing equipments survey by our mission:

Figure II-5-5 STRUCTURE OF VERTICAL HEAT EXCHANGERS



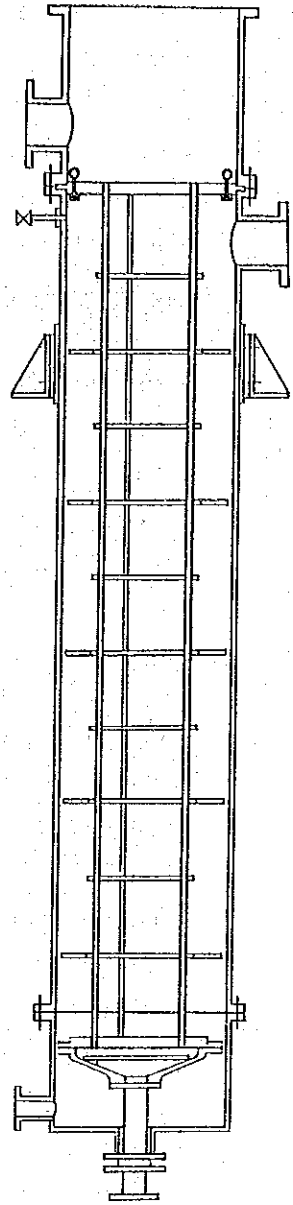
FIXED TUBE SHEET

HEAT EX.



FIXED TUBE SHEET

COOLER



FLOATING HEAD

CONDENSOR

- The Center's data only covers appr. half of the entire equipments for example:

Main Equipment List	15 units of the entire 33 units
Drawing	18 units of the entire 33 units

- The equipment numbers in the Drawings do not coincide the equipment numbers on actual heat exchangers, and, in changing the equipment numbers, follow-ups necessary to keep conformity in relevant documents and drawings are remaining to be made.

- In the attempt to clarify these unclear points from the photographs taken by the missionmembers, there are found a number of cases where they could not find the heat exchangers corresponding to the ones in Main Equipment List or Drawing. Thorough review on the List and Drawings should be made by the members of the Center in future.

e) Pumps

Table II-5-4 shows the pumps for the Topping unit, oil blending, product transportation and crude transfer. The following main pumps were changed from reciprocating types to centrifugal types:

- Crude transfer pump (2 units)
- Crude charge pump (2 units)
- Reflux pump (4 units)
- Reboiler pump (2 units)

These pumps excluding the reboiler pumps are in a smooth operation. However, in the case of the reboiler pumps the strainer becomes plugged in 15 minutes after changing over the reciprocating pump to the centrifugal one, and therefore the reciprocating pump is still in use as spare one. The Center stated the plugged material were observed to be "Ferric mud".

Table Ⅱ－5－4 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (PUMP) (1/4)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
P010/1A/B	Crude Charge Pump	Centrifugal pump ; Driver : motor Design condition Flow : 15㎥/H Total Head : 37.9m Motor : 5.5kw	2	one pump is in operation anogher is spare pump.
P010/2A/B	Heckman No. 1 Reflux Pump	Centrifugal pump ; Driver : motor Design condition Flow : 15㎥/H Total Head : 27.4m Motor : 2.2kw	2	one pump is in operation anogher is spare pump.
P010/3A/B	Heckman No. 2 Reflux Pump	Centrifugal pump ; Driver : motor Design condition Flow : 7.5㎥/H Total Head : 21.4m Motor : 1.5kw	2	one pump is in operation anogher is spare pump.

Table Ⅱ－5－4 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (PUMP) (2/4)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
P010/5A/B	Reboiler Pump	Centrifugal pump ; Driver : motor Design condition Flow : 20㎥/H Total Head : 13.6m Motor : 1.5kw	2	one pump is in operation anogher is spare pump.
		Reciprocating Pump : Driver : Steam Design Condition : unknown	2	Spare pumps

Table Ⅱ－5－4 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (PUMP) (3/4)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
P060/1A/B	Soda Washing Pump (for Soda)	Centrifugal pump ; Driver : motor Design condition Flow : 2.3㎥/H Total Head : 37.5m Motor : 3kw	2	
P060/2A/B	Soda Washing Pump (for Gasoline)	Centrifugal pump ; Driver : motor Design condition Flow : 7.5㎥/H Total Head : 5.4m Motor : 4kw	2	

Table Ⅱ－5－4 MAIN EQUIPMENT LIST OF EXISTING TOPPING UNIT (PUMP) (4/4)

ITEM No.	EQUIPMENT NAME	SPECIFICATION	Q'TY	REMARKS
P350/1/2/3	Cooling Water Pump (for Topping Unit)	Centrifugal pump ; Driver : motor Design condition Flow : 450㎥/H Total Head : 37m Motor : 75kw	3	
P500/1A/B	Fuel Oil System Pump	Screw pump ; Driver : motor Design condition Flow : 7,500lb/H Total Head : 23Kg／㎠・G Motor : 11kw	1	
		Screw pump ; Driver : steam turbine, Design Cindition : unknown	1	

The following facts will be clues to clear up the cause of the trouble.

- The crude charge pumps having strainers of the same type do not present a plugging problem.

- The result of analysis made on scales deposited on the tower top trays of C1 column shows that the content of the scale is Fe_2O_3 84.4%, Carbon 10.4% others (SiO_2 and others) 5.2%.

- Enough room for improvement is to be left in operation controls for furnaces, and the same control for Ammonia injection devices for corrosion prevention in the C1 column

- In the past 8 years, cleanings have not been made in the towers and pipings upstream of these pumps.

f) Gasolin washing facilities

The Gasoline washing facility is to wash the straight run gasoline to remove hydrogen sulfide and mercaptan contained in the gasoline before treated.

Fig. II-5-6 shows the general flow of the process. This facility was designed by a French Renovation Party in 1970's and was completed by the hand of the Center in 1984.

The operational conditions will be as follows: Either case has satisfied that

Doctor Test isnegative and Copper Corrosion is 1 max

	Gasoline	Soda Solution
Max	$6m^3/H$	$2.5m^3/H$ (20% NaOH)
Min	$3m^3/H$	$2.5m^3/H$ (12% NaOH)

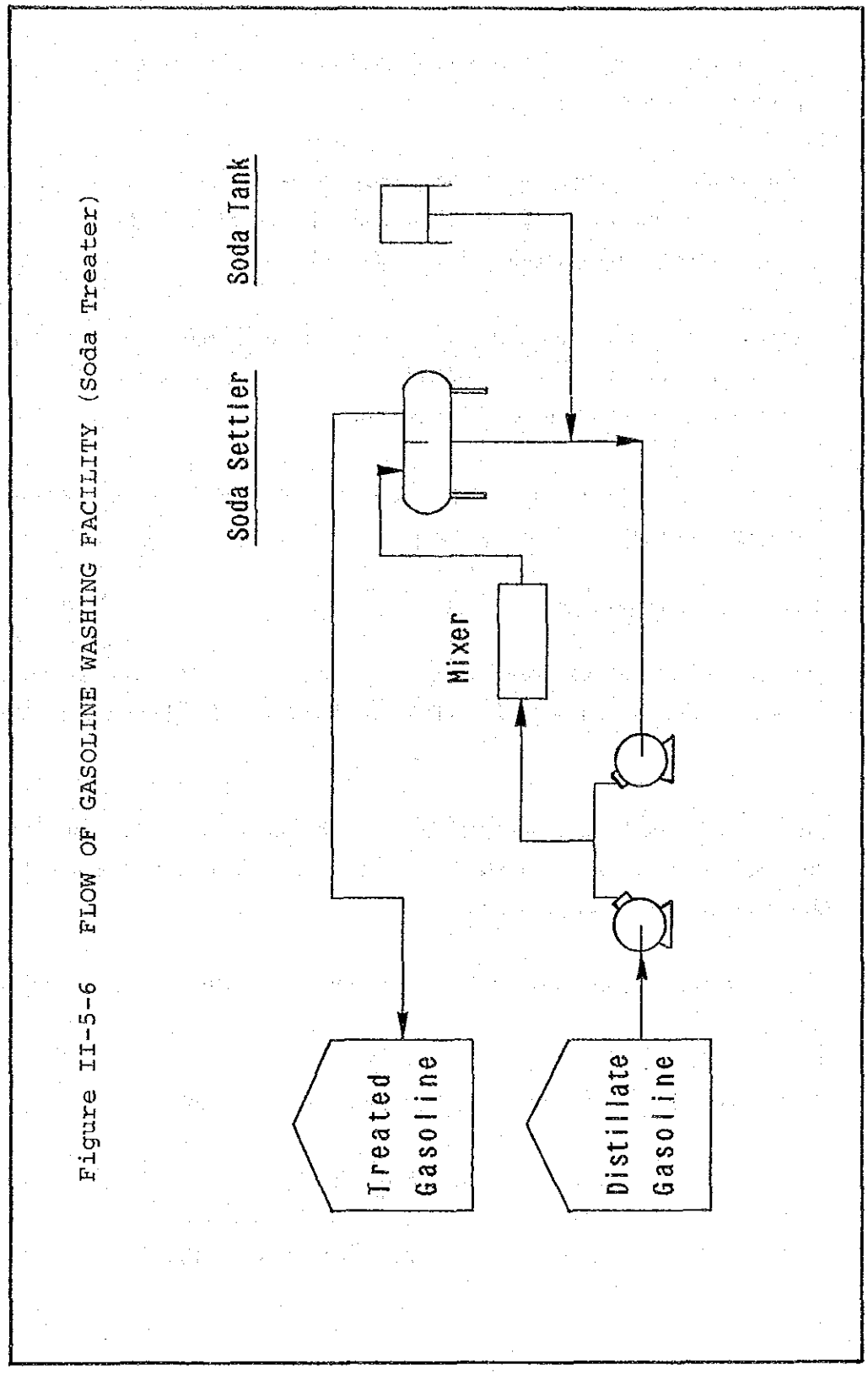


Figure II-5-6 FLOW OF GASOLINE WASHING FACILITY (Soda Treater)

(4) Situation of past renovations

The refinery plants of the Center were constructed in 1920s and most part of main equipments for the Topping unit, Wax plant, water treating facilities, and etc. remaining now had succeeded to the ones in the plant at that time.

The contents of the modification in 1940's by the Japanese Army cannot be confirmed now, and therefore the major Renovation thereafter only will be described.

a) 1972-1977

The renovations performed by French Engineers (Bureau d'Etude Industrielle et de Cooperation del'Institutes Francais du Petroleum) in the above period in as follows:

- Renewal of 3 units of reciprocating pumps such as reflux pumps (Completed in 1974)

- Instrumentation facilities modification including instrument panel in the control room (Completed in 1977)

- Addition of boiler plant (6T/H x 3 unit) (Completed in 1977)

- Addition of fuel oil system (Comleted in 1977)

- Gasoline washing facilities (Design only. The facilities were completed in 1984 by the Center)

b) 1979-1985

Renovation surveys by the Center itself started in 1979, and the renovation were executed in 4 phases from 1983 to 1985.

The objective of the renovation is to orient the refinery plants as an educational medium and to conform the plant to the advanced level of the present oil industries to present the basic oil production/refining technologies easily understandable to students.

Table II-5-5 shows the contents and invested amounts of renovation.

5.1.3 Crude Oil and Products

The refinery plants in the Center are processing the crude oil produced in the four oil-fields owned by the Center or Kawengan, Ledok, Nglobo and Semanggi fields. Judging from the geographical, transportation and marketing problems, apparently, the necessity and possibility for processing the crude oil from other Indonesian oil-fields in this refinery plant is not expected in the future.

Table II-5-6 and II-5-7 shows the total production in the 4 oil-fields over the past 6 years, and predicted potential production in the next 11 years in the same fields.

Kawengan crude is paraffin-base, and others are naphthenic-base relative to Kawengam crude. They are different in wax contents and distillates yields. Accordingly blocked operation is needed especially for effective production of wax distillate.

For this reason, in Menggung Crude Oil Storage Yard near the refinery plants, Kawengan crude oil is stored separately, and other crudes after being mixed each other are stored in the general name of Ledock crude oil.

Table II-5-8 and II-5-9 summarize actual annual production over the past 6 year (1979 - 1985) for Kawengan crude oil and Ledok one (Ledok, Nglobo Semanggi), and potential annual production over the coming 11 years (1985 -1995) for the same crude oil respectionaly. Either table shows the ratio Kawengan crude/Ledok crude is appr. 60/40.

For this reason, the plant is continuing a shift mode operation the so-called "Blocked operation" or 5 days operation for Kawengan crude followed by 3 days operation for Ledok crude, and this situation will remain unchanged in the future.

Table Ⅱ－5－5　　RENOVATED ITEMS BY CENTRE

Phase	Fisical Year	Investment Cost ($\times 10^6$ Rp.)	I t e m
Phase-Ⅰ	1982	22.541	• Safety Equipment & Facilities • Water Pumps • Fire Fighting Network Phase-Ⅰ in Refinery Side (Line, hydrant and monitor)
Phase-Ⅱ	1983	1,178.990	• Instrumentations in Crude Distillation Unit, Wax Plant and Utility Side • Insulation in Crude Distillation Unit, Wax Plant and Utility Side • Water Pipe Line in Refinery Side • Crude Oil Pipe Line in Refinery Side • Softener in Boiler Plant • Process Pumps in Refinery Side • Fire Fighting Nework Phase－Ⅱ in Refinery Side (Foam chamber in tanks)
Phase-Ⅲ	1984	81.970	• Conveyer in Wax Plant • Bridge in Refinery Side
Phase-Ⅳ	1985	－	• Installation of New Electric Generator

Source:　PPT Migas Cepu, July 1985

Table Ⅱ－5－6　　CRUDE PRODUCTION DURING PAST 6 YEARS

Year	1979	1980	1981	1982	1983	1984
Production m^3 (BPCD)	33,294 (570)	32,616 (560)	27,748 (480)	30,760 (530)	37,064 (640)	32,208 (550)

Source:　PPT Migas Cepu, July 1985

Table Ⅱ－5－7　　POTENTIAL PRODUCTION OF CRUDE OIL FOR 1995

Year	1985	1986	1987	1988	1989	1990
Production m^3 (BPCD)	55,000 (950)	61,900 (1,070)	70,000 (1,210)	77,700 (1,340)	84,250 (1,420)	87,700 (1,510)

Year	1991	1992	1993	1994	1995
Production m^3 (BPCD)	89,950 (1,550)	92,100 (1,580)	95,300 (1,640)	96,400 (1,660)	94,600 (1,630)

Source:　PPT Migas Cepu, July 1985

Table Ⅱ－5－8　　AVERAGE YEARLY PRODUCTION DURING PAST 6 YEARS

Crude / Year	Kawengan		Ledok		Total	
	㎘	%	㎘	%	㎘	%
1979 ～ 1984	18,670	57.8	13,610	42.2	32,280	100.0

Source:　PPT Migas Cepu, July 1985

Table Ⅱ－5－9　　AVERAGE YEARLY POTENTIAL PRODUCTION FOR 1995

Crude / Year	Kawengan		Ledok		Total	
	㎘	%	㎘	%	㎘	%
1979 ～ 1984	37,920	58.0	27,510	42.0	65,430	100.0
1985 ～ 1995	46,160	56.1	36,090	43.9	82,250	100.0

Source:　PPT Migas Cepu, July 1985

a) Crude oil properties and yield

General properties of Kawengan and Ledok crude oils are shown in Table II-5-10.

Either of them is a light crude oil and belongs to Intermediate-Intermediate base according to the classification of American Bureau of Mines.

The actual distillate yield of both of the crudes are summarized in Table II-5-11 - II-5-14 on the basis of 1984 annual report, monthly report January, 1984 and daily operational data (Kawengan: Feb. 13, '85 and Ledok: Feb. 8, '85).

The differences of figures in these tables are apparently caused partly by the fact that the plant was not continuing a stable operation, and however we estimate it may be stemmed from the fluctuations in crude oil properties as far as judging from the residue yields.

The crude oil tanks in the refinery are provided with mixing facilities using steam bubbling. However the absence of sufficient data on the fluctuating crude properties (specific gravity, distillation characteristics) including the ones in Menggung storage tanks makes it impossible to make reference to more suitable reasons than the above mentioned.

b) Crude through-put and products production amounts

The crude through-put and products production amounts are shown in Table II-5-15.

These actual values may differ slightly in figures compared to 1984 annual report (used in Table II-5-11) prepared by Administration Department: however these values are presented here to give an idea on the whole balance between the crude through-put and products production amounts.

Meanwhile, the distillates obtained from Kawengan and Ledok crudes are transported as products in single or blended forms except for gasoline and wax distillate.

