Figure II-5-15 FLOW OF GAS STATION

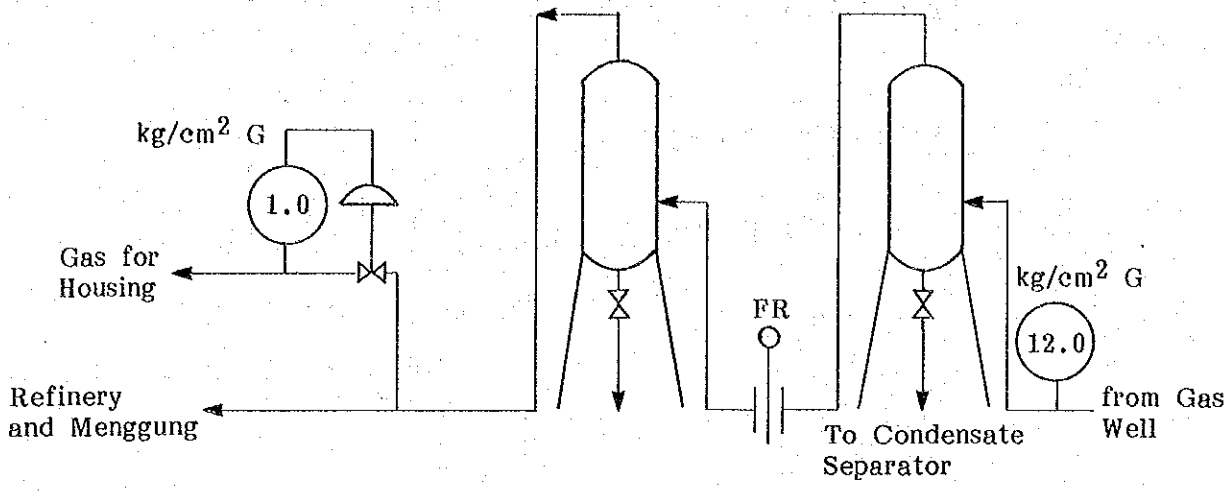


Table II-5-25 FUEL GAS CONSUMPTION FIGURE (Jan. 1985)

Production		Consumption		
Gas field	10^3 Nm^3	Plant and Facilities	10^3 Nm^3	%
Nglajo	362.7	Topping Unit	115.0	31.7
		Workshop	10.0	2.8
		Refinery Boiler	—	—
		Menggung Boiler	80.0	22.1
		Refinery Laboratory	27.8	7.7
		Training Laboratory	14.7	4.1
		Housing	96.0	26.5
		Loss/Flare	19.2	5.3
Total	362.7	Total	362.7	100.0

(3) Unit of fuel consumption

Based on data reported in 'Laporan Bulan Januari Tahun - 1985, Cebu' Jan., 1985 when no shutdown of main facilities took place, results of computation of fuel consumption for topping unit, boiler and overall refinery are given below.

Item		Topping Unit	Boiler	Power Plant	Refinery
Crude through-put	(Kl/M)	8,730	—	—	8,730
Amount of steam generated	(Ton/M)	—	8,152	—	8,152
Fuel heavy oil	(Kl/M)	689.7	25.6	—	715.3
Fuel gas oil	(Kl/M)	—	—	229.8	229.8
Fuel gas	(EFO Kl/M)	87.5	—	—	87.5
Total fuel	(Kl/M)	777.2	25.6	229.8	1,032.8
Fuel consumption ratio					
	(EFO-kl/charge)	0.089	—	—	0.118
	(EFO-kl-steam-ton)	—	0.0031	—	—

(*1) LHV of Fuel Gas : 7,040 Kcal/l (from Gas Components)
LHV of Gas Oil (Solar) : 8,770 Kcal/l (Sp.Gr 0.852, TS 0.08%)
LHV of Fuel Oil : 9,250 Kcal/l (Sp.Gr 0.940, TS 0.23%)
Conversion Factor : 7,040 - 9,250 = 0.761 EFO. l/N
8,770 - 9,250 = 0.948 EFO. l/l (Gas Oil)

(*2) Excluding Boilers in Menggung Area

The average fuel consumption ratio in Japanese refineries is 0.052 FEO-kl/charge kl for 1983-1984 and fuel consumption ratio for topping unit is 0.012 EFO-kl/charge kl.

From the above, the amount of fuel consumption in the center is clearly too much.

From obsolensence of the facilities, heat recovery rate and furnace efficiency etc., a simple comparison may be difficult but in case a topping unit is newly installed, fuel consumption is estimated to decrease to about 1/6.

5.3.4 Water Treatment System

(1) Outline of the present state

Water supply system at the center is given in Fig. II-5-16.

Raw water is first taken from the SOLO river with SOLO I pump (P100-1, P100-2) and supplied to reserviour for fire fighting and settling basin.

Water for fire fighting is used without treatment, but raw water in the settling basin is treated with aluminum sulfate and turned to clear water by absorbing/settling fine soil and humic particles.

Part of clear water is supplied to the power plant, wax plant and topping unit as cooling water. But at the wax plant and topping unit a unit of cooling tower is respectively installed and clear water is used for make up water supply.

On the other, the remaining clear water is stored in the middle tank and filtered with sand filter.

Part of filtered water is supplied to inside and outside of the refinery as drinking water by injecting chlorine for sterilization. The remaining filtered water is fed to boiler after removing calcium, magnesium, iron and other metals with softener, removing dissolved gas with softener, by using electric treater.

The respective water treatment system capacity and consumption balance as of January, 1985 (when the whole facilities of the center was being continuously operated) are given in Fig. II-5-17.

Naturally, amount of consumption of fire fighting water and potable water is not constant.

An example of water analysis is given in Table II-5-26.

Figure II-5-16 WATER SUPPLY SYSTEM

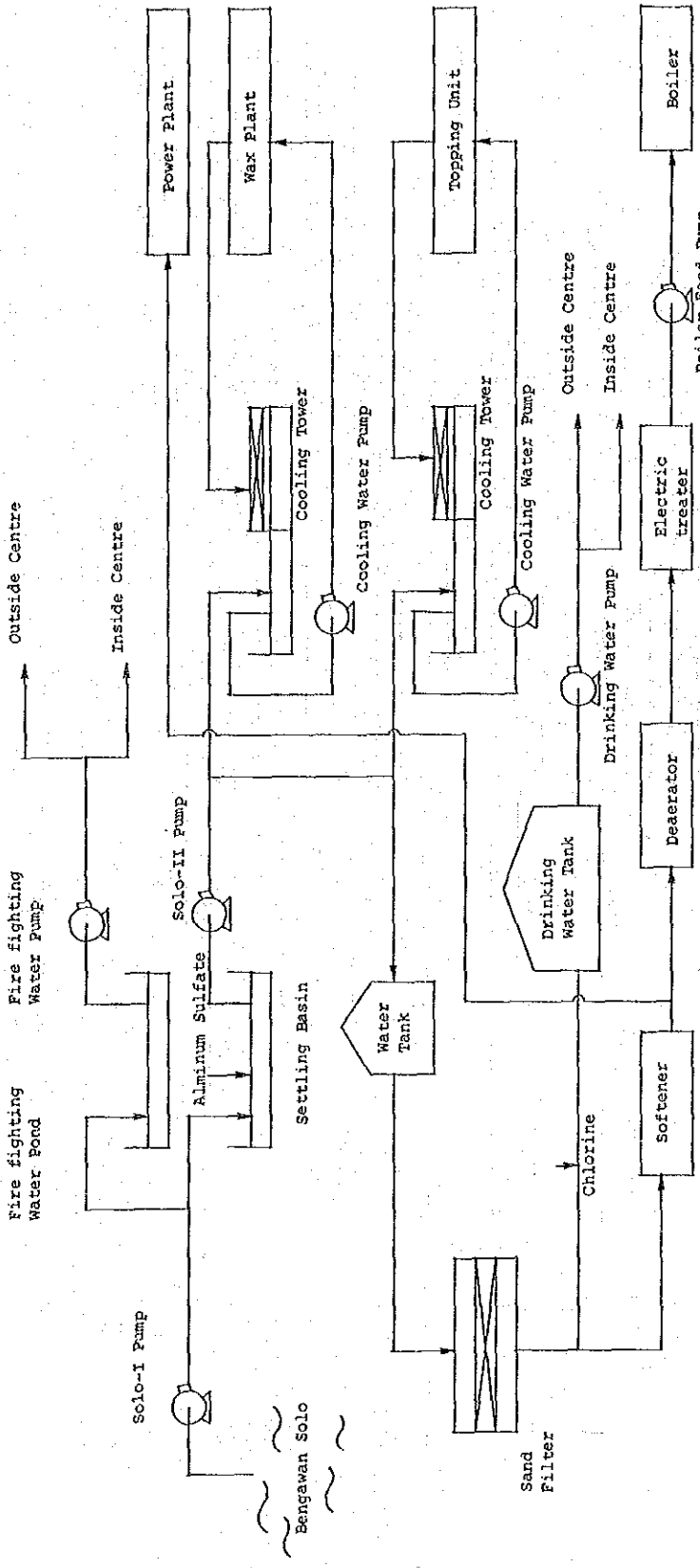


Figure II-5-17 WATER BALANCE AND CAPACITY

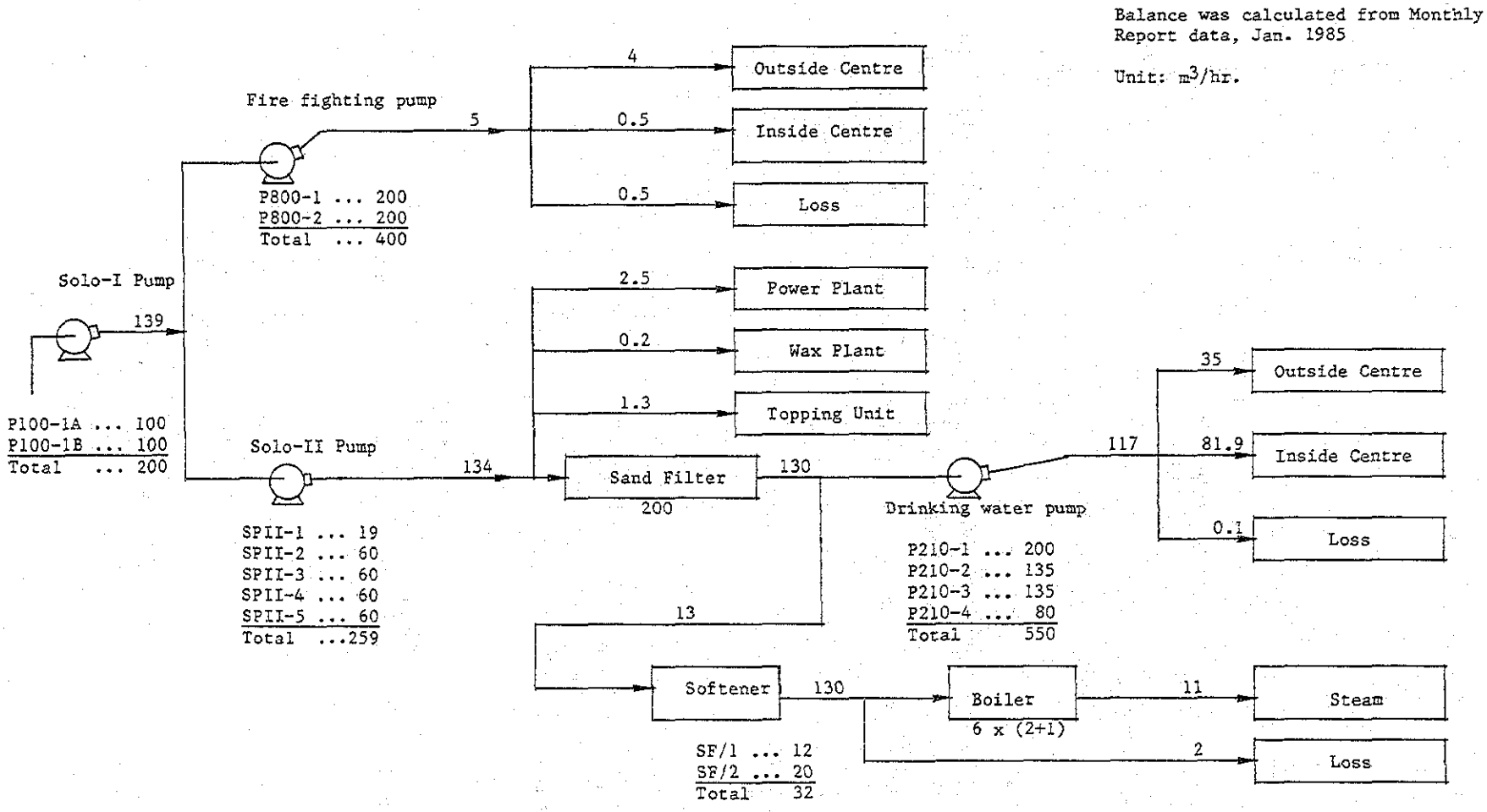


Table II-5-26 WATER ANALYSIS

	Solo River	After Setting Basin	After Sand Filter	Drinking Water	After Softener	After Electric Treater
pH	7.8	7.0	7.3	7.2	7.3	7.9
Hardness (German)	8.1	8.1	8.2	8.0	0.15	0.12
Turbidity	42	2.6	2.8			
Alkalinity (ppm)	350				227	230
KM_nO_4 Consumption (ppm)	12.6	7.5		1.6		
Total Solid (ppm)	240			160	240	240
Active Chlorine (ppm)				0.2		

(2) Outline of insepction

According to Table II-5-26, turbidity drops from 42 to 2.6 around the settling basin and amount of consumption of potassim permanganate drops from 12.6 to 7.5 showing the effective operation of the system.

Water coming from the settling basin is used for making up for circulating cooling water.

Table II-5-27 compares cooling water values of petroleum products manufacturing industries summarized in 'Report on the Establishment of Water Quality Standards for Industrial Water' by the Japan Industrial Water Association and values of OWRT (Office of Water Research and Technology).

Table II-5-27 MAKE-UP WATER ANALYSIS FOR CIRCULATING COOLING WATER

	Centre	JIWA*	O W R T	
			Make-up	Once-through
Turbidity	2.6	30		5,000
pH	7.0	7		5 - 8.3
Alkalinity (ppm as $CaCO_3$)	Ca.350	40	20	500
Hardness (ppm as $CaCO_3$)	145	50	130	850
Evaporation Residue (ppm)	Ca.160	200		

* Industrial Water Association, Japan

In the case of the center, alkalinity of H_2CO_3 content is found very high. Hardness is also high.

As observed, settling of $CaCo_3$ is liable to occur in water supply condition and it is found not suited for use in circulation at enriching condition. As mentioned in 5.2.4 Heat Exchangers, attachment of scales is very notable with E12A and 12B, etc.

In case using such water for circulating cooling water, it is desirable to lower alkalinity by injecting acid in make-up water and lower hardness of make-up water by lime softening and/or ion exchange method.

Further, for circulating cooling water, control is required by blowing optimum amount and injecting water treating chemicals, etc.

Turbidity before and after sand filter is 2.6 and 2.8 respectively and judging from the figures, it does not seem to be working effectively.

For potable water, standards in many countries are given as reference (Tabel II-5-28), and in the case of potable water at the center, turbidity and hardness is a little too high.

Table II-5-28 COMPARISON OF DRINKING WATER ANALYSIS

			E C			
	Center	Japan	Optimum	Max.	U.S.A.	U.S.S.R.
pH	7.2	5.8-8.6	6.5-8.5			6.5-8.5
German Hardness	8.0					
Hardness	143		35			33.2
Turbidity (ppm)	2.8	< 2	< 1	10	1-5	1.5
Alkalinity (ppm)	Ca.350					
$KMnO_4$ Consumption (ppm)	1.6	<10	2	5		
COD (ppm)	Ca.0.4	<Ca.2.5				
Total Solid(ppm)	160	<Ca.500	Ca.1500			
Active Chlorine (ppm)	0.2				0.2-0.3	

5.3.5 Boiler and Steam System

(1) Present state and outline of inspection

The capacity and construction year of softener and boiler are as given below.

Equipment		Capacity (Ton/hr)	Completion
Softener	I	12	1978
Softener	II	20	1984
Boiler	I	6	1978
Boiler	II	6	1978
Boiler	III	6	1978

Boiler is horizontal cylindrical smoke tube type with super heater.

Table II-5-29 gives the results of measurement of wall thickness of the important part of No. 3 boiler at standstill.

Figure II-5-18 shows the locations of measurement taken.