Table Ⅱ－5－10　　PROPERTIES OF KAWENGAN AND LEDOK CRUDE OIL

Properties		Kawengan Crude Oil	Ledok Crude Oil
Specific Gravity, 60/60 °F		0.8530	0.8305
API Gravity at 60 °F		33.2	38.9
Kinematic Viscosity, cSt,	at 100°F	5.17	3.46
	at 122°F	3.64	2.23
Pour Point, °F		80	20
Flash Point, "Abel", °F		< -35	< -35
Reid Vapor Pressure, psi at 100 °F		1.7	2.6
Water Content, Vol.%		0.18	0.15
Water & Sediment, Vol.%		0.15	0.05
Salt Content as NaCl	Wt.%	0.03	0.03
	lb/1000 bbl	10	10
Total Acid Number, mg KOH/gr		0.084	0.245
Strong Acid Number, mg KOH/gr		nil	nil
Sulfur Content, Wt.%		0.231	0.099
Asphaltenes Content, Wt.%		0.28	0.346
Wax Content, Wt.%		14.4	3.66
Conradson Carbon Residue, Wt.%		0.895	0.700
Ash Content, Wt.%		0.018	0.026
Characterization Factor, Kuop		11.8	12.0
Congealing Point, °F WAX		130	

Source:　Department of Refining and chemistry, Indonesian Petroleum Institute (Aug. and Oct. '72)

Table Ⅱ－5－11　　DISTILLATES FROM EACH CRUDE OIL (1984)

Crude / Distillate	Kawengan (kl)	Kawengan (%)	Ledok (kl)	Ledok (%)
	20,271	100.0	17,976	100.0
Gasoline	1,664	8.2	2,796	15.6
Kerosine	3,814	18.8	3,733	20.8
Gas Oil	4,406	21.7	5,723	31.8
Wax Distillate	4,200	20.7	—	—
Residue	6,925	31.1	5,288	29.4
Loss (＊1)	- 108	-0.5	436	2.4
Total	20,271	100.0	17,976	100.0

(＊1) Including Slop Oil(Kawengan:334kl, Ledok:118kl)

Table Ⅱ－5－12　　DISTILLATES FROM EACH CRUDE OIL (Jan. 1985)

Crude / Distillate	Kawengan (kl)	Kawengan (%)	Ledok (kl)	Ledok (%)
	4,818	100.0	3,911	100.0
Gasoline	275	5.7	629	16.1
Kerosine	966	20.0	936	23.9
Gas Oil	1,033	21.4	1,311	33.5
Wax Distillate	1,387	28.8	—	—
Residue	1,179	24.5	928	23.7
Loss (＊1)	- 22	-0.4	107	2.8
Total	4,818	100.0	3,911	100.0

(＊1) Including Slop Oil(Kawengan:53kl, Ledok:36kl)

Table Ⅱ－5－13　　DISTILLATE FROM EACH CRUDE OIL (daily)

Crude / Distillate	Kawengan (kl)	Kawengan (%)	Ledok (kl)	Ledok (%)
	79.693	100.0	84.563	100.0
Gasoline	5.746	7.2	16.775	19.8
Kerosine	14.714	18.5	24.985	29.5
Gas Oil	15.310	19.2	25.890	30.6
Wax Distillate	25.218	31.6	—	—
Residue	17.901	22.5	16.331	19.3
Loss (＊1)	0.804	1.0	0.582	0.8
Total	79.693	100.0	84.563	100.0

Table Ⅱ－5－14　　COMPARATIVE TABLE OF DISTILLATE YIELD

(%)

Crude / Distillate	Kawengan			Ledok		
	Year	Month	Shift	Year	Month	Shift
	100.0	100.0	100.0	100.0	100.0	100.0
Gasoline	8.2	5.7	7.2	15.6	16.1	19.8
Kerosine	18.8	20.0	18.5	20.8	23.9	29.5
Gas Oil	21.7	21.4	19.2	31.8	33.5	30.6
Wax Distillate	20.7	28.8	31.6	—	—	—
Residue	31.1	24.5	22.5	29.4	23.7	19.3
Loss	-0.5	-0.4	1.0	2.4	2.8	0.8

Table Ⅱ－5－15　　CRUDE THROUGH-PUT AND PRODUCTS PRODUCTION (1984)

(Unit : ㎘)

Crude Oil	Kawengan Crude Oil 20,271 Ledok Crude Oil 17,976 } 38,247						
Distillate / Product	Gasoline	Kerosine	Gas Oil	PH(*2) Solar	Residue	Total	% on Crude
Leaded Gasoline	3,000					3,000	7.8
Solvent	1,285					1,285	3.4
Kerosine		7,546				7,546	19.7
Diesel Fuel							
for own sale			3,156			3,156	8.2
for own use			2,013			2,013	5.3
BOD (*1)			933	154		1,087	2.8
Fuel Oil			3,792	3,491	4,028	11,311	29.7
Residue							
for own sale					4,798	4,798	12.5
for own use					3,079	3,079	8.1
Wax				86		86	0.2
Inventory			181	470	131	782	2.0
Total	4,285	7,546	10,075	4,201	12,036	38,143	99.7
(% on Crude)	(11.2)	(19.7)	(26.3)	(11.0)	(31.5)	(99.7)	

(＊1)　Batching oil distillate for jute industry

(＊2)　Paraffin high content solar is abbreviated, but blending component for BOD and Fuel Oil is extracted paraffin from PH Solar.

Source:　PPT Migas Cepu/Refinery Program Development Div., July 1985

The distillate gasoline containing hydrogen sulfide and mercaptan is treated in the gasoline washing facility (soda washing) and a part of it is transported to PERTAMINA for gasoline blending after being leaded, and the remainder to local industries as solvents for paint industries and others. The feed material for the wax plant is called wax distillate or POD (Paraffin oil distillate) or PH solar (Paraffin high content solar) because they have high paraffin content (appr. 30%).

Wax crystalized in cooled PH solar is separated for recovery by filter presses, and the remainder oil is called "Filtered Oil" which is used as a blending stock for fuel oil to be transported to PERTAMINA as well as used as one for Batching oil distillate (BOD) in Jute industries.

Of 1984 product manufacture record in Table II-5-15, the products transported to PERTAMINA by the Center are leaded gasoline, kerosine, diesel gas oil and fuel oil, and the total amounts to appr. 13,000 KL (34%).

On the other hand, solvent, BOD, residue oil and wax are sold directly to consumers in local industries, and the total amounts to appr. 16,300 KL (43%).

The balance, which is the inventory adjustments and in-house fuel consumed in the refinery plants, boilers and power plants, amounts to appr. 8,900 KL (23%).

5.1.4 Production Plan and On-the-Job-Training (OJT) Program

(1) Existing state of production plan

The Center is to work out the next year production schedule in the last July to report the crude oil through-put and products quantities manufactured in the Topping unit to PERTAMINA. This production plan is scheduled on the basis of the planned crude oil prodduction and OJT program.

The products manufactured records for respective Indonesian refineries (1982 - 1983) are shown in Table II-5-16 and 1984 Indonesian topping unit capacities for respective refineries are also shown in Table II-5-17.

According to these tables, the shares of Cepu refinery manufactured products are very small. Moreover an outstanding increase by new installations in capacities of Topping unit in Cilacap an Balikpapan has enhanced the Indonesian Topping unit capacities from 505,000 BPSD to 905,000 BPSD.: consequently the share of Cepu has dropped from 0.4% to 0.2%.

The Center is under an obligation to transport the products of the planned quantities reported in advance to PERTAMINA by the Center.

However in consideration of the charactor of the Center as a training organization and the actually negligible shares of the Center refinery plants in the entire Indonesian oil production, in the event of the quantitity of the products to be transported is caused to change or to be deficient in by the changed crude production or the changed shut-down periods of the topping unit. Such changes or deficiencies are permitted only if the reason of such changes and changed schedule are informed to PERTAMINA by the Center.

Table II-5-16 PETROLEUM PRODUCTS PRODUCTION OF DOMESTIC REFINERIES (1)

Unit: 1,000 kl (1,000 b/d)

	1982											
	Domestic Rifinery											
	Pangkalang Brandan	Plaju	S.Gerong	Wono-Kromo	Balikpapan	Dumai	S.Pakning	Cilacap	Cepu	Sub Total	Processing Deal	Total
		(Musi)										
Aviation Gasoline	-	14	-	-	-	-	-	-	-	14	-	14
		(14)										
Jet Fuel	-	-	1	-	-	-	-	-	-	1	289	290
		(1)										
Motor Gasoline	90	563	598	1	681	343	156	-	-	2,432	34	2,466
		(1,161)										
Kerosine	63	311	441	-	1,001	751	138	302	5	3,012	2,245	5,257
		(752)										
Gas Oil	48	651	473	21	864	275	142	177	6	2,657	2,912	5,569
		(1,124)										
Fuel Oil	-	377	17	8	1,725	77	19	22	2	2,247	771	3,018
		(394)										
LSWR	0	412	1,080	-	-	1,323	478	762	-	4,055	3,509	7,564
		(1,492)										
Naphtha	-	-	5	-	-	-	-	69	-	74	2,614	2,688
		(5)										
Asphalt	25	21	-	36	96	-	-	-	-	178	-	178
		(21)										
Others	83	417	115	1	475	62	83	35	10	1,115	661	1,776
		(532)										
		(5,496)										
Total	309 (5.3)	2,766 (47.7)	2,730 (47.1)	67 (1.2)	4,842 (83.4)	2,831 (48.8)	850 (14.6)	1,367 (23.5)	23 (0.4)	15,785 (272.0)	13,035 (224.6)	28,820 (496.6)

Source: Far East Oil Traiding Co., "Oil Industry in Indonesia", 15th Ed., Dec. 1984

Table II-5-16 PETROLEUM PRODUCTS PRODUCTION OF DOMESTIC REFINERIES (2)

Unit: 1,000 kl (1,000 b/d)

	1983											
	Domestic Rifinery											
	Pangkalang Brandan	Plaju	S.Gerong	Wono-Kromo	Balikpapan	Dumai	S.Pakning	Cilacap	Cepu	Sub Total	Processing Deal	Total
Aviation Gasoline	-	17 (Musi)	0	-	-	-	-	-	-	17	-	17
Jet Fuel	-	1 (17)	0	-	-	-	-	-	-	1	438	439
Motor Gasoline	88	403 (1)	400	1	206	205	228	736	-	2,267	9	2,276
Kerosine	39	304 (803)	249	1	273	424	128	1,080	6	2,504	2,430	4,934
Gas Oil	45	594 (553)	344	15	255	527	34	729	7	2,550	3,301	5,851
Fuel Oil	-	209 (938)	11	4	3	20	-	1,248	-	1,495	695	2,190
LSWR	0	486 (220)	663	-	525	1,627	589	-	-	3,890	4,496	8,386
Naphtha	3	- (1,149)	4	-	-	-	15	-	-	22	3,011	3,033
Asphalt	15	14 (4)	-	27	-	-	-	99	-	155	-	155
Others	57	259 (14)	120	4	52	0	71	878	12	1,454	656	2,110
		(379) (4,078)										
Total	247 (4.3)	2,287 (39.4)	1,791 (30.9)	52 (0.9)	1,314 (22.6)	2,803 (48.3)	1,065 (18.4)	4,770 (82.2)	25 (0.4)	14,355 (247.4)	15,036 (259.1)	29,391 (506.5)

Source: Far East Oil Traiding Co., "Oil Industry in Indonesia", Ed., Dec. 1984

Table Ⅱ－5－17　　TOPPING UNIT CAPACITY OF EACH REFINERY IN INDONESIA

Rifinery	Topping Unit		Ratio of Design Capacity
	Design Capacity	Crude Thrugh-put (1983)	
	(BPSD)	(B/D)	
(Pangkalang Brandan)	5,000	4,600	0.6
(Dumai)	100,000	59,600	11.0
(Sungai Pakning)	50,000	21,500	5.5
(Musi)	180,000	82,400	19.9
(Cilacap)	300,000(*1)	87,100	33.2
(Wonokromo)	3,000	500	0.3
(Balikpapan)	265,000(*2)	28,800	29.3
(Cepu)	2,000(*3)	700	0.2
Total	905,000	285,200	100.0

(*1) Expanded Design Capacity in Aug. 1983 (100,000→ 300,000 BPSD)

(*2) Expanded Design Capacity in Nov. 1983 (65,000→ 265,000 BPSD)

(*3) The figure reported by Far East Japan was 700 BPSD.
This figure is confirmed by the Centre.

Source: Far East Oil Trading Co., "Oil Industry in Indonesia ", 15th Ed., Dec. 1984

Table II-5-18 PRODUCTION PLAN FOR THE YEAR 1985

Amount of Crude Oil Processed / Production	Plan for 1985 Kl(Vol.%)	Actual figure 1984 Kl(Vol.%)
	40,000 (100.0)	38,247 (100.0)
Gasoline (*1)	3,600 (9.0)	4,285 (11.2)
Kerosing	8,000 (20.0)	7,546 (19.7)
Gas Oil	11,200 (28.0)	10,075 (26.3)
PH Solar (*2)	5,200 (13.0)	4,201 (11.0)
Residue (*3)	11,600 (29.0)	12,036 (31.5)
Loss	400 (1.0)	104 (0.3)

(*1) 70% for blending stock for gasoline is transported to PERTAMINA and the balance is sold to local industries as solvent.

(*2) It is used as raw material for wax, and filtered oil produced in the process, after being blended with distillate gas oil, is sold to Jute industries as a spinning oil.

(*3) This is blended with distillate gas oil to be transported as Fuel Oil to PERTAMINA, and the remainder is used for in-house fuel oil, or sold to local industries as fuel oil.

Table II-5-18 compares 1985 products production plan with 1984 actual production records. This plan suggests the intention of the Center to reduce gasoline and residue production and increase kerosine, gas oil and wax distillate.

Table II-5-19 and II-5-20 show 1984 operation record of the Topping unit and 1985 operation schedule of the same respectively.

Table II-5-19 OPERATION RECORD OF TOPPING UNIT, 1984

Period / Item	4	5	6	7	8	9	10	11	12	1	2	3
Operation		5 ⊢ (54) ⊣ 27				4 ⊢ (49) ⊣ 22			22 ⊢ (67) ⊣ 26			
Shut Down		I ⊢			II ⊢			III ⊢			⊢	

Causes for shut-downs abovementioned

I. Oil leakage at rivetted joints of C1 column or main tower body

II. Scheduled shutdown. However the same oil leakage as in I has occurred at C1 column rivetted joints also

III. Scheduled shutdown

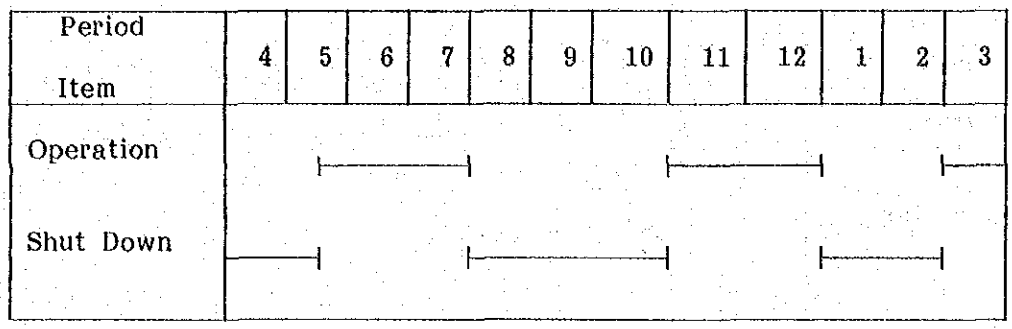
1984 opertion days were 170 days, and included start-up procedure (3-4 days x 3 times) and shutdown procedure (2-3 days x 3 times) durations, and therefore net operation days were appr. 150 days.

Calculating a daily average crude through-put from the annually crude through-put 255 Kl/day (appr. 1,600 BPSD) is given.

Due to the renovations made by the Center since 1979, the Topping unit capacity used as the base for the study was taken as 350 ton/day for Kawengan crude oil (appr. 2,400 BPSD) and 300 ton/day for Ledok crude oil (2,300 BPSD).

In consideration of the base for the study and actual records 1,600 - 1,800 BPSD and further possible variation and off-spec. caused by OJT, the Center's judgement can be said reasonable to place the nominal capacity at 2,000 BPSD (Appr. 320 KL/day).

Table II-5-20 OPERATION SCHEDULE OF TOPPING UNIT, 1985



Meanwhile, according to 1985 operation schedule, operation days are anticipated to be 150 days, and average daily crude through-put in appr. 270 KL/day (1,700 PBSD) for planned processing crude oil 40,000 KL.

Besides, it should be noted that in the reason of shutdowns in Table II-5-19 is cited oil leakages from riveted joints on the shell of C1 column or a main fractionator, and shut-downs due to the same reason have been repeated still in this fiscal year. Immediate improvement measures should be taken for the safety and further not to give to the training schedule a disadvantageous influence because such circumstances might disturb the training programs as well as the production plan.

(2) ON-the-job training (OJT) at refinery plants

As mentioned in chapter 4 of this Part, AKAMIGAS have a system of yearly two semesters and generally the students in the Refining Course who have completed lectures in the classroom and practices in the training laboratory are given OJT at the Topping unit for 2 months at the end of each semester.

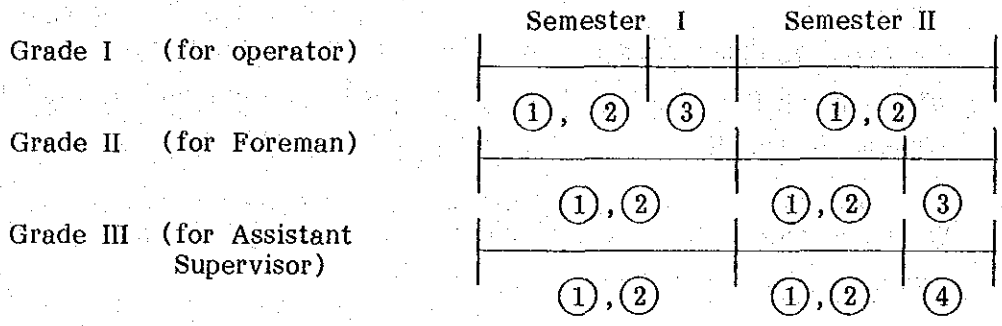
For this reason, for the plant operation periods on the production schedule a unit of 2 months should be the base period. In these periods, start-up operation, shut-down operation and emergency procedure should be acquired by the students.

a) Training at production facilities

The production facilities includes the crude oil production facilities in the oil-fiels, the refining facilities in the Refinery, and their affiliated facilities (utilities, off-sites and etc.), and these are all subjects for OJT though these are operated by operation personnel organized independent of the students.

For example, in the case of Refining Department Course, 2 months at the end of either Semester (Semester I or Semester II) are allocated to OJT and a practice course is given to a class of appr. 20 students by 1 lecturer, 4 instructors (2 shift leaders and 2 foremen selected from operation personnel).

For each Grade, an annual training schedule is illustrated in the following.



①: Lecture at Class Room
②: Practice at Laboratory
③: OJT at Topping Unit, Wax Plant and Utility Facilities
④: OJT at Refining Facilities in Cilacap, Balikpapan, Musi and Dumai

An actual activity contents of OJT is also shown in the below.

- Orientation (15 days)
  Studies of each unit operation, process operation condition, and quality control in the Refinery

- Special Order (35 days)
  Acquisition of fundamental operation (Start-up, shut-down, normal operation) technologies and trouble shooting/emergency operation technologies, technical calculation on pumps and insulation materials.

In special order, the students are given the practice of unit operations in direct contact with the actual facilities in addition to simulated operations and observations of instructor's demonstrations.

- Report preparations and discussions (10 days)

b) Simulators and pilot plants

In the Simulation Laboratory where its facilities are now being expanded, Process Control Simulator manufactured by Auto Dynamics Co. has been purchased and installed in the building completed in this June, and is being conditioned by instructors of the company.

Besides, in this building pilot plants made in West Germany will be installed and at the same time a part of simulators now located in the Training Laboratory is planed to be moved into this building.

Facilities possessed by the Simulation Laboratory (including items to be purchased this year) are as follows:

- Drilling Control Simulator — USA/SIMTRON Co.

- Process Control Similator software — USA/Auto Dynamic Co.
  Basic Unit Operation
  Crude Unit
  Vacuum Unit
  Product Fractionation
  Naphtha Reformer
  HDS Unit
  Amine Gas Treater
  FCC Unit
  Natural Draft Fired Heater

- Pilot plants — W. Germany/PILOT Co.
  Desalter
  Crude Unit
  Cat Reformer
  Thermal Cracker
  HDS & Hydrocracking Unit

As simulators, the Instrumentation Process Simulators of Plint Co. in England are also possessed by the Instrumentation Laboratory in addition to the above.

The objections and advantages of these installed facilities will be summarized into the following two points:

- In addition to the fundamental operation, the student can be given in a short period an extensive operation technique variations such as procedures for changing process conditions, finding out abnormalities and their measure operation techniques.

- Trainings on production facilities not owned by the Center can be made, and the dispatch costs for student in Grade III, who are given so far OJT at PERTAMINA refineries, also can be reduced.

At present the Center are aiming at effective training means and methods such as simulators and pilot plants, and reviewing the role of the present Simulator Lab. in the practice training and OJT.

On the other hand, these simulators and pilot plants cannot give the on-the-scene feeling because of their difference of scales compared to the actual facilities, and also in some aspect cannot replace the operations necessary for the actual facilities due to the simplified operations in these similators and pilot plants.

Considereing the balance between the above two approached for training, the most important theme to the Center in the future can be said to plan its renovation with emphasis on production facilities.

5.1.5 Operation Management

(1) Management structure and its manning

The entire organization of the Center has been already described in Chapter 2 of this Part, and the production facilities are being administered by Oil Field Program Development Division and Refinery Development Division in the organization.

In addition to the operation management of the production facilities, these Divisions are responsible to OJT for the students participated in lecture and practice in AKAMIGAS and other laboratories as the educational functions of these Divisions.

Fig. II-5-7 shows the organization of Refinery Program Development Division

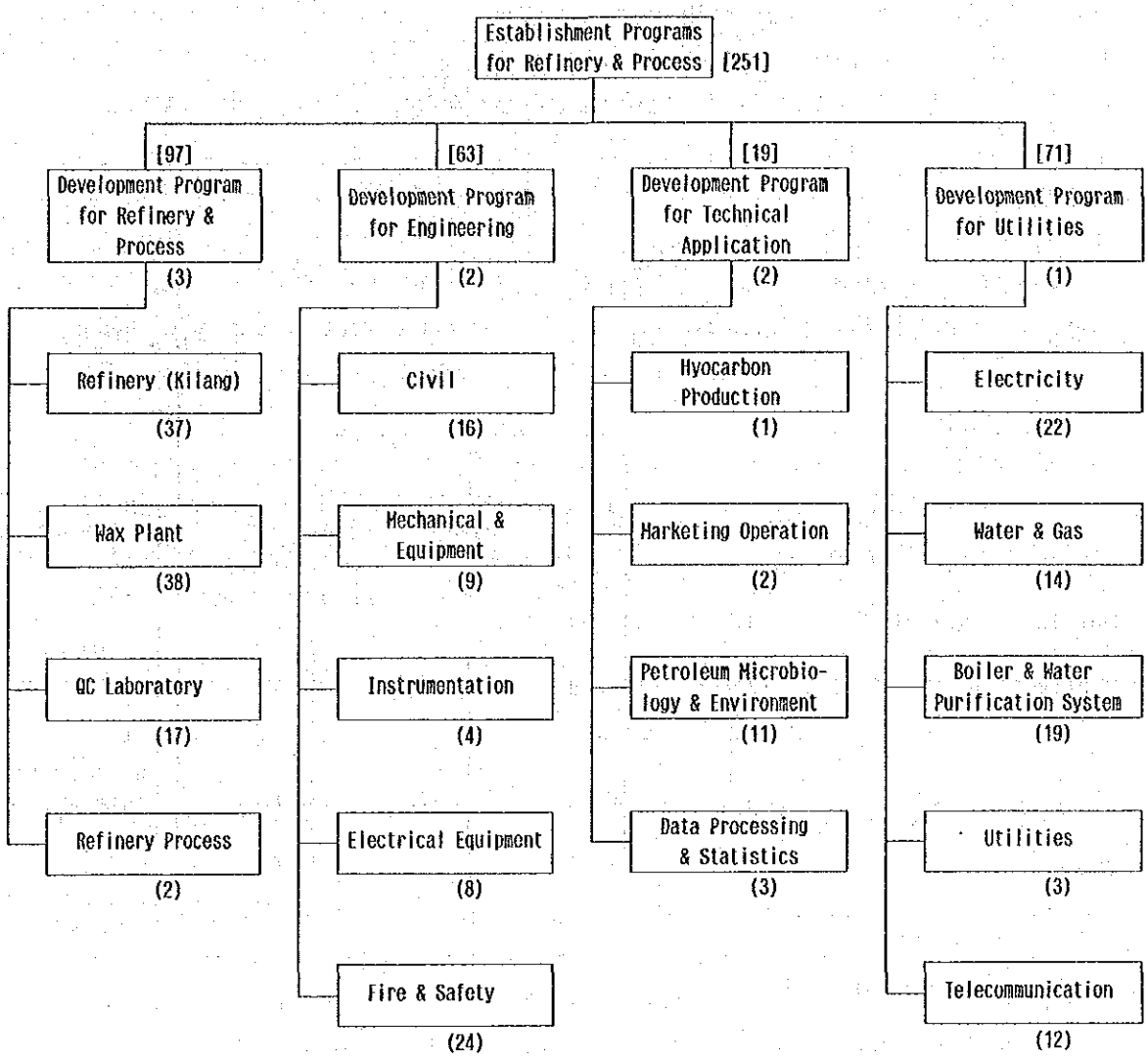
The total number of personnel in Refinery Program Development Division or 250 crewmen is clearly excessive for the operation of 2,000 B/D generally composed of the Topping unit and the Wax plant: such Indonesian state of affairs as necessity to maintain personnel for educational facilities and execution of training, the obsolete plants, the roles of a government operated enterprise to promote employment may justify this number of personel, however. Its validity cannot be a subject of a simple reasoning.

a) Refinery subsection

This Refining subsection is reponsible to the operation control of the Topping unit and blending of the distillates, and the operation control of product transportation facilities, and its organizational structure is shown in Fig. II-5-8. As for quality control, a separate Refinery Laboratory Subsection is responsible to.

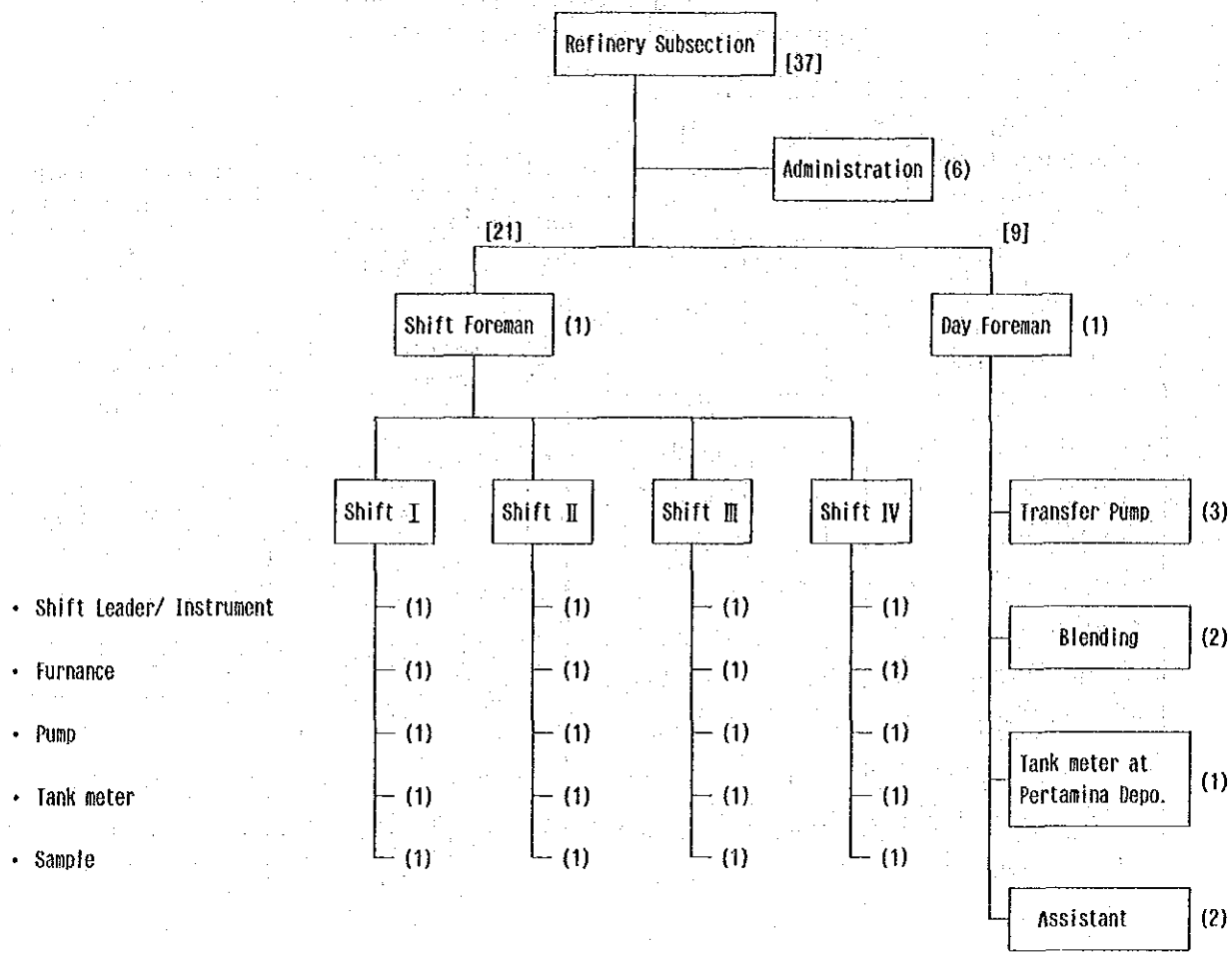
The operation of the Topping unit is performed by 3 duty 4 shift (1 duty five crewmen) service, and operations of blending and transportation facilities by day duty service.

Figure Ⅱ-5-7 ORGANIZATION OF REFINERY PROGRAM DEVELOPMENT DIVISION



(Note) ( )indicates Numbers of Employee

Figure Ⅱ-5-8 Organiztion of Refinery Subsection



(Note) ( )indicates Numbers of Employee

(2) Operation management

a) Operation manual

The operation manuals for the Topping unit has been prepared only in June, 1985 by Refinery Personnel Development Section staff for less experienced operators and students for OJT practice courses.

They describe on Start-up operation, Normal operation, Shut-down operation and Emergency procedures, and their frame works have been completed. Especially in Emergency procedures are described respective cases for troubles in utilities (steam, electricity, cooling water), fuel oil, and fuel gas, and leakages in furnace tubes.

However the conditions to be criteria in operation are not indicated in actual figures except for crude furnace heat-up conditions, and further diagrams for process sheets and time schedules for respective procedures are not also presented.

This manual is to be provided in the Control Room to be used as OJT text, and will be further revised by using the future experiences.

b) Operation records

The operation record of the Topping unit are maintained by entering hourly readings of panel board instruments in the Control Room and major local instruments into the log sheets, and, after measuring oil levels in both the crude and distillate tanks and their temperatures and specific gravities to check the material balance, by entering the results in a notebook.

The numbers of local instruments are deficient for proper operation management and therefore should be increased, as mentioned in 5.1.2. 3).

On the contrary, however, readings of some instruments have never been entered into the log sheets for one year or more. Particularly no entry

of information on material flow is a problem since it is of elementary necessity to analyse on operational performance.

Furthermore, test runs widely adopted in Japan have never been performed here that can give the basic data for performance surveys and reviews for improving the plant.

It should be particularly noted that the attempt to check respective equipment capacities and bottle necks by the Centre would encounter a serious limitation since really deficient operation records only are kept at present not to speak of the numbers of instrument deficient for proper operation management.

5.1.6 Quality Control

Quality control is carried out on the basis of the distillate property analysis data for process control and the property analysis data of products after blending or before transportation.

Analysis for routine operation management, including crude oil, is performed in the refinery laboratory adjacent to the Topping unit and Wax plant.

(1) Products specifications

The products specifications used in Indonesia include Directorate Jenderal Minyak dan Gas Bumi specification -1979, which applies to the products transported to PERTAMINA from the Center.

The products transported to PERTAMINA from the Center at present are the following.

Bensin Premium/Premium	(Mogas Premium)1/
Minyak Tanah	(Kerosine)
Minyak Solar	(Automabile Diesel Fuel Oil)
Minyak Baker	(Fuel Oil)

Note: 1/ In Indonesia, moter gasoline comes in two types: Premium and Super. Premium corresponds to regular gasoline in Japan.

These specifications are shown in Table II-5-21.

Gasoline transported from the Center to PERTAMINA is a blending stock of Mogas Premium, which is finally blended in Semarang PERTAMINA Depot for commercialization.

In addition to the above, the products which the Center sell directly to the local industries include solvent, BOD, residue and wax.

The respective detailed specifications are to be fixed between the Center and local industries. These applications and major specifications are as follows.

Kind of Oil	Applications	Specifications
Solvent	o For paint industries (large scale) o For leather industries	SBP 35-115[1/] is required. Same as the cut for the present motor gasoline
B O D	Jute industries	Pour point 80°F Max.
Residue	Fuel oil	Same property as pre sent product
Wax	For Batik industries	Same as above

Note: 1/ SBP 35-115 is a product type of special boiling-point spirits, which is solvent whose NBP is 35 to 115°C.

Table II-5-21(a) SPECIFICATION OF MOGAS PREMIUM

PROPERTIES		SPECIFICATION		METHOD	
		MIN	MAX	ASTM	OTHERS
KNOCK RATING:				D. 2699	
Research Octane Number	On	87			
T.E.L. Content	ml/AG		2.5	D. 526	IP. 116
DISTILLATION:				D. 86	
10% vol. evap. to	°C		74		
50% vol. evap. to	°C	88	125*		
90% vol. evap. to	°C		180		
End Point	°C		205		
20% - 10 % evap.	°C	8*			
Residue	% vol		2.0		
R.V.P. at 100 °F	psi		9.0*	D. 323	
Existent Gum	mg/100ml		4	D. 381	
Induction Period	min	240		D. 525	
Sulphur Content	% wt		0.20	D. 1266	
Copperstrip Corrosion (3 hrs/122 °F)			No. 1	D. 130	
Doctor Test or			Negative	D. 484	
Alternative Mercaptan Sulphur	% wt		0.0015	D. 1219	
Colour		Yellow			
Dye Content: Yellow		0.5			
Odour		Marketable			

Note: * Penyessuaian dibenarkan dengan menggunakan Volatility Adjustment Tab

Table II-5-21(b) SPECIFICATION OF KEROSINE

PROPERTIES		SPECIFICATION		METHOD	
		MIN	MAX	ASTM	OTHERS
Specific Gravity at 60/60 °F			0.835	D. 1298	
Colour Lovibond 18" Cell or			2.50		IP. 17
Colour Saybolt		9		D. 156	
Smoke Point	mm	16*		D. 1322	IP. 57
Char Value	mg/Kg		40		IP. 10
DISTILLATION:				D. 86	
Recovery at 200 °C	% vol	18			
End Point	°C		310		
Flash Point Abel or Alter-	°F	100			IP. 170
natively Flash Point TAG	°F	105		D. 56	
Sulphur Content	% wt		0.20	D. 1266	
Copperstrip Corrosion (3 hrs/50 °C)			No. 1	D. 130	
Odour			Marketable		

Note: * Jika smoke point ditentukan degan ASTM D. 1322, maka batasan minimum diturunkan dari 16 menjadi 15.

Table II-5-21(c) SPECIFICATION OF AUTOMOTIVE DIESEL OIL

PROPERTIES		SPECIFICATION		METHOD	
		MIN	MAX	ASTM	OTHERS
Specific Gravity at 60/60 °F		0.820	0.870	D. 1298	
Colour ASTM			3.0	D. 1500	
Cetane Number or		45		D. 613	
Alternatively Calculated Cetan Index		48		D. 976	
Viscosity Kinematic at 100 °F	GS	1.6	5.8	D. 445	
or Viscosity SSU at 100 °F	Secs	35	45	D. 88	
Pour Point	°F		65	D. 97	
Sulphur Content	% wt		0.5	D. 1511 /1552	
Copperstrip (3 hrs/100 °C)			No. 1	D. 130	
Conradson Carbon Residue	% wt			D. 189	
(on 100% Vol Bottom)			0.1		
Water Content	% vol		0.05	D. 95	
Sediment	% wt		0.01	D. 473	
Ash Content	% wt		0.01	D. 482	
Neutralization Value				D. 974	
Strong Acid Number	mg KOH/gr		Nil		
Total Asid Number	mg/KOH/gr		0.6		
Flash Point P.M.cc.	°F	150		D. 93	
DISTILLATION:				D. 86	
Recovery at 300 °C	% vol	40			

Table II-5-21(d) SPECIFICATION OF FUEL OIL

PROPERTIES		SPECIFICATION		METHOD	
		MIN	MAX	ASTM	OTHERS
Specific Gravity at 60/60 °F			0.990	D 1298	
Viscosity Redwood I/100 °F	secs	400	1250	D 445*	IP 70
Pour Point	°F		80	D 97	
Calorific Value Gross	BTU/Lb	18000		D 240	
Sulphur Content	wt %		3.5	D 1551 /1522	
Water Content	vol %		0.7	D 95	
Sediment	wt %		0.15	D 473	
Neutralization Value:			Nil		
Strong Acid Number	mg KOH/gr			D 473	
Flash Point P.M.cc.	°F	150		D 93	
Conradson Carbon Residue	wt %	6		D 1500	

Note: * Converted from Kinematic Viscosity.

(2) Products quality

a) Motor gasoline

Since the Center's gasoline is a straight-run gasoline, Octane number (F-1) is as low as 60, which is approx. 70 even when it is leaded by 2.5ml/gal, and it does not satisfy Premium Gasoline Specification RON 87 shown in Table II-5-21(a).

Straight-run gasoline treated by soda is leaded, then it is transported to PERTAMINA Depot adjacent to the Center as motor gasoline blending stock, by the pipe line. Futher, this gasoline is sent to PERTAMINA Depot in Semarang by tank lorries, where it is mixed with high-octane number stock sent from PERTAMINA refineries in Balikpapan and Plaju for commercialization. A part of this gasoline is returned to PERTAMINA Depot in Cepu, which meets the needs for motor gasoline in local markets.