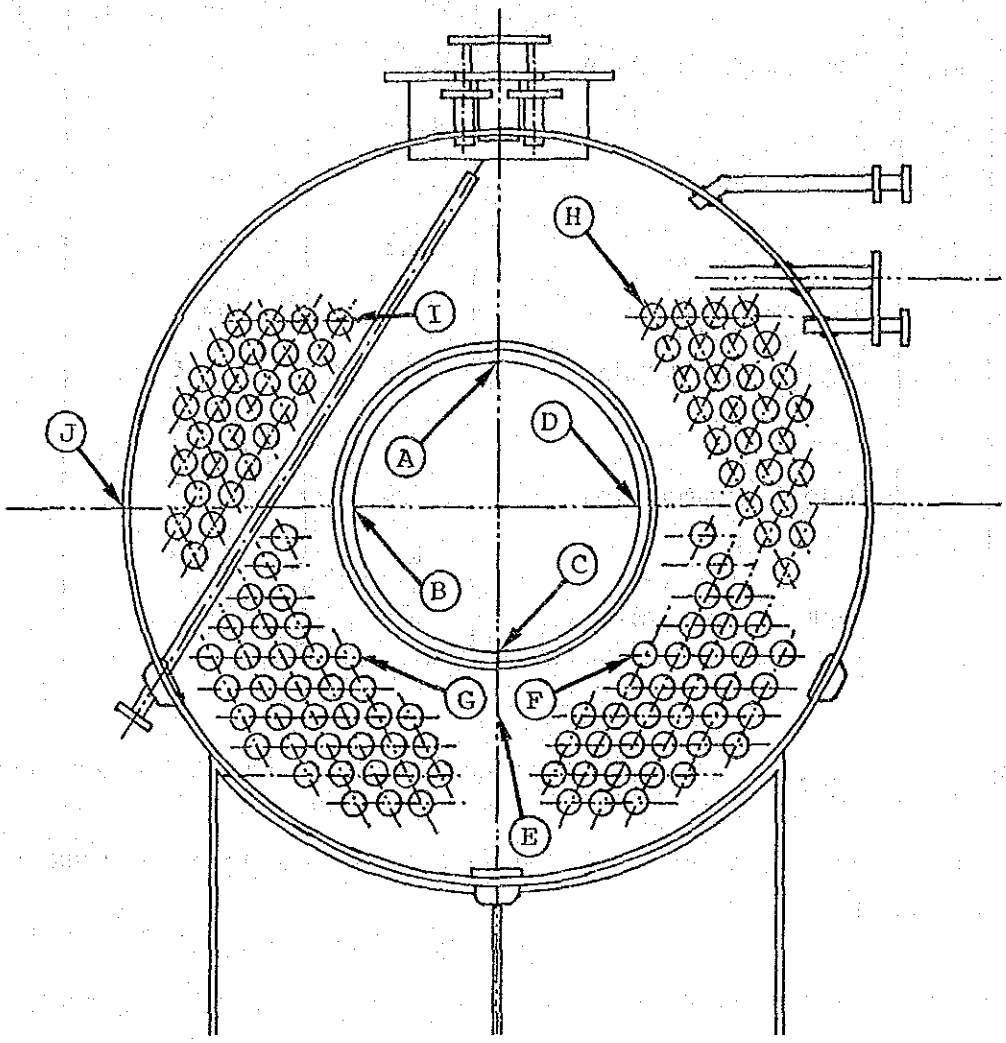


Figure II-5-18 POINT OF THICKNESS MEASUREMENT, BOILER

Table II-5-29 RESULT OF THICKNESS MEASUREMENT, BOILER

Point of Measurement		Thickness (mm)	
		Measured value	Value described in drawing
A	Corrugated fire tube	13.0	12
B	"	12.8	12
C	"	13.2	12
D	"	13.1	12
E	Tube plate	23.8	23
F	Primary smoke pipe	2.9	2.9
G	"	3.0	2.9
H	Secondary smoke pipe	2.6	2.9
I	"	3.0	2.9
J	Flue gas side shell plate	8.0	

By visual inspection, no problematic spot was found on the flue gas side.

Regular inspection of boiler is carried out one in 2 years according to the Indonesian law.

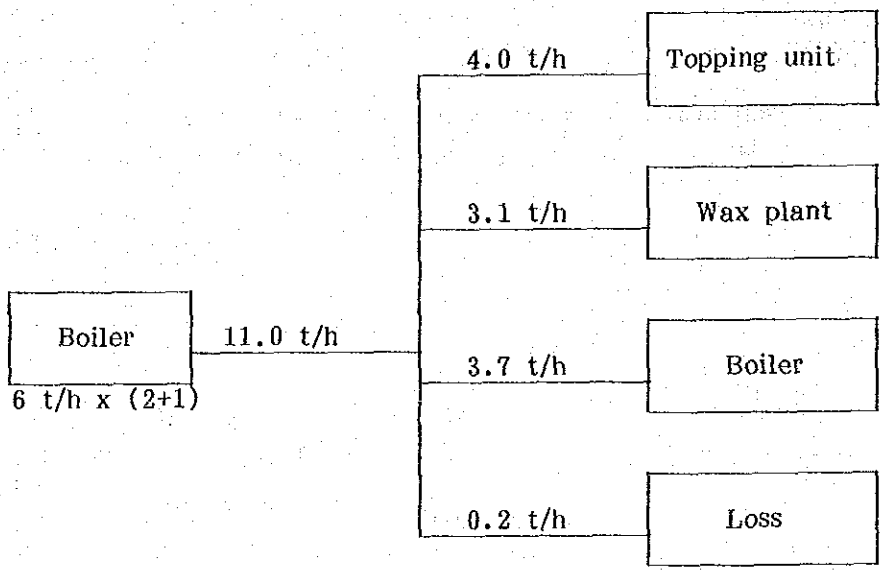
Therefore, inspection of safety valve is also undertaken every 2 years.

Maximum operating pressure for boiler is 10kg/cm^{2}G but the pressure of steam system is 7kg.cm^{2}G and there is no low pressure steam line over the whole area of the center.

Exhaust steam from the steam driven driver is bing discharged into the atmosphere.

But for stripping steam required in the topping unit, 7kg/cm^{2}G steam is reduced to 3kg/cm^{2}G by manual restriction by ordinary valve and used.

Average steam balance in january, 1985 when the whole facilities was in operation is given below.

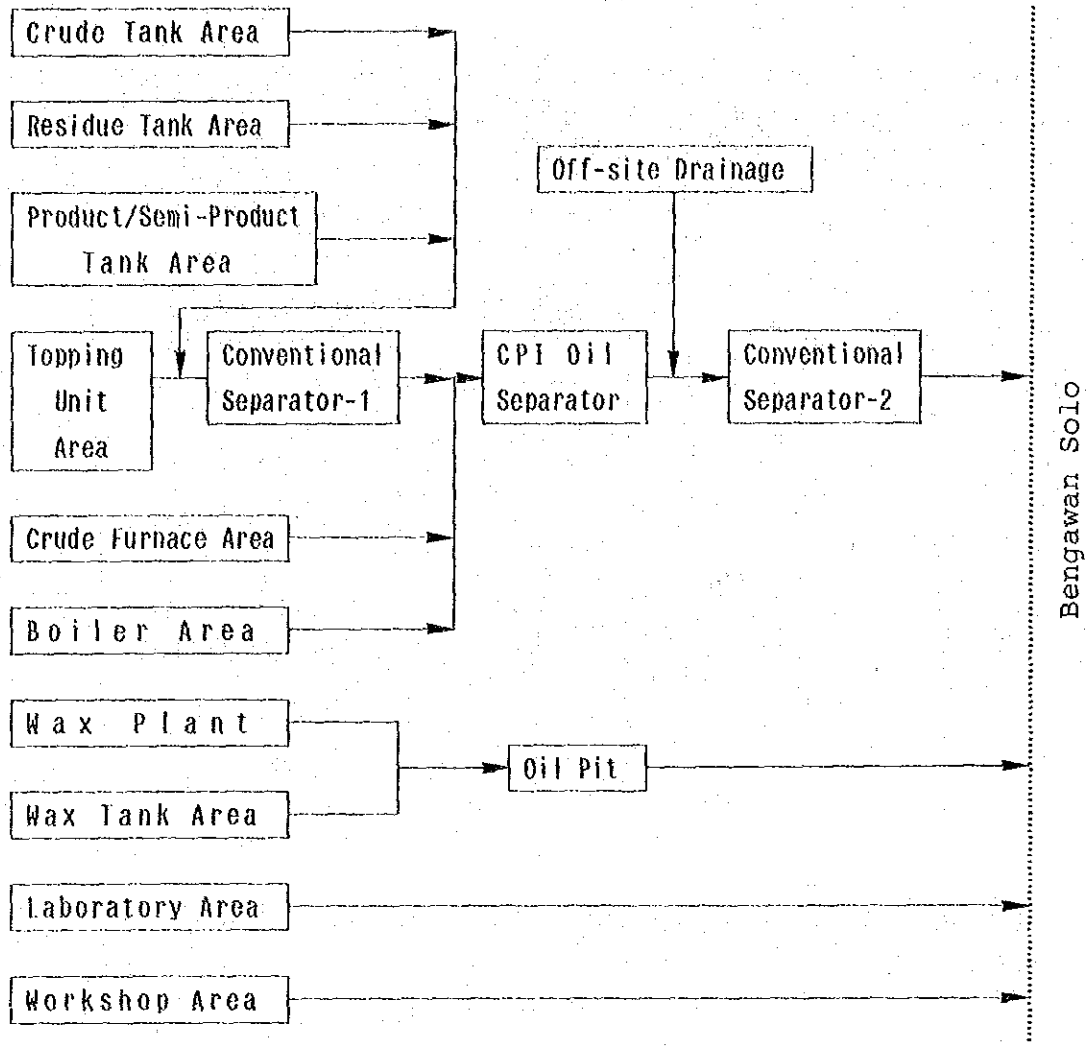


Also leakage of steam piping and damage of insulation material were noted at offsite.

5.3.6 Waste Water Disposal Equipment

(1) Present state and outline of inspection

Figure II-5-19 DRAINAGE SYSTEM



The conventional separator is simply a large oil pit and different from the so-called API separator.

Entrance of oil and water to the separator is located not in the center but at the corner and has no vertical slot baffle to even water flow.

Therefore, water flow in separator is not rectified and has poor separating function due to a large water depth and lack in length of separator, producing oil film on discharged water at drain outlet.

CPI separator is designed by the center itself and has good deparating function, producing little oil film at drain outlet.

Waste water from the conventional separator 2 is discharged into the SOLO river and there is a little oil film on the water surface around the area.

But at about 50m downstream, oil film is dispersed and not recognized.

5.3.7 Tank Facility

(1) Offsite tank

Crude produced at 4 oil fields is transported to Menggung crude base and fed to crude tank inside the center. It is then refined by topping unit and products/ semi-products are being fed to respective tanks. Further, semi-product oil is blended and treated with lead and turned into products and stored in product tank.

The following give characteristics of the tanks at the center.

- Very old and marked obsolescense is notable.
- Being connected with oil fields with pipeline, the capacity of crude tank is small.
- There is no seasonal variation and because product is sent to oil tanks at PERTAMINA, nearby, the product tank capacity is made small.
- Rivet joints are mostly used and most of them are cone roof type.

Since most of the tanks at the center were installed around 1928 when refinery was established, there is little data left on the construction and foundation.

For the inspection of the tanks at the site, the following points largely related to deterioration of the tanks were selectively observed.

- Oil leakage from rivet joints.
- Corrosion of roof plates due to hydrogen sulfide contained in crude, gasoline and other vapor.
- Corrosion of the bottom of shell plate due to water contained in crude and slop oil.
- The relations between the bottom plate and ground-water level which cause exterior corrosion of the bottom plate of the tank.

a) Leakage from rivet joints

There is a sign of oil leakage from all rivet joints of the tanks except T-143.