The properties of motor gasoline stock transported from the Center are as follows.

For reference, these properties were compared with Premium Gasoline Specification of the Ministry of Mines and Energy.

Properties	Analysis	Product Spec. (for information)
Sp. Gr. at 60/60°F	0.7505	
Knock Rating		
Research Octane Number F-1	77.7	87 Min.
TEL. Content ml/AG	2.35	2.5 Max.
Distillation		
10% vol Evap. to °C	86	74 Max.
50% vol Evap. to °C	105	88 - 125
90% vol Evap. to °C	142	180 Max.
End Point °C	191	205 Max.
20-10% Evap. °C	6	8 Min.
Residue % vol	1.2	2.0 Max.
RVP at 100°F psi	3.1	9.0 Max.
Copperstrip Test at 3 hrs/122°F	1	1 Max.
Doctor Test	Negative	Negative
Colour	Yellow	Yellow

The above RVP 3.1 psi is near to the minimum value: according to the latest records, the maximum value is 6.2 psi. Further, octane number/distillation properties (20-10% Evap.) are adjusted at PERTAMINA Depot in Semarang.

Since the demands for gasoline decreased recently, the delivery to PERTAMINA was not achieved smoothly as scheduled, which might reportedly cause refinery plant shutdown. In this connection, in order to avoid such a deadlock as far as possible, the Center is planning to manufacture the solvent and promote the sales of gasoline fraction.

b) Solvent

At present, straight-run gasoline is treated by soda to remove hydrogen sulfide and mercaptane, then it is delivered to local paint industries and leather industries. Further, to incease the sales, this gasoline must comply with SBP 35-115 Specification required by paint industries, which

are one of the largest gasoline users. The existing Topping unit is hard to separate naphtha within this cut range in view of the kerosine flash point.

SBP 35-115 properties of expected naphtha cut are as follows.

Normal Boiling Range, °C or product type	35 - 115	Test Method
Sp. Gr. at 60/60°F	0.681	IP 59
Distillation IBP/50%/EP	43/67/102	IP 123
Flash Point, °F	< 0	IP 33
Aromatic Content, % vol	3	IP 128
Kauri butanol No.	30	ASTM D1133
Aniline Point, °C	61	IP 2

c) Kerosine

The properties of straight-run kerosine from both Kawengan and Ledok crude oils are as shown in the following table. The Center does not think it necessary to improve quality furthermore (for example, by hydrogen treater and so on). For reference, this kerosine was compared with the Specification of the Ministry of Mines and Energy.

PROPERTIES	ANALYSIS LEDOK	ANALYSIS KAWENGAN	PRODUCT SPEC. (for information)
Sp. Gr. at 60/60°F	0.8066	0.8136	0.835 Max.
Distillation ASTM			
Vol Recovery at 200 °C % vol	53	51.5	18 Min.
End Point °C	269	273	310 Max.
Copperstrip Test 3 hrs/122°F	1	1	No.1 Max.
Odour	marketable	marktable	marketbale
Colour (Lovibond 18" Cell)	2.00	1.75	2.50 Max.
Smoke Point mm	18	18	16 Min.
Sulfur Content % wt	0.028	0.030	0.20 Max.
Flash Point (Abel) °F	132	134	100 Min.

d) Diesel fuel oil

Automobile diesel fuel oil is called "Minyak Solar" in Indonesia. It is different from diesel fuel oil "Minyak Diesel" for industry fuel.

Only Minyak Solar is manufactured by the Center. This oil has straight-run, light gas oil properties, thus making no problem

The properties of straight-run light gas oil from both Kawengan and Ledok crude oils are as shown in the following table.

For reference, this oil was compared with Ministry of Indonesia Mines and Energy Specification.

ASTM color of Ledok light gas oil is normally 2.0 to 2.5, and the value shown in the table shows the actual maximum value.

PROPERTIES		ANALYSIS LEDOK	ANALYSIS KAWENGAN	PRODUCT SPEC. (for information)
Sp. Gr. 60/60°F		0.8524	0.8516	0.820-0.870
API Gravity at 60°F		34.56	34.75	—
Colour ASTM		3.0	1.5	3.0 Max.
Cetane Index		49.4	51.3	48 Min.
Vis. Kinematic at 100 °F	cSt	6.8	4.2	1.6 - 5.8
Pour Point °F		20	35	65 Max.
Sulfur Content	% wt	0.08	0.025	0.5 Max.
Copperstrip (3 hrs/122°F)		1	1	No.1 Max.
C.C.R. on 10% bottom	% wt	0.0178	0.010	0.1 Max.
Water Content	% vol	Nil	Nil	0.05 Max.
Sediment	% wt	Nil	Nil	0.01 Max.
Ash Content	% wt	0.003	0.003	0.01 Max.
Flash Point, PM CC	°F	245	210	150 Min.
Distillation				
Recovery at 300°C	% vol	83	83	40 Min.

e) B.O.D (Batching Oil Distillate)

B.O.D is used as spinning oil when jute fiber is made into bags and ropes at the jute plant. This oil distillate serves to increase the strength of fiber which is not resistant to water.

B.O.D is blends of Ledok light gas oil and filtered oil which is dewaxed oil from Kawengan heavy gas oil by the filter presses (blend ratio : appr. 2:1), and the pour point is adjusted.

Properties of B.O.D are as follows.

PROPERTIES		ANALYSIS	PRODUCT SPEC. (for information)
Sp. Gr. at 60/60°F		0.8691	—
Flash Point, PM cc	°F	250	—
Pour Point	°F	85	85 Max.

f) Heavy oil (Fuel oil)

This oil is widely used as fuel for plants. There is only one type of product specification. The Center mixes residue with Ledok heavy gas oil, and adjusts the pour point (80°F Max.) before transportation. There is no particular problem in quality.

The properties of Fuel oil manufactured by the Center are shown in the table below. For reference, the specification of this Fuel oil was compared with Specification of the Ministry of Mines and Energy.

PROPERTIES		ANALYSIS	PRODUCT SPEC. (for information)
Sp. Gr. at 60/60°F		0.8724	0.990 Max.
Flash Point, PM cc	°F	270	150 Min.
Pour Point	°F	80	80 Max.
Vicosity Red I/100	°F, Sec.	512	400 - 1,250
Water Content	% vol	0.3	0.95 Max.
Sulfur Content	% wt	0.16	3.5 Max.
Calorific Value, BTU/lb		19,400	18,000 Min.
Sediment	% wt	-	0.15 Max.
C.C.R	% wt	-	10 Max.

g) Residue

Residue of both Kawengan and Ledok crude oils, blended with Ledok heavy gas oil, is transported to PERTAMINA as Fuel Oil, and also marketed direct to local industries without blending. In particular, the properties are not taken into considerations seriously.

Besides the above, this residue is also used as fuel in the refinery.

The properties of residue are shown below.

PROPERTIESOFRESIDUE	ANALYSIS	
	LEDOK	KAWENGAN
Sp. Gr. at 60/60°F	0.9175	0.9123
Flash Point, PM cc °F	250	250
Pour Point °F	105	110
Calorific Value, BTU/lb	17,925	17,925

h) Wax

Wax produced from Kawengan crude oil by the wax plant in the Center is yellow with oily odour.

This product is used for Batik, which is one of the traditional industries in Indonesia.

This quality is not taken into consideration seriously. Sample properties of wax are shown below.

PROPERTIES		ANALYSIS
Sp. Gr. at 60/60°F		0.7818
Penetration		—
Oil Content	% wt	2.58
Colour ASTM		3.0

(3) Testing facilities

The refinery is provided with a refinery laboratory (synonymous with Quality Control Laboratory) which performs daily operation control of plans, utility and offsite facilities, and products quality control.

To be concrete, this job is classified into the following:

- Properties analysis of crude oils, distillates and products used for operation control of the Topping unit and Wax plant;
- Water quality analysis of boilers, water treatment facilities, cooling towers and oil separators and
- Quality analysis of purchased soda, etc.

Crude oils, distillates and products properties are analyzed at Oil Lab. in the Refinery Laboratory building, and other properties are analyzed at Analytical Lab. in the Training Laboratory building.

The above two laboratories are also used for on-the-job traing (OJT) of students who major in the Refinery Lab. course of AKAMIGAS.

Practical training regarding fundamental oil analysis and general chemical analysis together with students who are taking another course is carried out at Oil Lab. and Chemical Lab. for educational training in the Training Laboratory. These laboratories are utilized differently from the above refinery laboratory.

a) Organization

The organization of Refinery Laboratory is shown in Fig. II-5-9.

This Refinery Laboratory is composed of 17 persons in total.

The Oil Laboratory adopts a 3-duty 4-shift labor system, and Analytical Laboratory performs its function daily.

The Oil Laboratory also performs analytical jobs entrusted by other companies besides Center's routine analytical jobs.

b) Sampling schedule

Shown in Table II-5-22 are the sample, test items and frequency of Topping unit, Wax plant, Boilers, Water treatment facilities, Cooling towers and Oil separators sampling frequency for the operations of Topping unit and Boiler is high: it is considered that this is because operation conditions are unstable due to fluctuation in crude oil properties and characteristics of facilities themselves. Therefore, this cause should be cleared up in order to aim at stable process control.

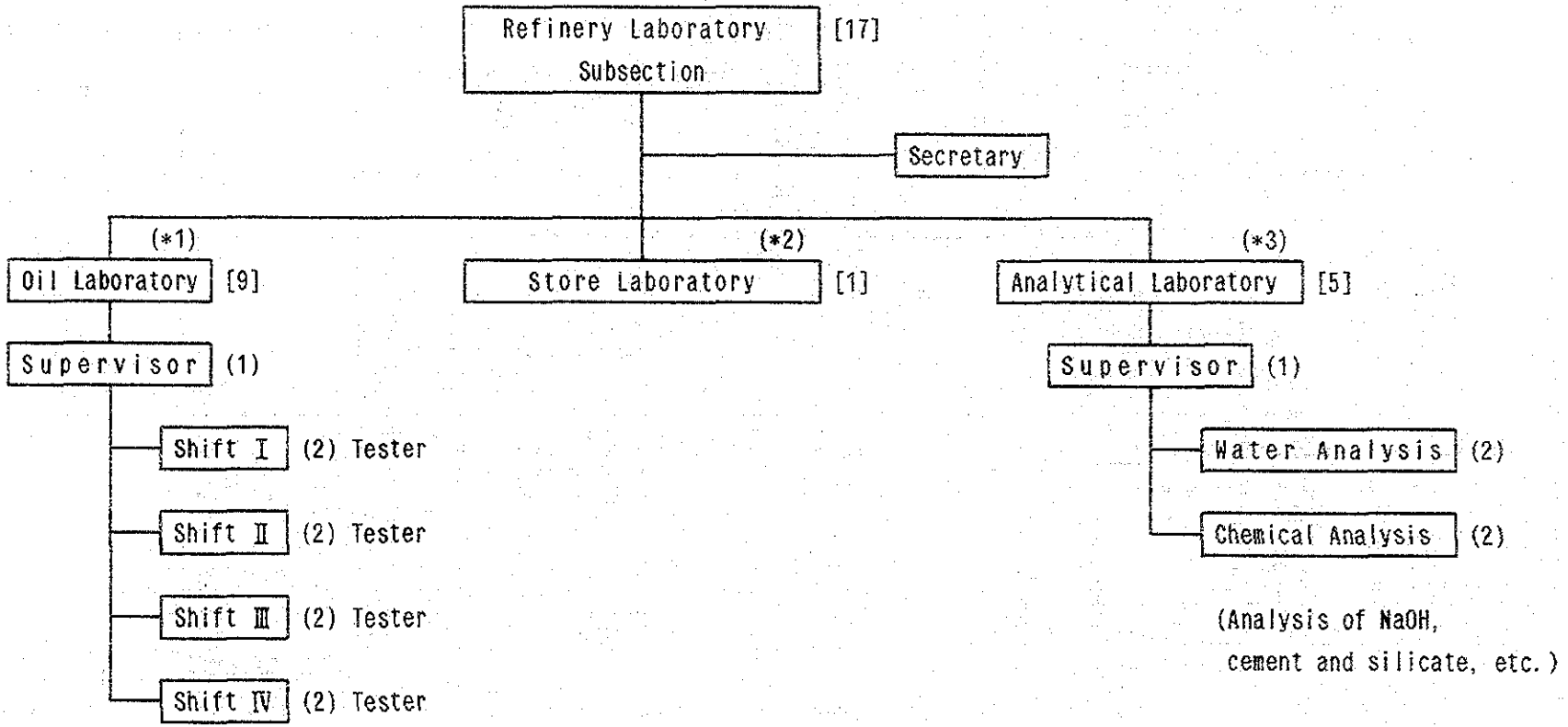
c) Reports

Crude oils, distillates and products analysis results are summarized in the predetermined format of report, which are reported to the relevant sections by mail besides communication by telephone.

d) Testing facilities

Table II-5-23 shows a summary of analytical testing items on the basis of the above sampling schedule.

Figure Ⅱ－5－9　ORGANIZATION OF REFINERY LABORATORY



(*1)　Routine analysis for oil and non-routine analysis for oil from other company

(*2)　Handling and storage of chemicals and glass ware

(*3)　Analysis for water and chemicals

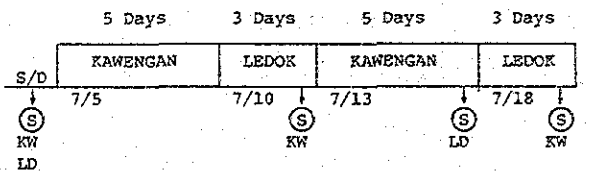
(Note)　(　) Indicates Numbers of Employee

Table II-5-22 REFINERY SAMPLING AND TEST SCHEDULE IN CEPU REFINERY

Unit or Facility	Sample	Testing Item	Frequency
Topping Unit	Crude Oil	Sp.Gr., RVP, Sulfur, Water, Vis., Pour Pt., Dist., CCR, Ash	Every charge to Unit
	(Stream Products)		
	Gasoline	Sp.Gr., Dist., Color	Every 4 hours
	Kerosine	Sp.Gr., Dist., Color, Fl.Pt.	Every 2 or 4 hours
	Gas Oil	Sp.Gr., Color, Fl.Pt., Pour Pt.	Every 4 hours
	PH Solar	Sp.Gr., Fl.Pt., Pour Pt.	Every 8 hours
	Residue	Sp.Gr., Color, Fl.Pt., Pour Pt.	Every 8 hours
	(Finished Products)		
	Gasoline	Sp.Gr., Dist., RVP, Doctor, Corrosion, ON	
	Kerosine	Sp.Gr., Dist., Color, Fl.Pt., Smoke Pt., Sulfur, Corrosion	
	Gas Oil	Sp.Gr., Dist., Color, Fl.Pt., Water, Pour Pt., Vis., Diesel Index, Sulfur	Every full tank or before shipping
	Residue	Sp.Gr., Fl.Pt., Pour Pt., Calorific Value	
	Fuel Oil	Sp.Gr., Fl.Pt., Pour Pt., Sulfur, Vis., Water, CCR, Calorific Value, Acid Number	
	BOD	Sp.Gr., Fl.Pt., Pour Pt.	
Wax Plant	PH Solar/AFO	Sp.Gr., Cong.Pt.	Every 8 hours
	Wax	Sp.Gr., Oil(1), Color, Penetration	before moulding or after treating
Boiler	Feed Water	pH, Hardness, T.S.	Every 2 hours
	Effluent Water	$CaCO_3$, Alkali, PO_4^{-3}	(Only from 8:00 to 12:00 AM)
Water Treatment	Drinking Water	pH, Hardness, Alkali, T.S., Cl, Fe, Turbidity, Bacteria, Pb, Mg	Once a month (Partly a day)
Cooling Tower	Cooling Water	pH, T.S.	Once a day
Oil Separator	Effluent Water	pH, Oil(2)	Once a week
	River Water	Oil(2)	

[Example]

(1) Crude Oil



(2) Stream Products

Shift I (Shift II and III are similar to Shift I)

8:00 Kero.
9:00 Gaso.
10:00 Kero.
11:00 Gas Oil
12:00 pH Solar/Residue
13:00 Gaso.
14:00 Kero.

[Abbreviation]

Cong.Pt. : Congealing Point
CCR : Conradson Carbon Residue
Corrosion: Copper Corrosion
Dist. : Distillation
Fl.Pt. : Flash Point
Oil(1) : Oil Content
Oil(2) : Waterbone Oil
RVP : Reid Vapor Pressure
Smoke Pt.: Smoke Point
Sulfur : Sulfur Content
T.S. : Total Solid
Vis. : Viscosity
Water : Water Content

Table Ⅱ－5－23　ANALYTICAL ITEM AND TESTING METHOD IN REFINETY LABORATORY

Analytical item	Testing method
1. Specific Gravity (for crude oil, petroleum oil and wax)	ASTM D1298 ASTM D941
2. Distillation (for crude oil, petroleum oil)	ASTM D285 ASTM D86
3. Flash Point (Tag Closed, Abel, Pensky-Martenes Closed, Cleveland Open Cup)	ASTM D56 IP 170 ASTM D93 ASTM D92
4. Smoke Point	ASTM D1322
5. Reid Vapor Pressure	ASTM D323
6. Viscosity (Redwood)	IP 70
7. Pour Point	ASTM D97
8. Water Content	ASTM D95
9. Conradson Carbon Residue	ASTM D189
10. Ash	ASTM D482
11. Sulfur (Lamp Method, High-Temperature Method)	ASTM D1266 ASTM D1551
12. Doctor Test	ASTM D484
13. Copper Corrosion	ASTM D130
14. Color (ASTM, Lovibond)	ASTN D1500 IP 17

Analytical item	Testing method
15. Octane Number (Research Method)	ASTM D2699
16. Calorific Value	ASTM D240
17. Acid Number	ASTM D974
18. Congealing Point	ASTM D938
19. Needle Penetration	ASTM D1321
20. Oil Content	ASTM D721
21. pH	ASTM D1293
22. Alkalinity	ASTM D1067
23. Turbidity	ASTM D1889
24. Hardness	ASTM D1126
25. Waterbone Oil	ASTM D3414
26. Total Solid	ASTM D1888
27. $CaCO_3$	ATSM D1126
28. PO_4^{-3}	ATSM D 516
29. Clorine	ATSM D1253
30. Bacteria (Colitis Germs)	ATSM D3870
31. Metal (Fe, Pb, Mg)	ATSM D1068 ATSM D3559 ATSM D 511

- Facilities and equipments in Oil Laboratory

The Oil Laboratory consists of staff room, preparation room for chemicals and glass wares and analysis room. The respective rooms and major analytical equipments layout are shown in Fig. II-5-10.