The greatest sign of leak was observed at T-101 but only seepage was observed and no flow of leaked oil was observed. Almost no sign of oil leakage reached the ground. This means oil leakage was stopped.

b) Corrosion of roof plate

Roof plates of T-107, 108, 110 and 114 is damaged by corrosion and replaced.

Many holes are presently noted on the roof plate of T-107, 110, 111, 112, 113, 115 and 116 due to corrosion. Damage must be noted on T-107 replaced in 1977, T-110 replaced in 1967 and T-112, 113, 115 and 116 installed anew in 1973.

c) Corrosion of the bottom of shell plate.

To check the state of corrosion inside the tank due to water remaining on the tank bottom, 3 points at bottom of shell of 9 crude and slop tanks respectively were measured.

d) Tank bottom plate and ground water level

Corrosion speed is faster with wet steel plate than dry steel plate.

Also when uneven structural quality exists in steel plate placed in the ground water, electrolytic pitching corrosion is caused. Therefore, it is important to keep the tank bottom as dry as possible.

Almost all tanks in the center have their bottom plate on the same level with the ground surface or a little below.

Further, because of poor drainage around the tanks, area near the tanks is flooded when it rains.

Although some tanks built on the foundation they are actually below the ground level.

(2) Oil dike

The tanks at the center are surrounded with oil dike for each block shown in Table II-5-30.

Table II-5-30 BLOCK FOR OIL DIKE

Block	Tank No.	Service
A	T-101, 102	Crude
B	T-122, 123	Residue
C	T-103 - 117	Intermediate & products
D	T-110-121, T-124-133	Ditto
E	T-138, 139	Fuel
F	T-201, 202	PH Solar
G	T-216	AFO (A-Filter Oil)

All dikes of A, B and E and part of D and F are made of rocks of about 30cm dia. jointed with mortar and they are not reinforced.

These have been installed recently and asbestos yar is wrapped around the pipe where it goes through the oil dike.

C is reinforced concrete.

Part of D and F are embankments made of soil.

Part of A and C have partition dike.

Some part of partition dike of A block are open at above the drain channel and at where 2 concrete Hume/pipe of about o40 cm dia. goes through, they do not work as partition dike.

There is no sluice valve at the drain outlet of B block dike.

C block dike has 5 drain outlets but none has sluice valve nor there is any sluice valve installed in the drain channel passing through the partition dike.

Also there were three spots where holes were not mended after piping went through.

Drain sluice valve of F block is installed inside.

5.3.8 Offsite Piping

No record has been kept on the piping installed around 1928 and thereafter, so history and specification are entirely unknown.

Much oil is seeped into the ground around the tank yard and the pumps for shipment and when a hole is dug on the ground, oil film is observed on the surface of ground water.

These oil correspond to one of the following items.

- Leaks from piping and tank
- Spill due to carelessness such as overflooding of tank
- Leaks from the pump and valve gland

Off site pipe line at the center are mostly installed underground and leakage from the pipeline cannot be detected at an early stage.

Since Kawengan crude and Ledok crude are sweet, corrosion is little due to the intermediate and finished products.

Therefore, exterior corrosion, especially corrosion of the underground portion under wet condition becomes number one problem.

By visual inspection, severe pitching corrosion of max. depth about 6mm was discovered between the cooling tower and topping unit.

Table II-5-31 shows wall thickness of crude, kerosine and residual oil pipings.

Table II-5-31 MEASUREMENT PIPE THICKNESS

	Measurement Point	Pipe Size (inch)	Measured thickness (mm)
A	Crude line above ground	8	8.6
	under ground		8.2
B	Crude line above ground	8	6.2
	under ground		5.7
C	Crude line above ground	8	1.8
	under ground		1.1
D	Residue line above ground	4	6.3
	under ground		5.9
E	Residue line above ground	6	5.5
	under ground		4.9
F	Kerosine line above ground	4	8.2
	under ground		7.9
G	Kerosine line above ground	4	7.9
	under ground		6.8
H	Kerosine line above ground	4	5.8
	under ground		6.3

5.3.9 Fire Fighting Equipment

Water taken from the SOLO river is supplied to fire-fighting reservoir.

Water from fire-fighting reservoir is supplied to the related facilities inside and outside the center with firefighting water pumps (P800-1, P800-2).

The fire-fighting water pumps have capacity of 200$m^3/_h$ capacity respectively, one is operated with motor and the other is driven by diesel engine and can be operated during power failure.

Also jockey pump is being operated to maintain designated pressure at all times and can meet small amount of consumption.

At main part of the site, water hydrant and water fire-fighting nozzle are arranged and foam nozzle is installed at individual tanks to prevent tank fire.

The tanks are divided into 2 blocks as shown in Table II-5-32 and to each block is attached foam station (foam liquid injection unit) and fire-extinghuising fluid can be selectively fed to the tank which got fire by operation of valves on hand.

Table II-5-32 FOAM CHAMBER BLOCK FOR TANKS

Block	Tank
1	101, 102, 122, 123, 138, 139
2	103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133

There are 3 types water spray systems to prevent spread of fire, one with ring shape ditributor on the top of cone roof, one with single nozzle and one with water spray ring on top of the shell.

Table II-5-33 gives a summary of respective water spray systems.

Table II-5-33 WATERING SYSTEM FOR TANKS

Type	Tank
Distributor on roof top	101, 102 103, 104, 105, 107, 108, 110, 111, 114
Pipe nozzle on roof top	122, 123
Ring piping on shell top	106, 109, 112, 113, 115, 116, 117

The distributor type is badly damaged except 101 and 102. Others are being in good condition, from the standpoint of water spray effect, top distributor ring is desirable.

The center has one fire engine and two portable fire-fighting engines. The respective specifications are given below.

Fire engine

Capacity	120 m^3/h
Head	7 kg/m^2G

Potable fire engine

Capacity	40 m^3/h
Head	7 $kg/m^2/G$

5.3.10 Workshop

(1) Outline of present state

Workshop comprises repair workshop, construction workshop, pipe shop and foundry.

The most of the machines and the equipments in these shops except machines which were installed after 1970 are very old and installed in 1920s or 1930s.

They are so old and utterly obsolete that they are unusable today.

As shown in the equipment list (Annex II-5-7) there are a good many number and variety of machines, but some are nothing but scraps.

Those barely used have lost accuracy and operability so much that their working rate is becoming very low, and some are found dangerous to operate.

The obsoletism utterly prevent machines from getting spare parts and leave them into deterioration making them unable to be repaired or restored.

Although the survey was not very thorough due to restriction in time and lack of measuring instruments, and can not be said to be strictly correct, but all machines operable were operated and diagnosed except new machines.

(2) Outline of inspection

The results of survey of individual object of each workshop are as follows.

Also short specification, manufacturing date, present state etc. of these objects are summarized in Annex II-5-7 'Equipment list' attached in Annex.

a) Repair Workshop

No. 3057 Lathe Machine
Operable. But the edge of bed way became round by abrasion, lost precision, sound in main gear box is big, presently used for wood-work. Unrepairable.

No. 3060 Lathe Machine
Out of use. As good as scrap.

No. 3063 High speed Lathe Machine
Presently used for small items, many bruises on bed way, large gap in screws. Smooth rotation of main spindle could keep high speed. Repairable.

No. 3065 Lathe Machine
Presently used. Rough slide face, large wear on leadscrew shaft, large sound and vibration. Unrepairable.

No. 3068 Lathe Machine
Out of use. As good as scrap.

No. ——— Lathe Machine (Item No. 6 on the list)
Presently used for small items, much abrasion on slide face, large vibration of main spindle, not available for accurate round finish. Unrepairable.

No. 3088 Lathe Machine
Large gear and motor sound, much abrasion on slide bed, lost accuracy, presently used for wood-work. Unrepairable.

No. 3078 Lther Machine

Usable, but for ristricted work range, much abrasion on slide bed and other surface, not sound too bad. Unrepairable.

No. 3075 Lathe Machine

Out of use. As good as scrap

No. 3071 Lathe Machine

Out of use. As good as scrap

No. 3104 Lathe Machine

Large motor and main spindle gear sound, much abrasion on slide face. Unusable.

No. 3113 High speed Lathe Machine

Motor damaged, main metals tightened out and un-adjustable, leadscrew shaft lost, carriage guide rod bent. Unusable.

No. 3109 Lathe Machine

Usable, but limited to low speed revolution on belted motor drive, much abrasion on slide face, low work capability. About 10%

No. 3143 Vertical Lathe Machine

Usable, but only for light work, because of wear on spindle clutch, damaged autocontrol and mannual only, turret head does not rotate, abrasion on carriage slide face, low speed on belted motor drive, 270 rpm and low work capability, about 10%.

No. 3136 Horizontal Boring Machine

Unusable, large motor and gear sound, damages on all over. Unrepairable.

No. 3140 Slotting Machine

Out of use, Motor damaged, table and slide face in good condition, type is old and belt and pulley exposed, unsafe. Repair and restoration is possible.

No. 3098 Horizontal Milling Machine

Presently used. No sound and vibration, but bruise at spindle nose cause vibration with attached accessory, bad cutter cause low cutting speed, abrasion of slide face cause beat in operation. Require much repair work for restoration.

No. 3132 Planing Machine

Usdable, but only for light work because of belted motor drive, 0.5-1mm depth scar and wear on midle of belt, low work capability, about 10%.

No. 3124 Radial Drilling Machine

Out of use. Large motor and gear sound, more than 2mm vibration on spindle, cannot make round hole, all shafts bent.

No. —— Shaping Machine (Item No. 21 on the list)

Out of use. Broken gear and worn clutch.

No. 3121 Shaping Machine

Presently used. But only low speed operation because of large sound and vibration on motor coupling, slide faces good enough but low work capability, about 20%, Unrepairable.

No. 3118 Vertical Milling Machine

Usable. No sound at main spindle because of low speed by belted motor drive, but large motor sound, lost accuracy by abrasion of slide face and bent shaft, unsafe because of no automatic feed stop. Unrepairable

No. —— Vertical Milling Machine (Item No.24 on the list)

The newest one with hardened bed way, no abrasion, sufficient work capability, but accessories kept badly.

No. 3150 Horizontal Oil Jack

Out of use. Hand pump, hose and cylinder broken.

Unrepairable.

No. 3155 Drilling Machine

Presently used. Belted drive motor, heavy vibration, only work for less than 25 mm ϕ. Unrepairable.

No. 3157 Drilling Machine

Presently used. Spindle vibration nearly 1 mm, cannot make round hole, no spares for bearing and spindle. Unrepairable.

No. 3149 Vertical Jack

Presently used. Cylinder head defaced roundly, much oil leakage from broken oil seal, used only for low pressure, manual type. Repairable by replacement of oil pump, hose and oil seal.

No. 3151 Surface Clean Table

Out of use. Motor and accessories lost,

Tools Room

Pipe wrenches, spanners, hand taps, dies and other hand tools are stored at tools room

Many kind of cutters and gauges for machine tool works were also kept in store at tools room.

But maintenance of these materials was not good and much of these were rusted.

Setting aside such hand tools like spanners and wrenches, tools which has cutting edge such as taps and dies seemed hardly usable by rust.

Because of lack of repair tool machine for maintaining tools in good state, even broken edge tools were kept unrepaired.

Even more unti-rust treatment was not applied, most of cutting tools wee not in usable condition. Handling tools such as oil jack and chain block were also stored in bad condition without repairing oil leeks and broken chains with lack of spare parts.

Screw guages which could be used as standard yet were rusted too.

Cutters in machine shop outside tools room generally were used with dull quality causing bad finish of faces.

b) Construction workshop

No. —— Hacksaw Machine (Item No. 1 on the list)
Motor and head did not move. As good as scrap.

No. 3250 Hacksaw Machine
Out of use. Movable but heavy wear on the head cause easy break of teeth.

No. 3243 Shearing Machine
Presently used. Large gear sound, dull edge of cutting blade cannot afford to cut thin plate, heavy wear on slide faces. Unrepairable.

No. 3241 Punching Machine
Out of use. Motor damaged and dies broken. Unrepairable

No. 3236 Radial Drilling Machine
Presently used. Abnormal sound in main spindle box and at motor coupling, vibration on spindle motor more than 1 mm. Unrepairable.

No. 3233 Bending Roller
Presently used. All of gears weared, gap on roller metals by abrasion, roller bearing metals weared but small sound by low speed operation, lost original capability of 9 mm. Unrepairable.

No. 3232 Grinder
Out of use. Two head, belt drive, does not operate due to motor failure, worn metals would cause dangerous vibration because of high rotating speed. Unrepairable.

No. —— Radial Drilling Machine (Item No. 8 on the list)
Out of use. As good as scrap.

No. 3225, 3226 Steam hammer

Out of use. Drive steam pipe broken, deep scar on piston, deformed hammer head. Unrepairable.

No. 3212, 3214, 3215, 3216 Arm Chain Hoist

Two units presently use. Old post and arm cannot afford to lift heavy materials, chains did not move smoothly by heavy rust, all parts must be replaced for use.

No. —— Grinder (Item No. 12 on the list)

Out of use. As good as scrap.

No. 3227 & 3230 Furnace

Out of use. Pipings removed, inside bricks crumbled. Repairable.

No. 3270, 3273 & 4 others Welder

Presently two units used, large sound during operation, low welding capability, only used for thin plate welding. Others are as good as scrap. Unrepairable.

c) Foundry

No. 0217, 3220 Foundry Equipment (item No. 1 - 9 on the list)

* 6 others

Almost all equipment presently unused. Air pipe flanges are off the place, discharge duct of blower unconnected. Motor operate bur furnace does not tilt. Molds are rusted and broken, not usable.

Modlding of white metals of plane bearing were being carried using temporary furance of laided unused fire bricks on the floor in small scale.

d) Pipe shop

No. 3304, 3309, 3312, 3315, 3318, 3321 Pipe Threader

All movable. But clutch lever did not move due to wear and fastened rust on the clutch. Heavy motor sound and vibration. Barely one unit for small objects was operating. Oldness causes bad operability. Unrepairable.

No. —— Pipe press

Presently not used. Hydraulic pressure pumps were damaged and left unreapired more the 2 months.

Great oil leakage at cylinder and great wear of the crank metal of pump. Unrepairable.

5.3.11 Buildings

Survey were conducted only for the buildings located at the Refinery plant site as shown in the Building List(Table II-5-34). Area, height, foundation, wall, structure, type of roof etc. of the buildings were shown in the List. Layout of these buildings are also shown in Annex II-2-2 'GENERAL PLOT PLAN'.

Only general observation were made on the buildings due to the insufficient time to check. Generally the buildings are built depending on the climate and living habit of the country and also depending on the material available in the country, therefore, it is not proper to make judgement which is good or not.

If the buildings were built from the user point of view and consequently satisfy the safety and other necessary conditions in the plant site, then it is to be understood that the buildings were built good.

Observation described under below are based on the above view point.

(1) Foundation

There are two type of foundation, continuous and independent, by the existence or non existence of hard wall, however, no problem was found such as sink of foundation for any buildings.

(2) Insufficient maintenance work

The rust was clearly seen on the corrugated and galvanized iron plate. It is advisable to paint or change the plate from the appearance point of view. Also the plate on the roof of Drum house in the TEL Plant was found partly turned over and same condition was found on the wall of Drum house. These were commonly found in the simply contructed buildings with steel structure and plates.

Table II-5-34 B U I L D I N G L I S T

No. B-	BUILDING	DESCRIPTION						REMARK
		Area, m^2	*Hight, m	Foundation	Wall	Structure	Roof	Old/New, Date
1	Topping furnace house	418	8.00	ind	corr	beam	corr	Old
2	Control room	40	3.10	cont	brick	conc	conc	New, 1978
3	Refinery laboratory	441	4.00	cont	brick	beam	corr	Old
4	Boiler house	252	8.00	ind	alum	beam	alum	Old
5	Wax plant	1,188	3.10	cont	brick	beam	corr	Old
6	Moulding house	1,080	5.00	cont	brick	beam	corr	Old
7	Tel plant	172.5	3.10	ind	corr	beam	corr	Old
8	Cooling tower pump house	320	5.00	ind	corr	beam	corr	Old
9	Safety office	143	5.00	cont	brick	conc	conc	Old
10	Power plant	461	4.00/7.00	cont	brick	beam conc	conc/asbes	New, 1973
11	SOLO-I pump house	84	3.00	ind	corr	beam	corr	Old
12	SOLO-II pump house	96	4.50	cont	brick	wood	tile	Old
13	Chemical house for treating water	74	4.00	ind	corr	beam	corr	Old
14	Drink water operation house	49.5	3.50	cont	brick	wood	tile	Old
15	Drink water pump house	165	3.50	cont	brick/corr	beam	corr	Old
16	Agitator pump house	240	3.20	ind	corr	beam	corr	Old
17	Repair workshop	1,760	8.00	cont	brick/corr	beam	corr	Old
18	Construction workshop	1,278	5.00	ind	brick/corr	beam	corr	Old
19	Training laboratory	2,800	3.20	cont	brick	beam conc/ beam	corr	Old
20	Training workshop	576	4.50	cont	brick	beam	corr	New, 1975
21	Engine training laboratory	392	4.50	cont	brick	beam conc	corr	New, 1975
22	Electrical training laboratory	576	4.50	cont	brick	beam conc	corr	New, 1984
23	Drilling training laboratory	504	4.50	cont	brick	beam conc	corr	New, 1984
24	Micro-biology laboratory	386	3.10	cont	brick	wood	asbes	New, 1978
25	Simulator & pilot plant laboratory	2,200	8.00	cont	brick	beam conc	corr	New, 1985

Note: * Hight: from floor to ceiling

LEGEND: ind; independent foundation
cont: continuous foundation
corr; corrugated galvanized steel
brick; brick or brick mortar
alum; corrugated aluminum
beam; steel beam
conc; reinforced concrete
beam conc; steel-framed concrete
asbes; corrugated asbestos cement
tile; roof tile

(3) Deterioration

Some buildings are found much deteriorated. Solo-II Pump house is a typical one of such buildings. It is made of wood and has a roof with tile but some of the tile has been lost. Although the location of pump house is outside dangerous area it is desirable to build new house made of iron steel structure because it is located inside the refinery plant.

(4) Bad working circumstances

Wax Plant and Moulding house are the buildings much deteriorated and ill lighted. Therefore it is dark for working inside the buildings. Most of the ceiling lamp are left broken and there are none of lighting window particularly in the Moulding house where they have no work at night. The condition could be improved by simple devices such as the use of sky light. Concrete floor and draining ditch inside the Moulding house are also very deteriorated, consequently, repair work will be necessary.

(5) Repair Workshop and construction workshop

Both buildings are old and have approximately same size. Although there may be a characteristic difference between Machine shop and forge, it is clearly found very dirty in the construction workshop due to the bad maintenance work. Also east facade of the buildings are quite same, however, deterioration of the latter building is much greater than the former.