Most of analytical equipments are made in West Germany, followed by U.S.A and England. No equipment made in Japan is found. Most of chemicals are from West Germany.

Regarding analytical facilities and equipments possessed by the Oil Laboratory, Annex II-5-2 shows a summary of the description, test method, quantity, applications, manufacturer, type, purchased year and equipment conditions.

- Facilities and equipments in the Analytical Laboratory

The analytical Laboratory is composed of staff office, balance room and analysis room.

The analysis room is provided with 3 analysis tables and 1 set of draft chamber. The list of Analytical facilities and equipments possessded by analytical Laboratory is summarized in Appendix II-5-35.

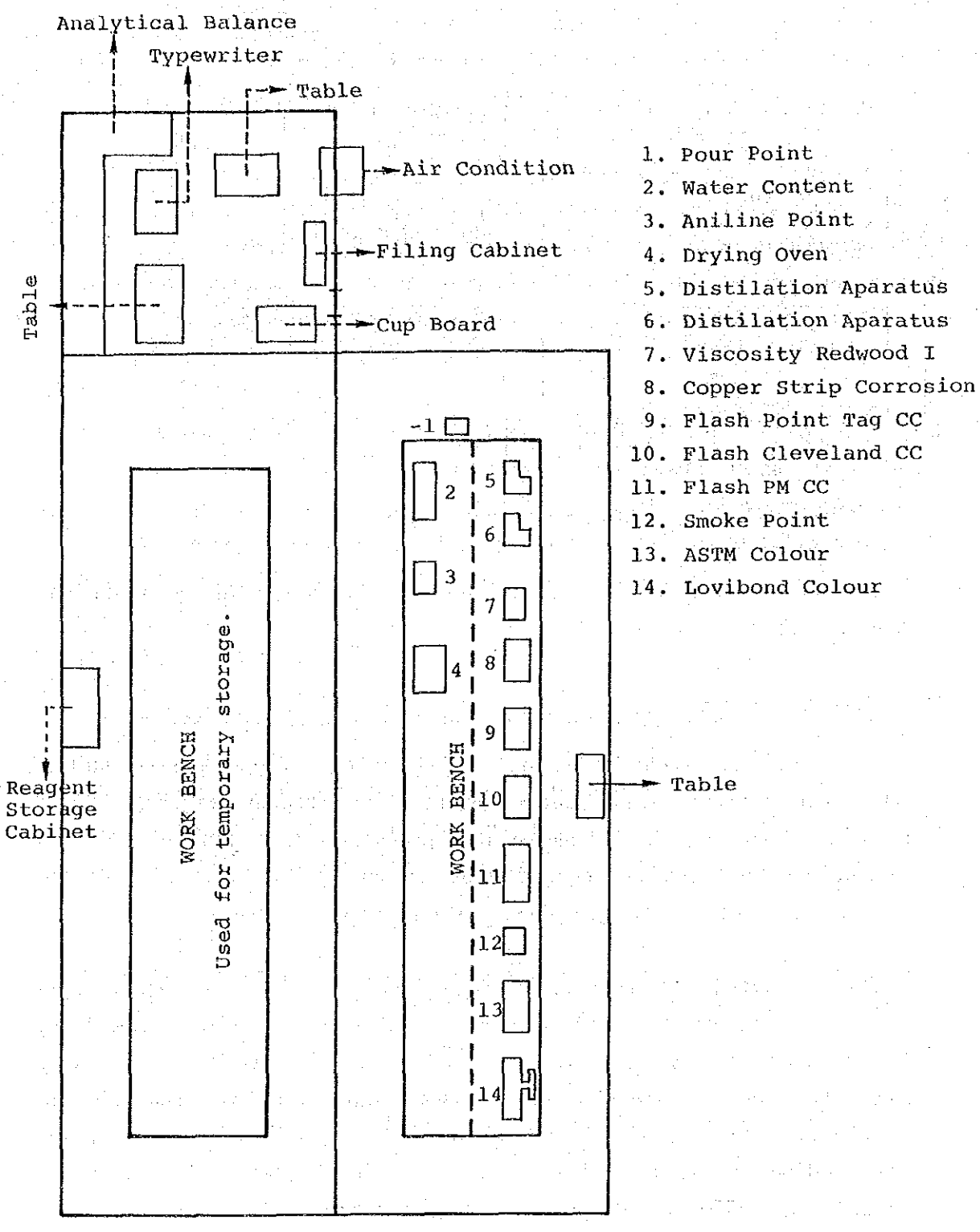
5.1.7 Purchasing and Inventory Control

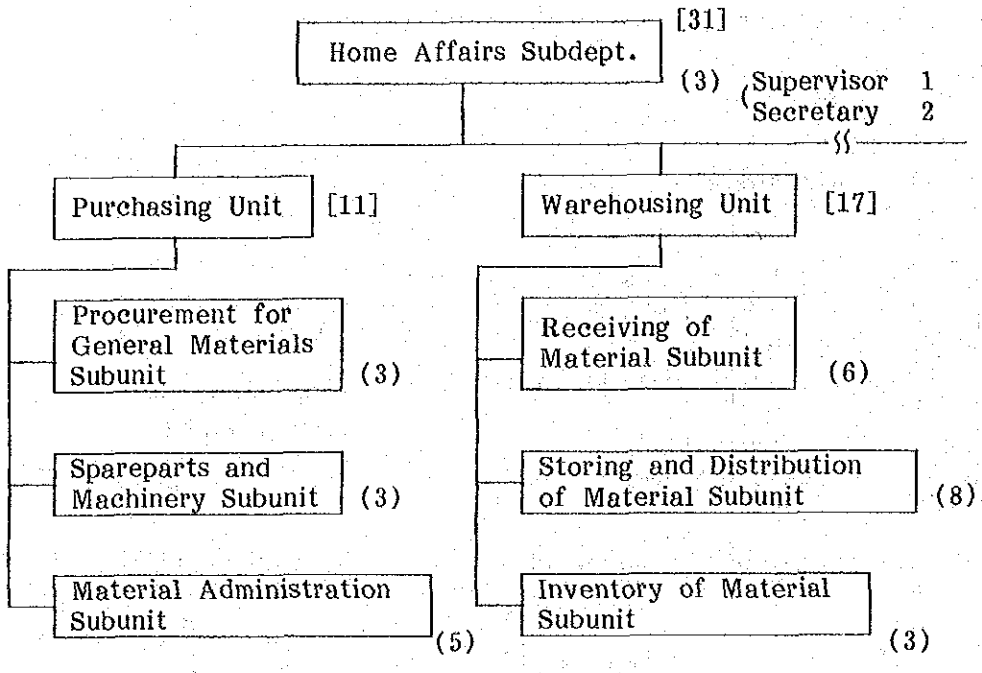
(1) Organization

Purchasing and inventory control are managed by Purchasing Unit and Warehousing Unit which belong to Home Affairs Subdept. of Administration Department.

The organizational configuration of these two units is as follows.

Figure II-5-10 LAYOUT OF OIL LABORATORY IN REFINERY LABORATORY





NOTE: ( ) shows personnel number

Home Affairs Subdept. includes 3 units of Security, Transportation and Accommodation besides the above.

(2) Purchasing Control

The structure of purchasing control is as follows. The purchasing unit is responsible for purchasing control regarding all products required in the Center. That is, the Purchasing Unit procures various kind of materials ranging from materials and equipment associated with refinery, oil field and training facilities to office supplies, stationeries and medicine.

Number of materials handled in the fiscal year 1984-1985 amounts to 8,538 items, but it seems that the organization corresponding to purchasing these big amounts of materials is well arranged and performs satisfactory functions. Materials and equipment include 1 those which are used mainly in production facilities, the consumption of which can be predicted, and which are retained as stock, and 2 those which are requested from users as needed. This classification poses no problem either.

The greatest problem for purchasing materials is that the spare parts of old equipment and machines made in foreign countries are hard to obtain, and many parts cannot be procured at all since manufacturing of those materials have already been discontinued. In general, it takes much time to procure spare parts of foreign made.

At present, however, the procurement of equipment, machine and material depends on imports from foreign countries in most cases, and only limited items can be procured locally. Foreign products are imported strictly in accordance with Governmental Law[1/] since CEPU Traning Center itself is a governmental agency, and procurement procedures are put under contol of Ministry of Finance.

Those who are engaged in import jobs must acquire the certificate of import. The Center itself is of course qualified for the import business. However, the promotional measures for local supply are taken, and positive purchasing of local materials is mandatory as long as their prices are reasonably lower than importing ones, and qualities are assured generally.

(3) Inventory Control

Warehousing Unit is responsible for routine inventory control.

The purpose of inventory control is to prepare readily for adequate supply of required materials to the user's requirement in the Center. The Center manages materials dividing them into MRO items and program items.

Note: 1/ Purchasing of import materials and equipment is provided basically by Presidential decree No. 29 (amendment, 1985) revised in 1984. This decree covers various provisions such as the difference of procurement method according to the ordering prices, supplier's qualification, guarantee of quality, tender invitation and governmental authorities and duties of its institutions on detail. In principle, this decree emphasizes open tender, lower price and local supplier's participation.

MRO items include 3 items, that is, ① Maintenance ② Repair and ③ Operation, which show 1 general materials required for daily maintenance, 2 spare parts for repair of mahcines and equipment, and 3 consumables such as lubricating oil, chemicals and office supplies respectively.

Program items are materials of which applications are clearly known in advance, and divided into periodical ones (for example, educational and training materials) and non-periodical ones (for example, equipment modifying materials). The budget for these materials are made by the beginning of every fiscal year according to the plan prepared in advance. On the other hand, inventory control is performed as follows in view of physical check and stock level control.

a) Physical check

In physical check, a stock list is prepared so that the quantity of actual stocks and stored material conditions can be seen anytime accurately. With the cooperation of Storing and Distribution of Material Subunit, Material Administration Subunit of Purchasing Unit checks all inventories at the end of fiscal year in order to prepare a report on increase or decrease of quantity, carry-over to the following fiscal year and storing conditions. Useless materials can not be disposed easily, and needed to be sold out by the specified procedure, and the earning must be deposited to Ministry of Finance.

b) Stock level control

Stock level control is carried out regarding MRO items. Analysts are actually responsible for this job. These analysts are respectively in charge for 1. Maintenance 2. Repair and 3. Operation of MRO, who perform the following duties.

- These analysts monitor the stock level so that first moving and top priority materials in particular do not run short, and review the stock level required periodically.

- the analysts review the stock level for general materials according to the monthly average consumption, material request sheet, memorandum from user on required materials and user's construction plan.

- the analysts plan to purchase makeup materials from the above review, stock card or the latest stock balance found by physical check.

c) Data on materials/machines and coding system

For stock control, MESC (Material & Equipment Standard Code) number coded to 10-digit figures is used. MESC coding system is a method used in Shell Group, which is also adopted in PERTAMINA.

In the Center, the following data on this system is fully arranged.

- MESC Standard Catalogue

- Coding Schedule

- General Index to MESC

Actually, besides MESC, this Center provides major foreign manufacturers' catalogues, operation manuals, parts catalogues, and these equipment and parts Nos. are also used in this Center.

(4) Warehousing

Storing and Distribution Subunit is responsible for maintenance of stored products. Number of stored products is approx. 11,000, among which general materials for office are included: the oil field related materials and equipment account for about 40% of all.

The oldest of the stored materials are used parts which are still usable such as pistons, cylinder liners, etc. for Thomassen engine for oil field, which have been stored since 1959. The products stored for a long time are mainly parts, which have mostly been removed from the machine main unit, since it was damaged, including Thomassen engine parts, and most of these

parts have almost no possibility of reuse. Notwithstanding, it is said that these obsolete parts have been stocked for educational training of trainees.

At present, there are always approx. 50 logistics related trainees, who are trained in a classroom within the warehouse building (logistics).

A greater part of stock machine parts and electrical parts are obsolete. Their physical storage conditions are unfavorable, and it is found that most of them are rusted. Some parts deteriorate during storage and are not good for use.

From these conditions, it is presumed that used parts are moving very slowly or hardly moving.

In contrast to the above, it is said that piping materials (valve, flange, pipe, etc.) are fast-moving parts. However, it is supposed that these materials are also moving rather slowly in view of the activity of the entire oil refinery. Among the stored materials are a considerable amount of new stocks such as cooler/condenser tubes, bubble caps and heating furnace tubes. This is due to certain modification of the schedule of replacement programme.

Stocks are classified and arranged well to some extent, and the respective parts are attached with a stock card which describes parts name, quantity, specification, and code No. There are some used parts in particular among many old stocks which may not be identified. In other places than material warehouses, materials are occasionally found. For example, in the wax molding house, many used parts are left without control, such as flanges, valves, bends foot valves with strainer, bubble caps, floaters for tank level guage, and electrical wiring cables, and a considerable amount of other used machines such as steam driven reciprocating pump are included therein. Also, in a wax plant house, a lot of heat insulating materials are stored. These are surplus parts used for rehabilitation.

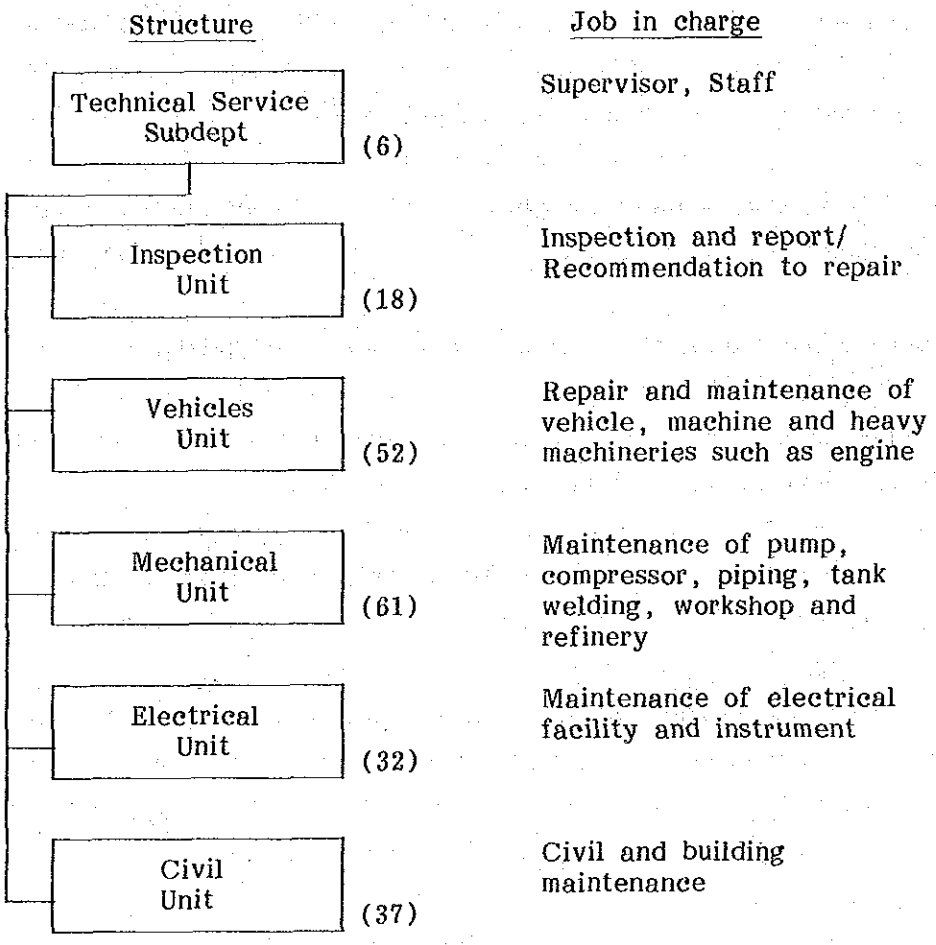
MESC Standard Catalog and Coding Scehdule are fully arranged, and many other leading makers' catalogs are stored in the office within the warehouse building.

In the Center, no computer has been utilized yet for purchase and inventory control.

5.1.8 Maintenance System and Workshop Function

The maintenance and repair of facilities and machineries in the Center are carried out by Technical Service Subdept. which belongs to Administration Department as a rule.

The organizational structure of technical Service Subdept. is as follows.



Note: ( ) shows personnel number

The job of each Unit of Technical Service Subdept. is directed to maintenance. However, Inspection Unit was newly established in 1984. Inspection functions which were included in each Unit respectively until then

were brought up together into one so far to improve the deficiency of the conventional maintenance system.

This Unit issues an equipment repair recommendation on the basis of inspection results, but it itself performs no maintenance operation.

The workshops belong to Mechanical Unit, which includes Repair Workshop (Machine shop), Construction Workshop, Foundry and Pipe Shop.

Technical Service Subdept. is composed of a total of 206 personnel, and the number of personnel seems to be excessive judging from our common sense.

The major reasons of excessiveness are thought as follows:

a) the subcontract system is not completely fullfledged, and employee's work range is wide;

b) a large-scale plant such as a machine shop is provided; and

c) the Center cannot rely on outside workshop for vehicles and heavy machineries, and therefore does repair work by itself.

In addition to the above, the reasons which are not found in a general oil refinery are that:

d) the Center is in charge or practical training education as a part of educational training curriculum in the Center.

e) the center is doing maintenance work for oil field facilities.

The personnel of Mechanical Unit by the type of job is:

20 for mechanics (operation, grinding and molding)
12 for pipe fitters
10 for welders
12 for maintenance workers in oil refinery

Thus, the number of workers is large. However, there are very few specialists: just 3 for welding and 3 for machines.

This is the same with other units: just 2 civil engineers and 4 electrical engineers. Insepction Unit established in 1984 has no specialist yet.

For the operation rate of machines in the workshop, except operation for repair and maintenance the operation for the training of trainees occupies some period of time: the ratio between them is 70 to 30%.

Repair shop is provided with a great many machines as described in Part II 5.3.9, a greater part of which are very old and not good for use in most cases.

Even those machines which may be narrowly used cannot maintain its machining precision, and therefore, it is low in instability. the operation rate of machines except 10 machines which are out of use is nearly 20%.

On the other hand, the refinery requires the services of the machine but not so for frequent. In fact, it is quite rare that bolts and nuts are manufactured, and cylinder liners, pistons, etc. are machined.