(6) Use of fire-proof material

Veneer plate is used for ceiling and side wall in both new and old buildings. Training Laboratory with 2nd floor, particularly, have large space and many divided rooms with partition wall. Considering the inflammable matters are handled inside the Laboratory it is therefore necessary to avoid fire by the use of fire-proof material.

(7) Comparison of the new and old buildings

There are remarkable difference between new buildings and old ones. New buildings use materials of better quality and the improvement have been made year by year. We can find good example of it in a Training laboratory. As No.B-20, B-21, B-22, B-23 laboratories have similar shape and size and located at the same place, we can easily compare and understand the situation of these buildings.

New training Laboratory is a very good building which was completed very recently with the full use of Alminum sash window.

5.3.12 Oil Well Facility

(1) Outline of production

The center processes crude produced in the following 4 fields.

Kawengan
Ledok
Nglobo
Semanggi

Table II-5-35 shows the number of producing well in each field for the past 6 years and Table II-5-36 gives potential annual output and actual output.

Table II-5-35 NUMBER OF PRODUCTION WELL BY EACH OIL FIELD DURING PAST 6 YEARS

Year	Kawengan	Ledok	Nglobo	Semanggi	Total
1979	15	9	14	3	41
1980	19	10	12	3	44
1981	16	11	12	3	42
1982	18	9	10	3	40
1983	20	8	12	4	44
1984	18	10	11	3	42

Table II-5-36 POTENTIAL AND ACTUAL PRODUCTION OF CRUDE OIL FOR THE PAST 6 YEARS

(Unit: m^3)

Year	Kawengan		Ledok		Nglobo	
	Poten-tial	Prod.	Poten-tial	Prod.	Poten-tial	Prod.
1979	45,000	16,389	13,000	6,825	12,000	8,433
1980	40,000	17,150	12,500	6,232	11,000	7,464
1981	38,000	15,380	12,000	5,001	10,000	5,817
1982	36,000	18,764	11,000	5,603	9,800	4,826
1983	35,000	24,088	10,000	5,351	9,500	5,838
1984	33,500	20,237	9,500	5,016	9.200	5,466

Year	Semanggi		Total	
	Poten-tial	Prod.	Poten-tial	Prod.
1979	6,000	1,647	76,000	33,294
1980	6,000	1,770	69,500	32,616
1981	5,950	1,550	65,950	27,748
1982	5,000	1,567	62,700	30,760
1983	5,900	1,787	60,400	37,064
1984	5,850	1,489	58,050	32,028

Potential output here means output in case oil is drawn installing drawing equipment to all non-dried up wells.

The center presently plans to reopen production by installing well pumping equipment at not dried-up wells and increase output by second and third recovery. Table II-5-37 and Table II-5-38 give the number of wells estimated to become operable and the summary of potential output by each well and by each year until 1995 by the above means.

Table II-5-37 NUMBER OF WELL CAPABLE FOR PRODUCTION BY 1995

Year	Kawengen	Ledok	Nglobo	Semanggi	Total
1985	16	8	10	2	36
1986	19	10	12	4	45
1987	23	12	14	6	55
1988	27	14	16	8	66
1989	31	16	17	10	74
1990	35	16	17	10	78
1991	39	16	17	10	82
1992	43	16	17	10	86
1993	47	16	17	10	90
1994	50	16	17	10	94
1995	50	16	17	10	94

Table II-5-38 POTENTIAL PRODUCTION BY 1995

Year	Kawengan	Ledok	Nglobo	Semanggi	Total
1985	31,000	9,000	9,100	5,900	55,000
1986	33,300	11,000	10,400	7,200	61,900
1987	36,500	13,000	11,800	8,750	70,000
1988	40,000	14,500	13,000	10,200	77,700
1989	43,000	16,500	13,200	11,550	84,250
1990	47,000	16,200	13,000	11,500	87,700
1991	50,000	15,700	12,800	11,450	89,950
1992	53,000	15,200	12,500	11,400	92,100
1993	57,000	14,700	12,300	11,300	95,300
1994	59,000	14,200	12,000	11,200	96,400
1995	58,000	13,700	11,800	11,100	94,600

(2) Outline of inspection

a) Kawangan oil field

This oil field is located about 17 km east of Menggung Crude Base. Because of impossible car traffic due to the damaged bridge, the present survey did not cover the subject.

b) Ledok oil field

Presently 10 wells are producing. Since metering equipment is not available, output by well and decrease of output by well are not studied.

The flow rate of oil/water mixutre pumped up from the wells is said unchanged.

Engine fuel to move pump is gas separated by the gas separator and the amount is sufficient at the present moment.

Underground oil pump is brought up to the ground about once in 6 months for repair.

Scaffold and machines are installed at all times for each well to raise and re-install this pump.

There were 7 gas/liquid separation vessels, of which 4 are presently running.

The separator was built about 1928 and of rivet joint construction.

Table II-5-39 shows results of measuring wall thickness of 4 vessels presently operated.

Table II-5-39 PLATE THICKNESS OF GAS/LIQUID SEPARATOR IN LEDOK OIL FIELD

Separator No.	Shell plate thickness (mm)		
	Original	Vapour phase	Liquid phase
1	10.2	10.5	8.9
2	12.5	10.2	11.8
3	10.2	4.3	6.8
4	10.2	3.0, 3.9, 3.1	3.7, 4.2, 4.7

There are 9 small cone roof type tanks to separate oil and water, of which some had a hole as big as more than 50 cm.

Since oil transfer lines from gathering stations at various locations to crude oil tanks (T-41, 42) at the Ledok Terminal was stuck, the piping was cut for checking, then heavy accumulation of scales was said to have been discovered.

These scales were sand particles, did not feel stickly as wax, and got scattered by poking with iron rod.

c) Nglobo Semanggi oil field

Of both oil fields, by the restriction of time only representative oil well, gas separator and oil transfer pump among the ground equipments at Nglobo oil field were observed.

- Oil well pump

Obsolescene of the oil well pump equipment surveyed was in surprisingly bad condition.

The equipment used was the one used from 1920s, driven by gas engine and belt. The first engine was left aside as scrap since a long time ago because of lack of spare parts, and operable engine was moved from other well and used.

But this engine was severely obsolescent and showed just like a collection of parts.

There was no fitting ignition plug available and one size smaller screwed plug was force fitted.

Severe backfire occurred probably due to defective caburator. Backfire noise was also heard from oil well near the No. 2 block station.

The condition of engine installation was poor and the back rises about 4 cm with concrete foundation by each stroke of pump.

Two cogs of pinion gear of spur gears which is the drive part of oil well pump were found continuously missing and due to lack of spare gear, it was still used, which might cause loss of another tooth because of forced impact.

For the maintenance of underground pump, the scaffold of drilling rigs was left and used same as Ledok oil field, but there occurred severe damage on the brake drum belt which was used for pump drawing out operation.

- Gas Separator

Gas separator at the No. 2 block station was surveyed. The equipment was installed in about 1928 and quite obsolete. The condition and function of the equipment is same as that of Ledok, description is omitted.

- Oil transfer pump

There was only one 2-cylinder recipro-pump driven by gas-engine and belt. The pump had been used since the opening of the oil field, and it was antique and obsolete.

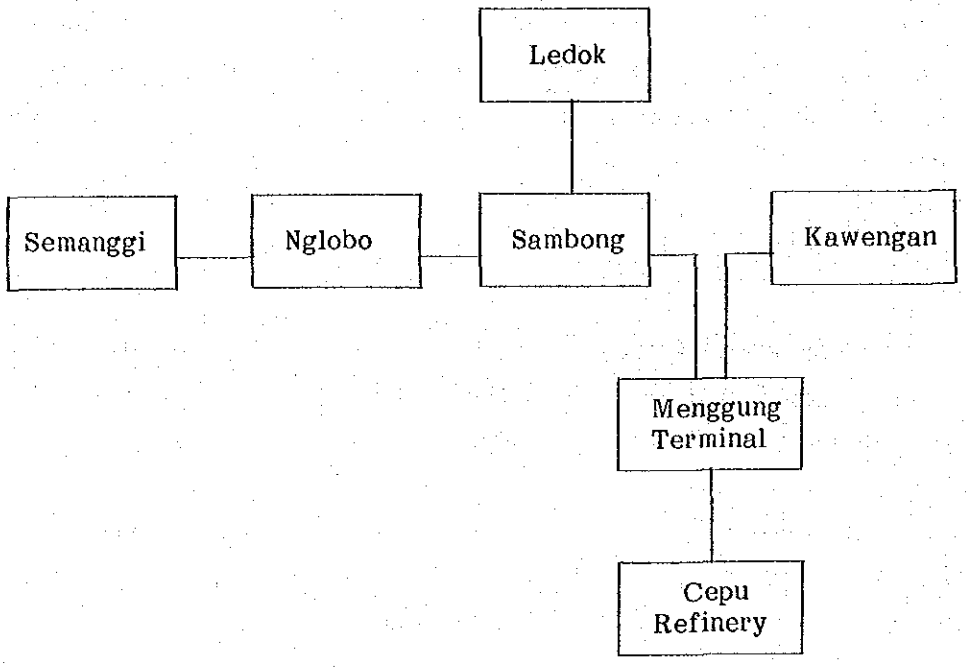
Although this pump was extraordinarily big, moving stoke was very slow as 6.5 times/cylinder per minute, which seemed to indicate the imbalance of oil feed amount against the size of the pump.

5.3.13 Crude Pipe Line

(1) The present state and outline of inspection

Fig. II-5-20 shows a scheme of crude flow from each oil field to Cepu Refinery.

Fig. II-5-20 FLOW SCHEME OF CRUDE OIL



Because of time restriction and impractical transportation to Kawengan due to the breakdown of the bridge, a survey was made on the pipeline from Menggung to Ledok Oil Field only.