No order for machining is received from the outside. Primary repair works in Repair Work Shop range from major engine overhauling to small repairs. Further, this workshop is also engaged in service job such as oil replacement for machineries.

As already described, machines and facilities in Work Shop are very old most of which were installed in 1920 and 1930's, and the manufacturing of these machines have already been stopped. Consequently, spare parts for these machines cannot be obtained, and the attachments and accessories are damaged or found missing. Since, in case they are repaired, substantial

costs are required and then original accuracy cannot be recovered, no maintenance for these machines is carried out at all substantially.

The storing and control of cutting tools and measuring instruments are done in tools room that is one special corner of the machine shop, which always locked. For storage conditions, the tools and instruments are arranged and classified, but some extremely worn or damaged ones are stored without any repair.

The above is a general description of maintenance and workshop functions. No problem is found for both entire configuration of technical Service Subdept., and workshop function in this system, and it is therefore considered that the entire system is satisfactory.

However, the problem is that (1) equipment and facilities are very old and need modifying, and that (2) personnel configuration is satisfactory, but specialists are short.

Regarding (1) above, refer to Part III Diagnosis and Countermeasures 4.8 Workshop.

Regarding (2) above, it is necessary to foster specialists, but this training is required not only in workshop but over the entire Technical Service Subdept., and this specialist training must be taken seriously in order to produce satisfactory results as educational training organization.

For this purpose, it is preferable to invite a training specialist from the outside in order to train training staff and specialists.

5.2 Mechanical Problems of Atmospheric Distillation Unit

5.2.1 General

In the previous section 5.1, discussions have principally been concentrated on those problems related to the process, operation, and administration of the existing atmospheric distillation unit of the Centre. This section, therefore, discusses mechanical problems of the unit in line with the following classification of equipment on the basis of results of the field inspection work done by the JICA study team during its stay in Cepu.

Despite a very limited time duration available for the field inspection in Cepu, an open-inspection was made for some selected major equipment in addition to an ordinary on-stream inspection.

a) Tower and Vessel
b) Furnace
c) Heat Exchanger (incld. Cooler and Condensor)
d) Pump
e) Piping
f) Instrumentation
g) Structure and Insulation

Safety problems of the existing refinery will also be discussed briefly in this section.

5.2.2 Tower and Vessel

(1) Outline of the present state

Because of insufficient time of survey, the inspection of this item was performed mostly on C1 Column which is main fractionator and most important tower of this plant. There are twin C1 columns, C1A and B, and these two have utterly same size and construction.

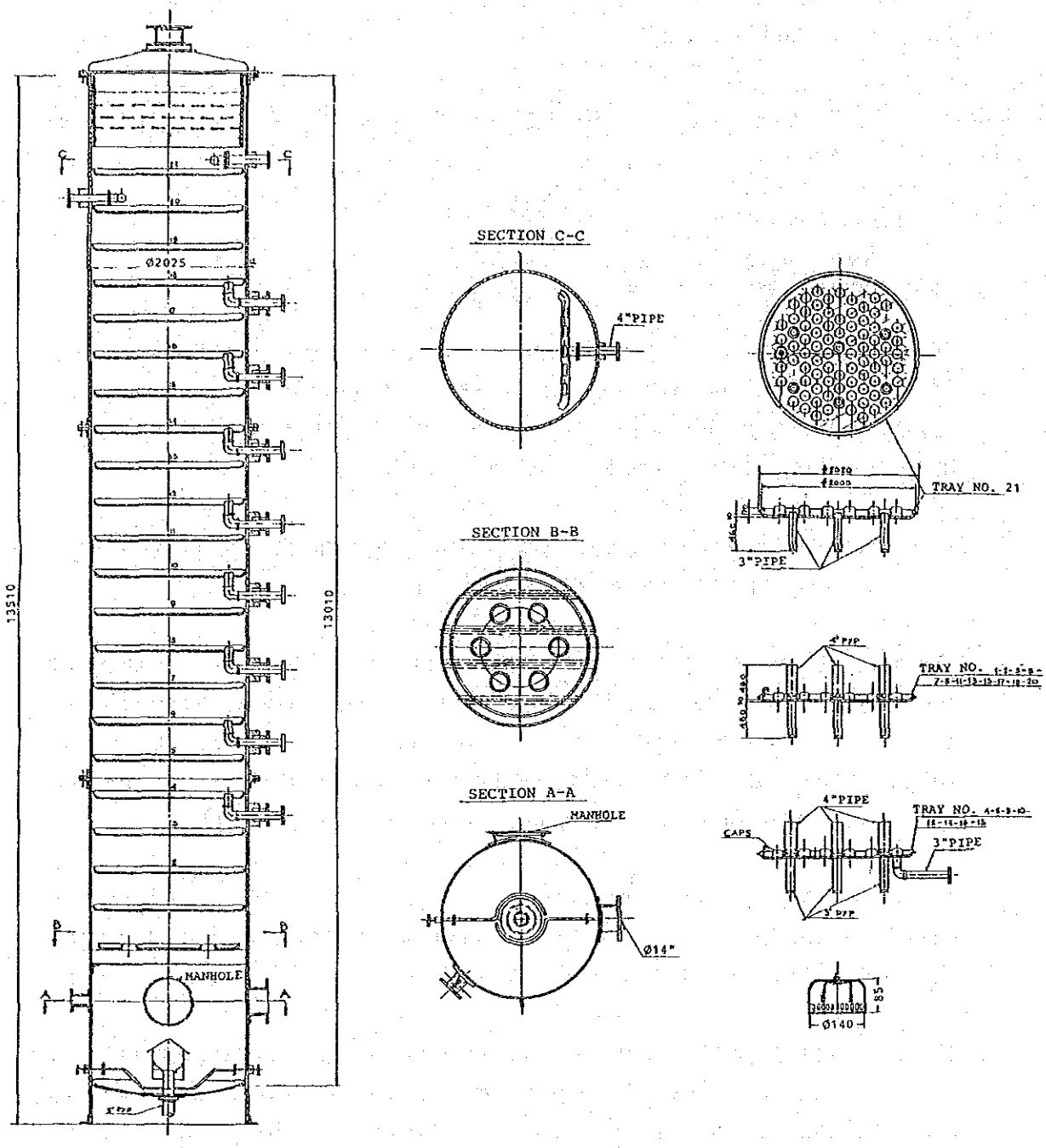
According to the history file of the columns C1A has not been used since 1970 and put in naked with no insulation at all now.

The year of construction of this refinery plant is said to be nearly 60 years ago, 1920s. Since then the all of towers and vessels have not been renewed and remained in old riveted joint construction just as it was in original state. The shell of C1 column consists of three shell rings and has two horizontal flange joints in mid sections as shown in Fig. II-5-11.

Top cover, the big one piece lid of carved plate, is attached at the top of shell by bolted flanges. Only one manhole is located at the shell bottom and there are no ones in the middle of the column.

So, there are some difficulties of making inspection and/or cleaning of inner trays, for top cover must be opened and trays must be lifted upward one by one from the top of the tower for that purpose, and there are no other ways. For this reason the survey was made only on top tray portion and at the tower bottom.

Figure II-5-11 STRUCTURE OF C1 COLUMN



On the other hand, since it was known that the buckling had been taken place at the shell bottom of C1B has 'History File of H1(C1)' which contains records of 1968 - 1975 and shows inspection was made nearly each two years in this period.

The description in this record is very rough and lacks consistency. However, by this record top 8 trays and their bubble caps were found severely corroded in 1972 and exchanged with lower 8 trays because there were no spares.

After that, in 1975 all of these upper trays and caps are recorded to be in good condition, but no allusions about lower trays are found. and there are no record after 1975. Until now C1 column suffered oil leakage from its reveted joints so often that the leaked joints were confined with Fig. II-5-9 Sketch of C1 Column [shaped welded strips over them to prevent leakage again.

In 1984 vertical riveted joint of the lowest shell ring caught fire following oil leakage and sealed in the same way, but caught fire again June 10, this year. The detail about this trouble will be described afterward.

(2) Outline of inspection

a) Baffle sleeve of tower top

Tower top sleeve was severely attacked by corrosion, wire mesh fell in pieces, support angles for mesh were thin by corrosion, scale accumulation was thick on the baffle plates.

b) Top tray and shell

Excessive fouling was found on the tray, bubble caps were almost buried in the accumulated deposit. The deposit was severer at the southern half of the tray reaching 6 to 7cm in depth, and a little thiner at the opposite side where upper part of caps' slits could barely be seen near the reflux nozzle. Inside of the shell was severely corroded with heavy pock-marked pitting corrosion on the whole surface. Distributor pipe of

reflux nozzle became paper-thin. Bubble caps were also damaged with corrosion, and some of them lost their skirt from under the top of the slits. Tray itself kept unexpectedly good and no open corrosion holes were found.

c) Deposited sludge

The result of sludge analyzation is as follows.

(unit wt%)

Item	Result	Remark	
Fe	59.0	Compound base as:	
SiO_2	< 0.1	Fe_2O_3 [1]	84.4
SO_4^{-2}	0.3	carbon	10.4
S^{-2}	0.5	others	5.2
Ash	87.0		
Carbon	10.4		

Note: [1] The component of the deposit was mostly made up of Fe_2O_3 which derived from the corrosion of iron materials such as shell and tray.

d) Bottom

No sludge accumulation on the bottom and almost clean, pock-marked pitting corrosion on whole surface inside of the shell. The buckling deformation swelled outward were seen around over inlet nozzle from C5, C4 columns.

e) Bottom tray

The lowest tray were observed from the bottom. In the extent that could be seen through the holes of baffle plate located under the tray, the underside of tray and inside of riser pipe was severely attacked by corrosion, and many of the caps had been lost.

f) Buckling

Since it was known that there was buckling at the bottom shell beforehand, we took off insulation and surveyed it. The size of buckling was nearly 1m long and 22cm in width swelling outward above the nozzle with maximum hight of deformation of 14mm. (see Fig. II-5-12)

The thickness measurement of this location showed min. 7.8mm and max. 9.8mm which meant about 4mm reduction from original thickness on drawing 12.0mm at thinnest part. The time of occurrence of buckling was unknown. However, after the fire took place on June 10, 1985, repair was made by putting reinforcing channels on both side of the buckling.

The buckling calculation was tried under the condition shown below related to seismic and wind load. for reference, calculation was made at skirt part except the place of buckling.

(Condition)

Temp./Inside press	350°C/0.5Kg/cm^{2}G Material low carbon steel (JIS SS41)
Seismic coefficient	0.3 (by high press. gas control law)
Wind load	base hight 8m (by JPI)
Thickness of plate	7.8mm

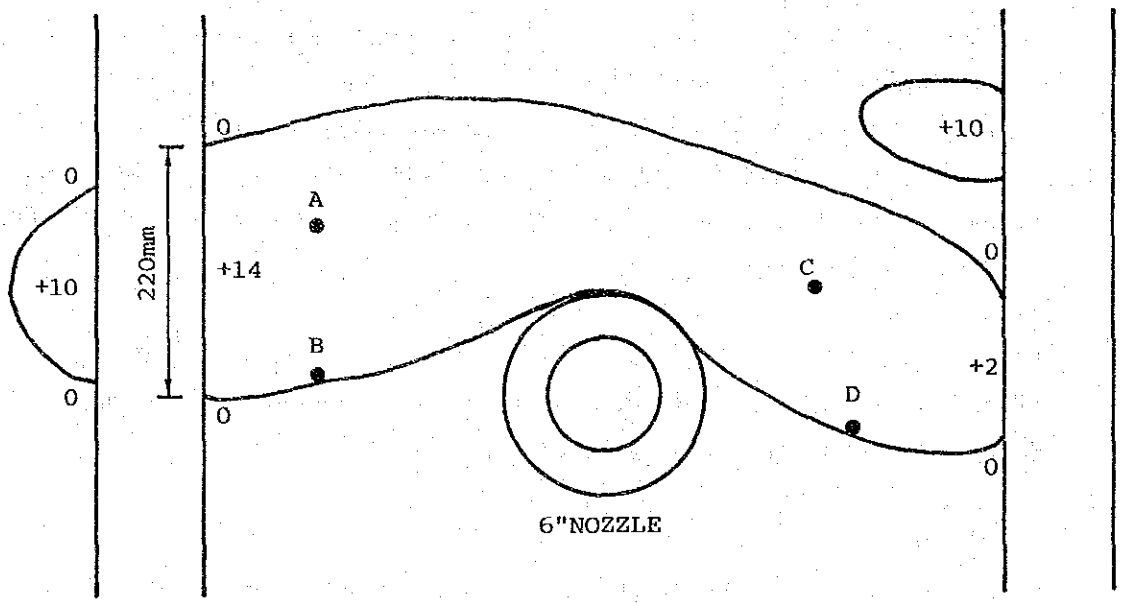
(Result)

	Seismic	Wind	Allowable Stress
Shell: tensile stress	1.43	1.32	3.19
compression "	1.87	1.75	8.12
Skirt: compression "	2.00	1.87	8.12

Unit Kg/mm^2

Result shows no stress exceeds allowable stress and no condition exist for buckling. (show reference Ann. II-5-4 attached in the Annex of this report)

Figure II-5-12 SHAPE OF BUCKLING AND MEASUREMENT OF SHELL THICKNESS



[60 x 120 x 5.2
Strengthened Channel

Measurement thickness
(By use of Ultrasonic thickness meter)

A	at the point buckling	7.8
B	at the point buckling	8.2
C	at the point buckling	9.8
D	at the point buckling	9.0

g) Thickness measured

Thickness was measured at some points shown bellow with ultrasonic thickness meter.

- Bottom head 9.6mm
  10.1mm
- Bottom skirt 10.1mm
- Top head cover 7.7mm 7.8mm
- Top tray min. 6.3mm max. 7.1mm av.6.6mm
- Top shell 10mm minus pitting corrosion

Top shell measurement was made from inside and hardly done because of harsh corrosion. There were many pittings reaching 2mm depth. The numbers in the following table which was collected from past data show thickness of shown places, and it is not necessarily adequate to compare these numbers because of uncertainty of measuring point and method, and yet show tendency of thickness reduction.

(unit mm)

	1953	1968	1972	1975	1984	1985	original
Top head	9.8	11.7	11.0		6.5 7.1 7.2	7.7 7.8	12
Shell	10.0	8.4 10.8	9.0 11.0	9.0 9.6	8.5 9.0 9.5	*7.8 *8.2	12
Bottom head	10.5					9.6 10.1	12

* thickness at buckling

h) Fire accident

As mentioned before the fire took place at the vertical riveted joint of lowest shell ring June 10, 1985. This portion got oil leakage and fire in 1984 and sealed with welded steel plates in the shape of channel as shown in the Fig. II-5-13.

But oil seepage continued through along the rivets into the channel and beeing stored insidiously, then again went through the rivet joint into inside of the skirt and caught fire.

5.2.3 Furnace

(1) Outline of the present state

Since there was no sufficient time for cooling down furnaces in our shut down inspection schedule, the survey inside furnace was performed only about F1B which was not used at that time.

There are four furnaces of the same type and size, and they are interchangeable switching oil streams by inlet and outlet headers. Three of them (F1A, B, C) are for crude oil heating and the other one is for C2 reboiler.

Presently, F1A and C are used for crude oil heating in proportion to the treating barrels of crude oil and F1B is beeing put at rest. But it is said that deterioration of each furnace are at the same level, and this can be assumed from the 'History File of Furnace' too. So F1B can represent others properly. By the History File, the inspection had been made each two years from 1968. And it shows the deterioration of wall and tubes which existed at first had grown harsher year by year. But there are no records of inspection after 1975, so the state of recent 10 years is unknown, and it is said that no maintenance had been made utterly in this period.

As shown in Fig. II-5-4 the structure of furnace is old and obsolete box type with no radiation tubes on the side walls. By the record the lowest two row of tubes which suffer affection of radiation had been finned, but

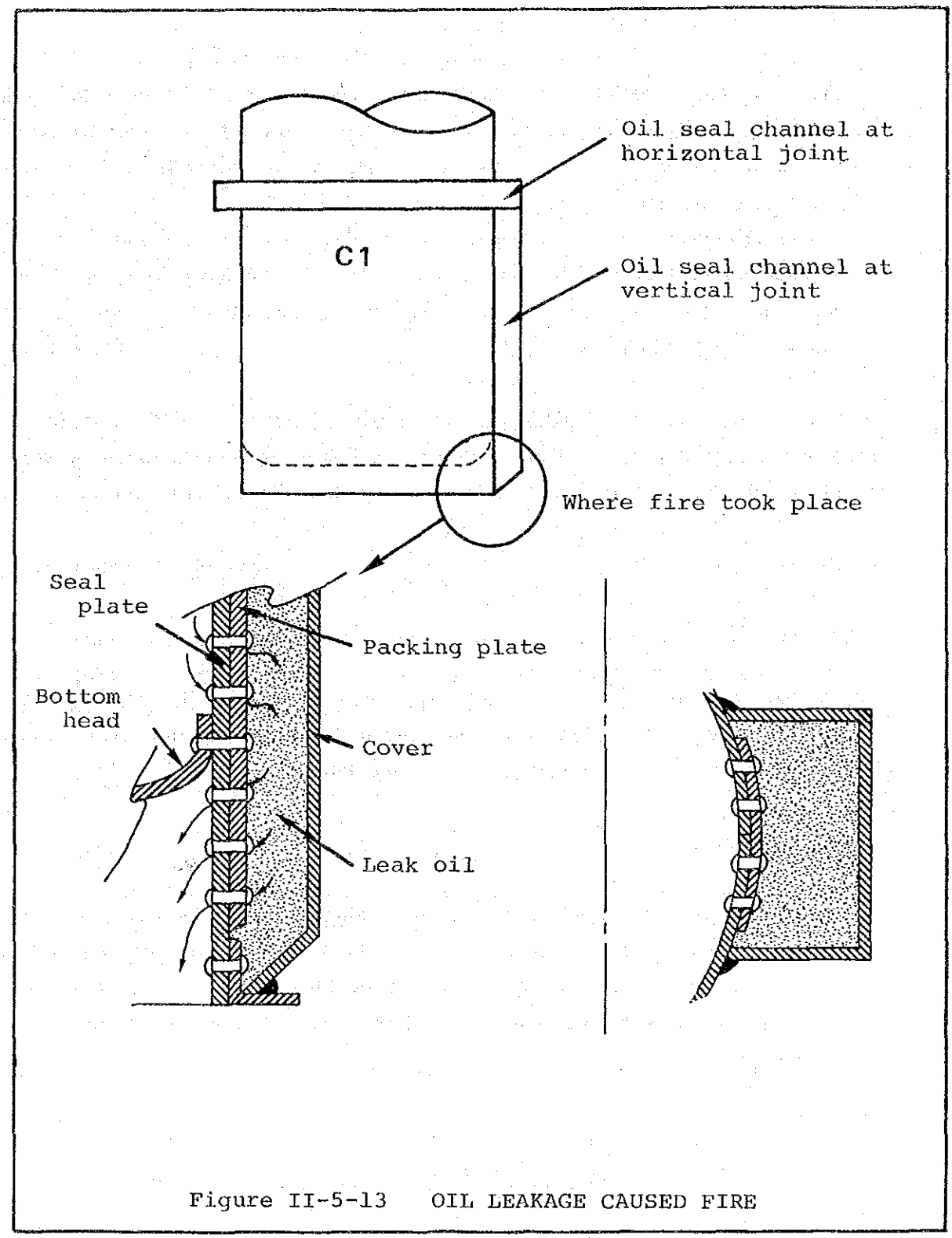


Figure II-5-13 OIL LEAKAGE CAUSED FIRE

bare now. Furnace body is constructed with steel structure and brick walls both inside and outside.