This pipeline was installed in about 1928 burying 5" pipe underground along the road.

When the road width was extended recently, existing piping was dug and moved to the side of the road, because the piping came under the road.

Sleepers were generally installed on the ground and the piping was laid on them but part of underground piping was still left.

In moving the pipe, some portions which could not be dug were replaced by new 4" pipe.

At the joints of these parts there are some points where instead of using reducer, 5" pipe was drawn and covered on top of the 4" pipe and fillet welded.

By visual inspection, there found a sign of repairing hole at one place.

Original wall thickness of the pipeline was not known but wall thickness was measured at each of the following points shown in Table II-5-40.

Except newly replaced C1, all pipes were installed around 1928.

Table II-5-40 MEASURED VALUE OF PIPE THICKNESS

Measured Point	Distance from Menggung	Diameter of Pipe (inch)	Pipe Thickness	Remarks
A	1.9	5	6.5	
B	3.0	5	6.5	
C1	4.8	4	8.6	Renewed pipe
C2	4.8	5	5.7	
D1	5.9	5	5.3	Immediately below the opening
D2	5.9	5	4.9	Immediately above the opening
E	6.7	4	5.9	
F	8.7	4	5.5	
G	9.7	4	8.0	

Height, distanc and reading of pressure gage during crude transfer at each point was as given in Table II-5-41.

Table II-5-41 CRUDE OIL PIPELINE

Location	Level (m)	Distance (km)	Readings of Pressure Gauge from Menggung (kg/cm^2G)		
			Case 1	Case 2	Case 3
Semanggai	227	30.2	-	-	-
Nylobo	165	19.6	22	20	18
Magersaran	170	17.0	6	5	3
Nyawenan	75	11.3	11	10	6
Sambong	50	6.7	12.5	11	8
Ledok	> 50	10.7	-	-	-
Sitimulyo	42	1.7	18	16	12
Kawengan	110	17.0	-	-	-
Menggung	29	0	-	-	-
Refinery	27	1.2	-	-	-

PART III

DIAGNOSIS AND COUNTERMEASURES

Part III DIAGNOSIS AND COUNTERMEASURES

Chapter 1 General

Part II described the actual survey of the Cepu training center and observation and inspection results of facilities at the site, and also described some discussions and recommendations about several technical problems. Based on these results, this Part describes the diagnosis results and countermeasures of survey concerning about the refinery, incidental facilities, workshop, laboratory, and training activities of the center.

In addition, the proposal for the topping unit in this Part was made from the viewpoint of renovation of existing facilities. Therefore, the consideration and proposal concerning a new plant shall be made in Part IV.

Chapter 2 Operation Management Problems of the Refinery

2.1 Operation Manual

The following points should be taken into consideration when the operation manual of the topping unit will be revised:

(1) Add to the manual the process flow sheet on which the process conditions such as temperature, pressure, and flow rate and the main measuring instruments are described, and the simplified flow diagrams for the feed line of crude oil, run-down lines of distillates, fuel/ gas lines, and steam line.

(2) Chart every procedure by employing the time schedule chart and check sheet as long as possible to make the procedure more understandable.

(3) Express the process operation conditions, utility conditions, properties target of distillates, and run-down temperature, which are important for concrete judgment, with the numeric values as long as possible. For example, the operation conditions of furnace shall be expressed as desribed below:

Fuel oil:	Original pressure of burner 2.0 to 3.0kg/cm^{2}G
Fuel gas:	Original pressure of burner 0.4 to 0.6kg/cm^{2}G
Furnace pressure:	the pressure shall be negative.
Damper and register:	They shall be properly positioned in consideration of flame, furnace pressure, and excess air ratio.
Oxygen %:	The target is set at 3.5±0.5% (Excess air ratio of 20 to 30%).
Tube skin temperature:	Less than 450°C

(4) Add the management and use conditions of chemicals such as ammonia and soda. For example, the management and use conditions of ammonia injection facilities are described as follows:

- Adjust the injection amount according to the crude oil type and operation conditions, and check that the flow rate of rotameter is appropriate.

- The pH of gasoline circulation tank drain for Heckman No. 1 shall be kept within 6.5± 0.5.

- Check for the protectors (gas mask and vinyl gloves) and the shower for cleaning eyes required at leakage.

(5) Clarify the work responsibility of each operator and the equipment in his duty, and add the facility and equipment list for each person in charge.

2.2 Operation Record

The record of the check list for daily inspection during operation, the shift to shift note book, and the log sheet shall be taken certainly and used as both the basic data for diagnosis of, performance of facility and the data for maintenance.

In addition, the whole scale test run of all the facilities such as the topping unit shall be executed once or twice a year as the basis to diagnose their performances and to modify them.

2.3 Equipment List and Maintenance Report

The contents of the equipment list and maintenance report provided from the center are neither sufficient nor well filed because the facilities in the center are too old.

Therefore, these records shall be kept in order and used for the improvement study of facilities and their maintenance plan.

2.4 Operation Control of Furnace

(1) Tube velocity of furnace

The current tube velocity of the existing furnaces are much lower than the lowest limit.

As discussed in Part II, the plan for changing the parallel use of the existing 2 furnaces to the serial use causes the pressure drop of tube (The current pressure drop of about 1kg/cm^2 goes up to about 8kg/cm^2) so as to raise the problems such as the pump head and the resisting pressure of heat exhangers and furnace tubes. Even this plan enables improvement of the current condition but the tube velocity is still low so as to cause tube coking.

According to the study result in Part II, the optimum size of furnace tube of the 2,000 BPSD topping unit is 2.5 inches. Therefore, if 1 unit of existing furnace is employed and the current furnace tube is replaced with this size of tube, the total improvement must be required due to the burner capacity and the efficiency of furnace.

In this case, the pressure drop of furnace tube goes from the current value of about 1kg/cm^2 up to about 16kg/cm^2 so that the crude charge pumps and heat exchangers need to be replaced.

(2) Operation Control

The monitoring facilities shall be improved inthe following points for the safety of each furnace and energy saving:

a) Renovate the indicators and recorders of temperature inside furnace, tube skin temperature, and stack temperature

b) Install the furnace pressure gauge (draft gauge).

c) Install the oxygen monitor (switchover type). (This is used also as a sampling facility for the combustion gas analysis.)

d) Install the flow meters at each furnace for fuel oil and fuel gas.

e) Install the alarm for monitoring the oil temperature at the furnace outlet.

f) Improve the peep hole position.

2.5 Operation Control of Columns/Vessels and Heat Exchangers

The measuring instruments for measuring the temperature, pressure, and flow rate concerning to each column/vessel shall be completely provided and expanded, and measured values must be recorded on the log sheet so as to be used for not only checking the balance of their materials but also checking their performances.

Moreover, it is important for operation control to plot these data items and quality data of distillates and others on a graph, analyze them, and clarify the relationship between yield, quality and operation data.

For the heat exchangers, the thermometers and flow meters are completely provided and expanded to check the degree of fouling according to the reduction of the heat transfer coefficient. Further, the tube velocity for cooling water needs to be checked to minimize corrosion and if necessary, energy-saving operation to be performed by replacing the cooling tower pumps and cutting the impeller shall be studied.

2.6 Operation Control of Pump

The cause of strainer plugging of the Centrifugal-type reboiler pump needs to be investigated and determined according to the four conditions described in section 5.1.2 of Part II:

If the cause is totally determined according to each of these points, it can be assumed that the scale generated in the furnace tube of topping unit and the scale of Fe_2O_3 caused by corrosion of the inside of tower move to cause plugging of the pump strainer. In order to solve this problem improvement of strainer such as switching strainer or automatic cleaning strainer can be considered but this is not a drastic measure.

Therefore, the following measures shall be taken from the viewpoints of preventing generation and deposition of the scale on the upper stream side:

- Improvement of operation control facilities for the furnace
- Sufficient management for the measure against corrosion (by injecting NH_3)
- Regularization of cleaning the tower of upper stream and the inside of piping

2.7 Quality Control and Testing Facilities

The daily frequency of sampling distillates and the number of testing items in the center are too high. It can be assumed that these are caused by the instability of operation management of the plant.

In order to obtain the distillates with stable quality, periodical opening, cleaning, and maintenance of facilities shall be first executed to enhance the functions of the facilities. And next the relationship between the crude oil properties and operation condition shall be grasped to check the optimum operation condition for the fluctuation of crude oil properties and investigate the cause of instability of distillates properties.

If the distillates with stable quality can be obtained, the execution of total test run once or twice a year and the reselection of routine testing items enable great reduction in the sampling frequency and the number of testing items.

Most of the testing facilities and equipments have been used for 10 to 15 years since they were purchased so that they are at the time of renovation, and some of them are defective and cannot be used.

Most of the facilities and equipments used in both Oil and Analytical Laboratories were made in West Germany and the United States. Therefore, it's hard to get their spare parts.

In consideration of these conditions, the equipment disabled for use due to a failure and the equipment which has been used for 10 to 20 years and whose spare parts are hard to get shall be replaced.

Further, the Refinery Lab. is used as an OJT facility. If it is considered that automatic analyzers will be in high demand among the Indonesian refineries in the future, the automatic distillation tester, automatic flash tester, and other testers which have low MTBF (Mean Time Between Failures) and have been well used in Japan shall be recommended for this laboratory.

2.8 Energy Saving

Energy saving is resulted from the cost awareness and as the barometer for evaluating it, the reduction of fuel oil/gas consumption finally becomes important.

As described in section 5.3.3 of Part II, the following points may cause an insufficient cost awareness:

(1) Crude oil and natural gas to be energy sources can be easily obtained nearby.