Tube coil is supported at the both header boxes with steel beams for each row, and at the same time supported at the bottom of tube coil with two intermediate supports. (Fig. II-5-4 is somewhat different from actual one and shows only one support)

Originaly there were refractory baffles for flue gas composed of molded refractory blocks arrayed on the tubes, but almost all blocks fell off and there are no vestiges remained.

Stacks, made of steel plate with no refractory inside, stand at the top of each furnace, had no trouble by losing their thickness according to History File. But no inspection was made on stacks this time.

(2) Outline of inspection

a) Outside wall

The wall of both side is divided into four spans with vertical steel structures, and each span has vertical crack on the brick wall. Particular cracks are mended by cement caulking.

b) Inside wall

Deterioration of inside wall was unimaginable. Cracks were on every where, some parts swelled inward. Almost all surfaces of fire bricks were melted off and remains were hardly left. Brick layers around the burner were depressed downward. floor was scattered with fallen bricks everywhere.

c) Support beam

I beams of the intermediate support at the coil bottom were stripped bare of their brick and refractory coating, and severely oxidized.

d) Baffle

All baffle blocks fell off and no remains of baffle were left. Some of the blocks rested on tubes.

e) Surface of tubes

Severe changes of color were seen especially on the bottom row tubes affected with flame. Middle portion of these tubes changed white with sloughed scale.

f) Tube arrangement

The tubes were originally arrayed in zigzag arrangement, but lost their order and could be seen straight up to the ceiling through between tubes somewhere. Deflecting tubes could be seen also.

g) Thickness of tubes

Thickness measurement was carried on the middle and extreme right and left tubes of the lowest row. Two points, that is middle and end (back wall side) of tube, of these each tube bottom was measured by ultrasonic thickness meter.

Results:

	middle	end
middle tube	8.1 mm	9.2 mm
left "	1.0 mm	8.8 mm
right "	7.0 mm	9.6 mm

Since there was no record of tube thickness, the corrosion rate could not be calculated. The standard thickness appopriate to these tubes is 8.6mm (4" Sch. 80).

At the middle point on the left tube, where particular value was shown, the measurement was repeated in the vicinity of the point, but no value was differed.

h) Return bend

The thickness was measured on the lowest row bends too, the results show there remains enough thickness in general. Four bends of the back wall side and one bend (last bend) at burner side and also outlet elbow were selected, and measurement was done at one point on the crest.

Results:

back wall side (from left facing wall)	13.8	11.6	16.6	15.3mm
burner side bend		2.3mm		
outlet elbow		1.6mm		

Particular value at outlet elbow was checked repeatedly and no change was shown.

5.2.4 Heat Exchangers

(1) Outline of the present state

As for maintenance record there are 'History File of Heat Exchanger' and 'History File of Cooler' in the Center.

According to these records inspection was made nearly every two years during only seven years from 1968 to 1975, and these descriptions are not sufficient enough.

By these records, retubings of leaked tubes were made partly or entirely for heatexchangers until now, but as for condensors and coolers few tubes were changed and put in use successively by clogging leaked tubes with wooden plugs, and then plugged tubes reached 30% of all tubes of one condensor or cooler in the worst case.

It is said that no maintenance had been done for quite a long while and troubles had been cured by occasional treatment. The survey proved this fact too.

In this survey open inspection was not made because of reasons below,

a) Insufficient time of survey was allowed.

b) As almost all exchangers and coolers are fixed tube sheet type, internal observation of shell side and measurement of tube thickness cannot be performed even in case of opening them.

c) Almost all coolers and condensors have open channel, and so there was no big difference between open and not-open inspection.

d) Because of no-maintenance for a long years, external deterioration was observed. And there was fear of having trouble on following operation by misrefitment in case of opening them.

In effect, there might have been some difficulties of opening unusual vertical type of exchangers which are not used in modern refinery.

(2) Outline of inspection

Therefore the inspection was done only at open channel side for tubular type cooler and condensor which is now in use.

Following E2A - E15B show this kind.

As for the cooling water, refer to 5.3.4 'Water treatment facility' in this chapter.

E2A Tube sheet severely corroded with pock-marked pitting corrosion, many algae.

E2B Tube sheet severely corroded with pock-marked pitting corrosion, end of tubes melted off by corrosion severely, one plug, many algae.

E2C Tube sheet severely corroded with pock-marked pitting corrosion, many algae.

E3 Tube sheet severely corroded with pock-marked pitting corrosion, 38 plugs, many algae.

E4A Tube & Tube sheet relatively good, many algae.

E5 Tube & Tube sheet no big corrosion, 9 plugs.

E7 Tube & Tube sheet no corrosion, 5 plugs, many algae.

E9 Inside of tubes severely corroded, 2 plugs.

E11 Inside of tubes severely corroded, 1 plug.

E12A Reduction of area more than 1/3 by hard fur inside almost tubes, a few complete cloggings, not usable condition.

E12B Severer than E12A, almost all tubes clogged, 1 plug, not usable condition.

E13A Tube & Tube sheet severely corroded, irregularity by overall corrosion attack on Tube sheet, Tube end melted, 3 plugs, many algae.

E13B Same as 13A, but more bitter corrosion inside of tubes, 8 plugs, many algae.

E14B Tube & Tube sheet no corrosion, 5 plugs, many algae.

E15A Relatively good except inside corrosion of tubes.

E15B Extreme corrosion inside of tubes, few thickness left, many algae.

E8A (Box cooler) Tube surface relatively good with little scale.

E17A (Box cooler) All coil surface covered with white scale (fur), many severe pitting corrosion, under the stone hard scale many pitting corrosion, reaches 4mm max. in depth. Three points of no pitting corrosion on coil and inlet nozzle each was measured of their thickness.

Results:	coil (3 in)	4.4	4.7	4.1 mm
	nozzle (4 in)	5.4	5.4	5.1 mm

Inside of all channel shells were severely attacked by corrosion, and one got hole.

As for E1B, top cover thickness was measured at three points.

Results:	No.1	18.3 mm
	2	18.7 mm
	3	18.6 mm

5.2.5 Pump

All old reciprocating pumps were renewed to new centrifugal pumps from Dec. 1984 to Jan. 1985.

All of these new pumps were running well without unusual vibration and heat.

The performance check of the pump's characteristics could not be done, because the pumps (7.5 - 20 m^3/hr) and motors (1.5 - 5.5 KW) were so small that there were no individual flow meters for pumps and no A/V meters for motors.

C2 reboiler pumps (P010-5A, B) were not used in spite of new installation because of cavitation caused by scale piling in the suction strainer which came from C2 column. Old reciprocating steam driven pump was beeing used in this place.

Fuel oil pumps (P500-1A, 1B) which were newly installed in the process area with fuel oil supply unit are screw type, one motor driven and the other steam turbine driven. Because of lack of spare parts for steam turbine, one pump (P500-1A) could not never be used and lost its standby position.

5.2.6 Piping

Generally the arrangement of piping such as elevation and path was poor. There were some damaged valves and fittings, a flange which lost its bolts partly and flanges with poor tightening arrangment of bolts (uneven length on both sides). A thermometer uneasily fitted to pipe was left dead.

Steam inlet and outlet pipings to the old replaced reciprocating pumps were left unused and not removed. Useless pipes of removed condensor were left on the stage. These are not only unsightly but also unsafe for operational works.

In general, there were so many valves and flanges compared to the scale of piping.

The design idea of blocked operation or interchangiability of heat exchangers and furnaces increase the number of valves and chances of trouble at the same time. Maintenance of equipment and improving of credibility could reduce the number of valves to the minimum required, and this is the way in modern refinery. Too many flanges cause the chance of leakage too. A number of flanges at high temperature piping had no insulation and increasing heat loss. At steam piping steam leak from main line valve gland was found. Troubled motion of steam traps was found too.

Vibration of piping could not be found during operation. As for piping standard, the Center has 'Piping Material Specification'. 8 classes provided in this specification cover all ratings used in the refinery. But this standard was made in recent years, and in reality, old piping of superannuated plant causes difficulties of applying proper materials.

By this reason, mix using of valves and fittings were found and this means difficulties of maintenance. In this survey, measurement of thickness at several points of main process pipes were made by ultrasonic thickness meter. Results are as follows.

Location	Thickness (mm)	Size (in)	Sch. 40 (mm)
E1B Crude outlet elbow	13.9	6	7.1
F1A outlet elbow	4.5	4	6.0 (Sch.80:8.6)
V1 inlet elbow	7.6	10	9.3
V1 to C1 elbow (before T)	13.6*	18	14.3
C1 inlet elbow	11.7	14	11.1
C2 outlet elbow	14.8*	16	12.7

Note * meter is different from others

As original thickness is unknown the thickness of Sch. 40 pipe (applicable pipe class) is shown for reference.

5.2.7 Instrumentation

(1) Outline of inspection

All instrument of control loops are pneumatic and func tioning well without major troubles. But by auto control offsetting was taking place in more than 90% of loops. Twelve point Temperature recorder for furnaces once installed in field was taken away on account of false recording.

No trouble was noticed for existing control panel instruments too. The calibration of input and ontput signals was performed properly by the Center members.

The offset of controler did not take place when manualy controled, and then the reason of causing offset in autocontrol were supposed as follow.

a) At calibration, corresponding adjustment of the span between transmitter and controller was not properly performed.

b) PID action of controler was not adjusted.

c) Deviation of signal air pressure for internal calculation from proper value.

As for a) the Center is able to correct it itself, but b) and c) need manufacturer's performance.

(2) Maintenance

Maintenance schedule of instrument was provided as the periodic check sheet, but seemed not necessarily performed as described in it. Actually, the calibration of instrument was beeing done during shut down only after abnormality found and reported.

Field transmitters and controllers seemed to have any trouble both inside and outside by observation, but displacer tubes of LS and LT got heavy rust at connecting pipes, flanges and valves.

Both field mounted temperature indicator and element had no trouble. Level gauges got heavy rust outside of gauges for C1 - C5 and V1, and also get fouled inside of gauges for V2 - V8.

Function of control valves were good. But LCV 010-1 - 6, got heavy rust outside and damaged. One of them lost air pressure gauge and others have tarnished cover glass which hinders a person reading dial.

All pressure conduit tubes are assembled by screwed fittings because of low pressure and no defect was found. Supply and signal air piping and tubing were good, regulators were well maintained and no damage was found. Instrument air was supplied directly from main supply pipe to individual instrument with no block valve on the main pipe side. But this is understandable for where small numbers of instrument exist in relatively small area.

Calibration equipment provided in the training laboratory for training purpose is used for calibration of pneumatic instruments of the process plant too.

Calibrator, 7 in number, consists of two groups, one is for calibration work and the other for training activity. During past 10 years all instrument calibration was performed by the Center itself without manufacturer's contribution. Few spare parts for maintenance are stored. Purchasing spare parts needs 3 months to 1 year to get after order. In some cases less important instrument were left unmended without spare parts in relation to budget and period of supply.

5.2.8 Structure and Insulation

(1) Structure

As primary structures, there is main structure and sub-structure. Main structure has main columns and vessels on it. Substructure has condensors and coolers on it. Those two were built side by side and connected with beams into one.

Main structure has C2, C3, C4 and C5 on first stage (GL + 5m), C1A.B on the second stage (GL + 8m) and V1 on a little higher stage (GL + 9m). The hight of top stage in GL + 21.6m. Substructure is much lower than main structure, and the highest stage 10m above ground. This structure has four tiers of divided levels and has 21 coolers and condensors placed on it.

Lower portion of the structure, that is, supports lower than GL + 10m of main structure, supports of substructure, beams and struts of these supports were protected with fire proof coating. But most of them fell off and became no use for fire protection.

(2) Insulation

There are renewed portiones mixed with old ones. Renewed portions, such as columns and vessels coated with rock wool and aluminum plate covering, and part of piping with calcium silicate and aluminum plate covering were in good condition. But other old insulation on piping and heatexchanger which is diatomaceous earth was severely deteriorated and fell off in many parts. Most of high temperature valves and flanges were not insulated.

5.2.9 Safety

Some points about safety consideration was noticed during survey.

(1) Fault of insulation

Some many parts of high temperature piping had lost their insulation and became not only inefficient for protection of heat loss but also dangerous for burns to the human body.

Many pipe flanges in high temperature service had no insulation, and these must be insulated from the same point of view.

(2) Lack of fire proof coating

Supports, beams and stays of main and substructure which held important equipment such as towers, vessels condensors and coolers on them had lost fire proof coating at so many parts, and became mostly naked.

So became vulnerable of collapsing by accidental fire. So that these must be repaired as immediately as possible.

(3) Unused piping

In spite of replacement of old steam driven reciprocating pumps to new motor driven ones, the steam inlet and outlet pipings were left unremoved.

These were not only unsightly but also became harmful for the access for maintenance and operational work. These pipings must be removed.

(4) Obstacles on structural stage

Obstacles such as connecting pipes and parts were left on stage after E4A and E6A had been removed.

These were unsafe for human passage and must be removed.

(5) Lack of stopper bar around stage

There were not stopper bars at the periphery of many stages. This causes fear of slipping of the foot of a working person or rolling off of material from top of stage, then causes serious personal damage.

Stopper bars must be prepared as promptly as possible.

(6) Slippery footing by oil spill

Floor around fuel oil supply unit was extremely smeared and very slippery by spilt oil, and very dangerous for access.

And also at delivery pump site, oil spills were much more severe.

Oil spouted from valve gland each time of delivery strokes of reciprocating pump made pool on the ground preventing a person from operating line header valves badly.

These must be quickly improved.

(7) Hose station

There were no hose station in the plant area. A only like one exist on the main stage but had no connected hoses at all.

The hose station which supplies steam, compressed air and water are very useful not only for maintenance service but for safety activity.

(8) Flare stack

Flare stack system was not equipped well.

There were no seal drum to prevent backfire, and no igniter at the stack. Liquid-gas separator existing now were not designed well also. These of all must be improved.

(9) Ammonia injection equipment

Cylindrical bottle of liquid ammonia was vulnerably set. In case of earthquake it would fall down and blow off toxic gas from broken connector.

It must be firmly fixed (like by chain) to prevent from falling.

(10) Safety shoes

Generally, in refinery it is necessary to prevent inflammable liquid from igniting by static electricity charged to human body by such as rubbing of clothes.

For that purpose safety shoes that have low electric resistance ($10^5 \sim 10^8 \Omega$) is used.

Such kind of care must be paid.

5.3 Offsite and Associated Facilities

5.3.1 Power Plant

(1) Outline of present state

The Center has three generators driven by diesel engine, two of them are commonly in operation while one stands by. Generated electricity is supplied to the facilities in refinery compound and to associated ones scattered around in CEPU. One of the generators is put into shut down after 200 hours operation in turn in order to give them equalized operation, and given minor maintenance in this while.

Two of them was put into operation May 25, 1973 and the other one Dec. 1, 1977.

The specification for these three generators is as follows.

Diesel Engine (M.A.N. West Germany)

Type	G6V 30/45 ATDG
Capacity	950/1120 BHP
R. P. M.	500

Generator (SIEMENS West Germany)

Type	1DK4612-5 DE06-2
Capacity	820 KVA
Voltage	6.3 KV
Current	75 A
Power Factor	0.8
Frequency	50 Hz

The installation of whole of these equipment including associated facilitie's and buildings was performed by SIEMENS.

(2) Outline of inspection

Both engines and generators were in good condition with no abnormality of sound and outside defect. The indications of meters on the panel are correct. The logging of operation condition were performed correctly and accurately.

Accessories and accompanied tools are well maintained. But, a little wrong was found. That is there were some oil leakages from pipes in the basement and received with vessels, and this should have to be mended easily. Inside of the panel, there were dust and cobwebs.

(3) Maintenance

The overhaul of generator and associated machines are performed every 4 - 7 years (manufacturer recommends 3 years), and some wrong-anticipated parts are replaced at the same time. The overhaul are being carried under the supervision of SIEMENS.

Daily operational management are performed according to the directives of manufacturer's instruction. The troubles occurred in the past is shown in 'Power Plant Trouble Record' attached to the annex of this report (Annex II-5-5). The trouble has so far been smoothly put under control and no major problems encountered at present.

(4) Future demand and revamp plan

a) Estimate of demand

Presently, maximum load is set at 1,100 KW, and actual peak load through January to April 1985 was as follow.

Jan.	920 KW	(603,220 KWH)
Feb.	990 "	(575,580 ")
Mar.	965 "	(530,510 ")
Apr.	860 "	(513,090 ")*

Note * Refinery plant was shut down

The maximum load in 1986 is estimated to increase to 1,300 - 1,500 KW by following reason.

- Completion of Simulator and Pilot plant laboratory
- Installation of Simulator and Pilot plant
- Installation of drink water supply pump (200 KW)

b) Additional installation of generator

Two generators operation like now (max. output 1,300 KW) cannot afford increased future demand, then No.4 generator of the same capacity is going to be installed and operated from Apr. 1986. This machine (second hand made in 1975) which was bought in 1977 and kept in warehouse of the Power plant, was thoroughly checked and needed spare parts have been ordered by SIEMENS. The installation will be made under the supervision of SIEMENS and M.A.N. engineer. The site is prepared in the present Power plant house. After No.4 generator was put in operation the output of Power plant will reach 1,950 KW with three generator operation.

5.3.2 Electrical Equipment

(1) Distribution equipment

The electricity generated at Power plant is supplied to refinery and affiliated facilities in CEPU through the distribution system which has transformer stations located at appropriately divided regions of load. The distribution system is loop type and has 10 transformer stations (MC1 - 8, TSPI and II). MC1, 2, 3 and 8 of which are located in the refinery and others are located at outside of refinery. These transformers (200 - 500KVA) drop voltage from 6KV to 380V/220V.

There are two other transformers (650KVA, 200KVA, 6KV/440V) installed with their switch gear in the house located near Power plant. Refer to Fig. II-5-14 about above description. Each transformer station is Metal Clad Cubicle type which contains one transformer and switch gear in it. There are two voltages as power sources (380V, 440V). MC1 - 8, STPI and II stations supply 380V, and other two transformers (650KVA, 200KVA) supply 440V through three switchgears (SG650-1A, B and MCC650-3) to facilities in refinery which have relatively large motors (generally more than 30KW) and also to small Y connection motors in special facilities.

a) Outline of inspection

Transformers and switchgears are contained in Cubicles or in a house and periodically maintained that there seemed to be no trouble. But maintenance records are seemed not to be kept well.

Cables are buried directly under the ground, and damage to cable for the power line took place 1 or 2 times in a year. Troubles in recent are as follows.

i) Short circuit of main cable joint (within several months after installation)

ii) Short circuit of main cable at the terminal of Cubicle.

iii) Short circuit at bifurcation joint of low voltage cable

The causes of trouble are seen as i) poor workmanship ii) moisture inside the panel and iii) poor workmanship. Spare parts generally stored in the Center are limited to materials of high importance. Other spares such as small fuses are available at Surabaya.

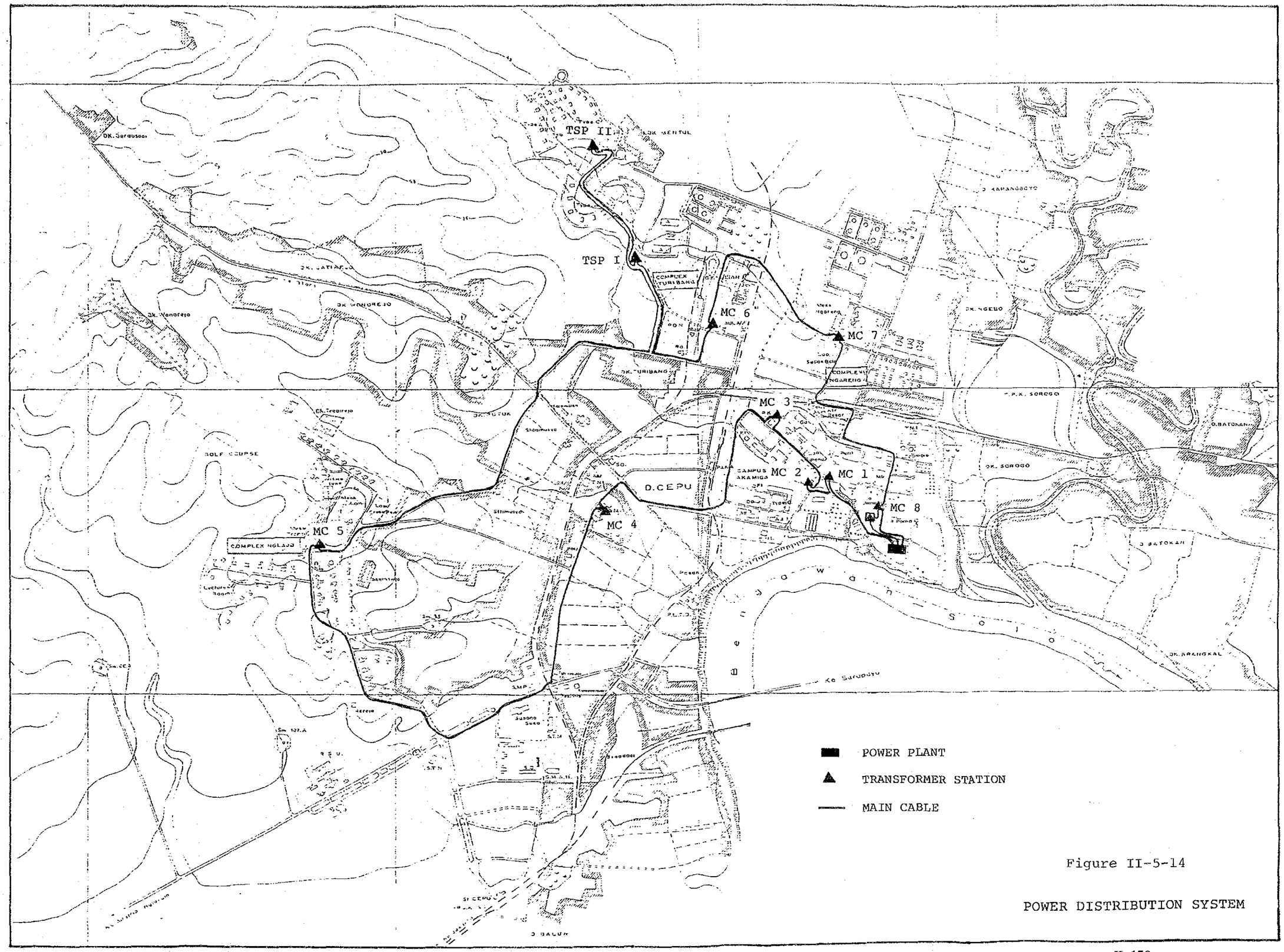


Figure II-5-14

POWER DISTRIBUTION SYSTEM

Spare parts stored:

Main fuse	(delivery	2-6 mths.)
Main cable 3Cx95 mm^2	("	1 mth.)
Joint kit for cable	("	1-3 weeks)

Inspection tools are as follow, half of them are old type.

- Flaw detector for buried cable	1 (BICC)
- Mega tester	2 (unknown)
- Circuit tester	2 (Philip/Siemens)
- Resistance meter	1 (unknown)
- Ground resistance meter	1 (National)
- Clamp meter	2 (Kyoritsu/England)
- Phase detector	1 (Siemens)

(2) Motor and switchboard

a) Outline of present state

In general, plants and facilities are small that most motors except pump motors for fire fighting, water supply, boiler feed and etc. are smaller than 10KW in capacity.

All motors in topping unit, soda washing and boiler plant, and most of motors in wax plant were recently replaced (mostly 1984 - '85).

Operation report (Mar. 20, 1985) said that all motors including these new motors and old ones in operation were operating well without any particular heat, vibration and abnormal current. And our survey endorsed this fact generally.

All motors and switchboards are installed in the house, and paintings for old motors were renewed, and there were no remarkable damages outside of motors. Motors except a few small ones were properly fixed on the concrete foundation and no vibration was found.

Switchboards were firmly mounted on foundation or on the rack of wall. On the other hand at the turminal boxes of motors, many badness were noted. Some of them lost their covers and/or dirtied with oil and dust.

The insulation resistance measurement were tried on some of the motor circuits including power cable and motor coil, and showed no defects that thought to cause particular problem. As for cables, there found bad workmanship of connecting cable to motor box such as poor protection and support. All power and control cables are directly buried under ground.

Application of explosion proof grade for motors in hazardous zone were properly done.

b) Outline of inspection

Though the inspection were not performed on all motors and switches, the following descriptions show only about some defects which were found on field survey.

- Refinery (Kilang) pump motor No.9 (Fuel oil system)

  Loosened tightening gland at the cable inlet of turminal box. Insufficient cable support and contact of cable with spilled oil. Switchboard lost all cover bolts and explosion proofness. Drain steam near by affected switchboad and caused rust inside of it, and switch contactor were getting rust into some trouble.

- Refinery (Kilang) compressor motor

  Switch was very old, its cover were tightened with wire loosely, far from explosion proof and inappropriate to the zone.

  Cable inlet was stuffed with packing and cable was not supported. Motor was not explosion proof, unsuitable to the zone. Resistance showed 0.3M and liable of leakage.

- Wax plant motor P200-11B (No. ED37)

  Cable was protected by metal plica tube, but loose at turminal box, and liable of short circuit by external pulling force.

- Wax plant motor P200-13 (No. ED20)

  Cable was not protected, wire setting at turminal box was loose and liable of short circuit.

- Wax plant motor No.11 (No. ED12)

  Very old with no cover at charged brushes. End of cable were bent abruptly at tueminal box and unsafe.

- Wax plant agitator motor No.14 (ED143)

  Mounted on second stage, got vibration in operation. Cable were not supported at both motor and switch sides, and liable of short circuit by external pulling force.

- Utility pump motor No.6

  Resistance 0Ω , out of use by pump's damage.

- Fire water pump motor No.1

  Resistance 5Ω , unsuitable to use.

- Fire water pump motor No.2

  Resistance 0Ω , one motor wire grounded. Unsuitable to use.

c) Maintenance

Maintenance work as periodic check was scheduled, but seemed insufficient and not necessarily performed as provided. Actually maintenance action was taken after the trouble was reported. Only operators grasped daily condition of facility, and there were no record taken. The survey taken by the Center members in Mar. 1985 was only by visual inspection, and no resistance measurement were performed.

As for drawings, single line diagram is prepared, but it lacks description about low pressure lines to each motor on the secondary side of transformer. Amendment of drawing corresponding with actual changes of equipments have not been done yet. Simple drawings attached to motor list also show no supply lines from particular switch boxes.

(3) Lighting

a) Outline of inspection

- Incandescent light

About 100 incandescent lamps of 80 w explosin-proof type are used in the topping unit.

Cover glass is generally very dirty and there are many imperfect cable connection joints, some are held with caulking but mostly loosely jointed and lamps inside move with cable.

Putty filled in the gap of gland or between gland holder and cable is hardened and cracked to be of any use.

The body of lighting equipment is obsolete and many seem to be poorly packed.

Explosin-proof property is thus lost and in unsafe condition.

Also some joint boxes have poor cable connection, unsealed holes which are not used and some missing cover bolts, causing lack in explosin-proof property and unsafe.

The cable used is lead sheathed (about 1mm thick) braided wire which is not commonly used for explosin-proof cabling in refinery and they are not desireable for securing explosin-proof property of gland.

- Flood light

For illuminating overall topping unit and offsite tanks, 1,000 w explosin-proof type flood light is used.

The lighting equipment is new and no problems are foreseen. But switch installed on the pole is old and loosely covered and cable is also loosely connected and explosin-proof property is lost as mentioned before.

Also in the event outer force is applied to cable, connection may be off causing shortcircuit.

- Street light

Street lamps in the site are non explosin-proof type generally used. Some fluorescent lamps are soiled with many insects, etc. inside the cover glass decreasing illumination effect but no problems are encountered in general.

- Other overall situation

Emergency light is installed inside the topping unit but small engine generator installed in the furnace house is obsolete and ready for being scrapped.

Even if it can be excited, since it is not automatic, it will not serve for emergency purpose.

Also no plug socket for temporary lighting required for maintenance work etc. was not installed in the plant area and inconvenience was felt for the survey actually.

Also, lighting condition at nighttime was checked during the current survey. minimum required lighting is installed in refinery plant and in utility areas and there should be not much difficulty for operating valve and meter reading.

b) Maintenance

Some of maintenance work for lighting equipment is put on schedule but the content is not sufficient nor carried out as scheduled.

Burnt bulbs are being replaced each time and no unlit bulbs were found.

In the maintenance schedule, no checking of cover glass cleaning and loose junction box is included.

(4) Grounding equipment

a) Outline of inspection

- Power Plant

Grounding is properly carried out for generators, operating panel, building and fuel oil tanks and maintenance hand hole, wires and grounding rode are adequate.

Carbon steel bolts and nuts are used for connecting the grounding rod and wire inside the hand hold and they are much rusted.

- Refinery plant and utility

Grounding wire is not protected at the riser part from the ground in tank farm. Also, many grounding wires are extended for some distance on the pavement and some are smeared with thick oil and soil.

They will lessen the strength and performance of gounding wire.

Regardless of their size, tanks are contacted with ground at one point and independent grounding rod is driven for each tank.

Grounding wire is connected not with the tank body but with bolt on the flange of the valve side of the nozzle.

No grounding is made on the structure of topping unit and no grounding wire is connected with tower, vessel and heat exhanger, etc. on the structure.

The structural steel of the furnance house (11 x 38.5 m) is connected to grounding at one point.

- Electrical Equipment

Grounding system is 3 phase 4 wire neutral line grounding type.

Neutral point on the low voltage side of transformer is grounded installing grounding rod and at load side neutral line of cable is connected to neutral terminal of each load.

For each panel, neutral line of feeder cable is connected to neutral bar.

Among the additional or improved electrical equipment, some are equipped independently with body earth but generally grounding of electrical equipment is securely made.

Galvanized steel pipe of 1-1/2" x 6 m is driven into ground as grounding rod same as refinery plant and utility.

For connecting pipe and wire, carbon steel bolts and nuts are used.

b) Maintenance

Each grounding resistance value for power plant is regularly measured each year and the value is found good. The result of the present study also shows good ones.

All grounding resistance values measured at each earth rod in August, 1984 shows satisfactory values.

(5) Lightening arrester

No lightening arrester has been installed to date.

According to data prepared before World War II, the site is reported as non-lightening area and for the past 60 years, lightening has been rarely experienced and no damage has occurred.

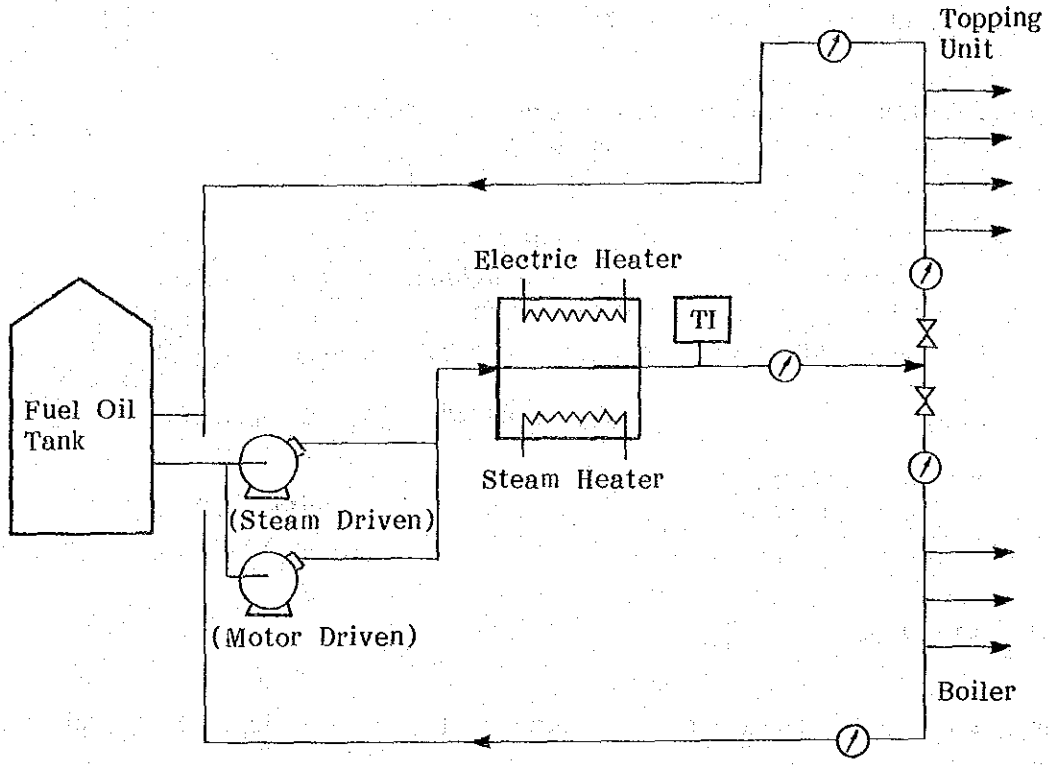
Siemens did not install lightening arrester in designing the power plant in 1973.

Necessity for lightening arrester is considered very little.

5.3.3 Fuel System

(1) Fuel Oil System

An outline of fuel oil system is given in the figure below.



It comprises 2 line circulating systems on Topping side and Boiler side.

Flowmeter is not installed with each furnance.

Electric heater is used only during start-up and operated at outlet oil temperature of 55°C and when reached normal operation, it is switched to steam heater and outlet oil temperature becomes 125°C.

Insulation of fuel oil piping and fuel oil tank has already been carried out.

Fuel Oil System has 2 screw pumps, one is driven by motor and the other is driven by steam turbine.

But steam turbine (made in France) is not presently used because of difficulty in procuring spare parts.

In general, the residue of Kawengan or Ledok crude is used, but at the time of startup, gas oil is mixed to adjust pour point.

Representative properties of residue are given below.

Item	Kawengan Residue	Ledok Residue
Sp. Gr (60/60° F)	0.9315 - 0.9472	0.9080 - 0.9127
Sulfur (wt %)	0.214 - 0.242	0.263 - 0.473
Viscosity, Redwood I/140°F (sec.)	219 - 226	217 - 231

(2) Fuel Gas System

The gas station of natural gas is located in Nglajo area about 4 km from the refinery.

The gas stations comprises 2 stage gas-liquid separation tower and condensate separator but the latter is not presently used.

The properties of natural gas are given in Table II-5-24.

The pressure at the separation tower is 12 kg/cm^2G. The gas line is branched from this gas station to the refinery and company employee housing and to the latter gas is depressured to 1.0 kg/cm^2 with pressure control valve and transported. The flow is given in Fig. II-5-13.

Further, at the gas station, flow meter with recorder for total flow rate of natural gas is installed but not presently used.

On the other hand, gas is used at the pressure of 0.5-0.8 kg/cm^2G as fuel gas in the refinery for topping unit, boilers in Menggung district, testing facilities and offices in the center, etc.

The amount of gas used in January, 1985 (estimated from the past actual data) for each plant and facilities is given in Table II-5-25.

Table II-5-24 PROPERTIES OF NATURAL GAS

1.	Component (mol %)		
		H_2S	Nil
		CO_2	25.1
		N_2	0.5
		CH_4	69.1
		C_2H_6	2.8
		C_3H_8	1.3
		$i\text{-}C_4H_{10}$	0.3
		$n\text{-}C_4H_{10}$	0.2
		C_5H_{12}	0.1
		C_6H_{14}	0.2
		C_7H_{16}	0.2
2.	Gas gravity	calculated value	0.844
3.	L H V	calculated value	7,040 Kcal/Nm^3