(2) 70% of the products are transported to PERTAMINA and in the current cash flow system, the handling charge of the output and through-put of crude oil is low.

(3) The production facilities are old so that various technical and economical problems are raised to execute great modification.

Based on the results of renovation survey centering around the topping unit, the model operation management considers to be possible as a primary educational facility. Therefore, at this time of the renovation, it is desirable to promote energy conservation and foster the cost awareness.

2.9 On-the-job Training

For effective training, it is important to positively use the process control simulator and pilot plants. However, these facilities are greatly different from the actual production facilities in size so that they neither are so real nor covers all the works in actual plants because the work contents and time are simplified.

The simulators and pilot plants are currently ready for use. If the balance between actual plants and them is considered, the renovation (modification or replacement with a new equipment) of the old topping unit can be determined as a requirement to enhance the effect of educational training activities in the center because it is very effective for OJT of the trainees from the PERTAMINA which has the latest refining facilities.

2.10 Quality Control and Process Flow

(1) Recovery of LPG fraction

Crude oil of both Kawengen and Ledok is processed by the liquid-gas separation facility near their oil well to collect the accompanying gas. This collected gas is used as the fuel to drive the oil well pump and oil transfer pump and it is also used as the fuel for the company houses nearby. The balance in quantity is unknown but it is not heard that the surplus amount is always emitted in large amount from the flare to the atmosphere.

On the other hand, LPG component in crude oil can be calculated as follows based on the LPG component in the distillate gasoline of IBP-100°C measured by the Department of Refining and Chemistry of Indonesian Petroleum Institute (in August and October of 1972). It can be seen that the LPG component is a very little.

	C3 Fraction	C4 Fraction
Kawengen crude oil:	Trace	0.14 (wt% on Crude)
Ledok crude oil:	Trace	0.04

Also, during actual operation of the topping unit, the overhead of gasoline separator is connected to the flare line.

However, no gas fraction can be seen during the operation.

In addition, the vapor pressure of gasoline is not so high as to cause the quality problem.

Therefore, LPG needs not to be recovered newly employing the stabilizer for the topping unit.

(2) Reforming of naphtha and desulfurization of Kerosine and gas oil

The reason for the straight-tun gasoline, which was added lead as the gasoline blending stock for automobile, remains undelivered from the center to PERTAMINA, was said to be that the gasoline was low-octane so that it could be accepted by PERTAMINA. However, the actual reason was that the demand of motor gasoline was sluggish. Also, expecting the case that it cannot be transported as the gasoline blending stock in the future, the center plans to transport it as a solvent. Therefore, the naphtha reformer needs not to be newly installed to raise the octane number.

The sulfur and other properties of kerosine and gas oil have currently no problem if the Ledok gas oil is used for blending heavy oil. Therefore, the gas oil needs not to be desulfurized.

The center is not provided with the plant, for processing the petroleum distillates with a catalyst under high pressure, which is generally installed in the latest refinery. Therefore, some people considers to newly install the naphtha reformer or kerosine/gas oil hydrogen desulfurization unit in the center. However, there is less naphtha and kerosine/gas oil so that this idea is too unrealistic in such a small plant. As the result, it is reasonable that this problem is supplemented by completing the process simulators and pilot plants.

(3) Increase in production of wax distillate

As the wax distillate, which is the feed to wax plant, the heavy gas oil is separated from the Kawaengan crude oil.

According to the analysis report of this crude oil submitted by the Laboratory and Chemistry Department of the Indonesian Institute, the wax exists at high density at more than 350°C on TBP distillation cut and is distributed on the both sides of the peak at 450 to 500°C.

That is, the wax exists at high density in the distillate corresponding to the heavy vacuum distillate of the continuous vacuum distillation unit.

Therefore, it can be understood as a general idea that the wax production can be increased by installing a new vacuum distillation unit.

In this case, the vacuum residue is not suited for asphalt because the Kawengan crude oil is based on paraffin, so that it is as a fuel oil blended with the dewaxed vacuum gas oil/ gas oil or used for home consumption. In addition, the center tried to manufacture asphalt by blowing the atmospheric residue of Ledok crude oil based on naphthene but gave it up because the ductility was too small.

The asphaltene (0.35 wt%) in the Ledok crude oil is much lower than that in the heavy crude oil of the Middle East which is gneerally used as the asphalt material. Therefore, if the vacuum residue is separated by the vacuum dfistillation unit, it is difficult to use this oil for asphalt.

Provided that the ratio of Kawengan crude oil to the total processed crude oil is 5:8 and the yeild of wax distillate to crude oil is 31.1% (recorded in 1984), and the number of work days is 150 days/year (same as that of the topping unit), based on the topping unit of 2,000BPSD, the capacity required for the vacuum distillation unit can be calculated as follows:

$$2{,}000 \times 5/8 \times 0.311 = 390\text{BPSD}$$

The vacuum distillation unit of about 400BPSD is not economical but unrealistic in the same manner as the naphtha reformer and the kerosine/gas oil hydrogen desulfurization unit.

Next, deep cut of heavy gas oil with the topping unit can be considered as a method to increase the production of wax distillate.

However, the current operation condition of the furnace for the existing topping unit exceeds the limit judging from the coking in furnace tube, deterioration of tube, and other factors.

Therefore, if installation of a new topping unit were employed as a renovation plan, it can be considered that deep cut of heavy gas oil can be realized by re-circulating the residue in the furnace at the limit furnace outlet temperature of 365°C or by feeding high-pressure steam (or feeding condensate) to the furnace inlet tube.

The detail studies above these ideas will be left to the future study. In addition, the deep cut causes the properties (such as pour point and viscosity) of heavy gas oil to vary. Studying whether the wax plant needs to be modified according to this property variation and survey of influence of the produced wax properties on the user will be the future subjects.

2.11 Purchasing and Inventory Control

For the purchasing and inventory control, the duties are well classified by their functions and the organizations are well composed corresponding to these duties. Therefore, it seems that the aim of clarifying duties and smooth management is well established.

However, it cannot be concluded by only this survey how branching of duties balances with the work load to be handled. But, it seems that branching of duties causes subdivision of organization itself, so that from the view of the personal organization it becomes uneconomical. According to the actual survey over the material warehouse, the following points can be pointed out:

a) There are a large number of mechnical and electrical spare part items stored but many of them are very old and some parts have already lost

their parent machines.

Among these old spare parts, it is desirable that those required for training are picked up and transferred to the training facility and those unexpected to be used in the future are scrapped.

b) It is doubtful whether the stock amount of each new material such as furnace tube, heat exchanger tube, or bubble cap well balances with its actual need. However, without performing the preventive maintenance of the equipment, this kind of inventory will not be reduced.

c) Off-the-book new materials can be found non-controlled in the places other than the warehouse. This is not favorable for both maintaining quality of materials and capital assets management. Therefore, it is desirable to return them under the control of the warehousing unit.

d) In general, the storage condition is no good. Especially, a number of used spare parts are rusted and some of them may not be allowed for use. The disused parts shall be scrapped and the remaining parts need to be reordered and rust-proofed.

e) The stock card is not completely standardized. It is not surveyed at this time how effectively the MESC code is used. But, it is desirable that coding shall be handled as a matter concerning the introduction of the computer since coding is meaningless if it causes complication of the work to be done.

From the viewpoint of general concept inventory control is described above. However, the above proposals are not necessarily appropriate and to the point because the Cepu training center has the following special conditions:

(1) Restriction generated because the center is a government body.

(2) Most of the equipment and materials must be purchased from overseas.

(3) The facilities are very old.

According to the above conditions, it must be considered that the ideal inventory control (in a wide sense) cannot be executed in the Cepu training center.

Chapter 3 Mechanical Problems of Atmospheric Distillation Plant

3.1 Tower and Vessel

Column C1B has already caused buckling so that it is abnormal that the column is currently used.

Oil leak has been often found from the rivet joint and caused the fire even if the casual mending was taken against it.

Therefore, this column shall not be used any more and it shall be renovated.

For renovation of this column, it shall not be replaced with the same column as the conventional type. It shall be improved for easy maintenance. That is, the current column has no side manhole so that the middle trays need to be lifted one by one from above and taken out for inspection after removing the top cover.

To eliminate this very troublesome and time-consuming work, it is desirable that the new facility employs 3 side manholes for enabling each tray to be taken out by dividing it into pieces. Further, the tray shall be changed from the current bubble cap type to the valve type and the number of side-cut nozzles shall be reduced to the minimum required number. The column itself shall be a monoblock welded structure. Therefore, the column weight can be greatly reduced.

Though the current column does not employ anchor bolts, the new column shall have the improved structure and it shall be fixed with anchor bolts. In addition, unnecessary folumn C1A shall be removed.

Open inspection cannot be performed for column C2 at this time and there is no maintenance record for this column. Therefore, the degree of deterioration cannot be checked. however, the structure is the same as C1B and this column has been used for about 60 years. So, oil leak from the rivet may occur (though the operation condition is more mild than that of C1B). For easy maintenance, column C2 also needs to be renovated.

Moreover, it is desirable that evaporator V1 shall be renovated because it is very old and has a rivet structure, and its operation condition is most severe. Columns C3, C4, and C5 are also old and of bubble cap tray type. However, they are small and their maintenance seems to be not so difficult. Therefore, it is possible that they can be used as they are.

3.2 Furnace

The furnace is in an extremely bad condition so that it shall not continue being used. In this condition, it is not unusual if furnace wall falls at any time.

Though the furnace tube thickness has not become so thinner as to be critical, the thickness of 1.0mm was detected at a point. Since this may not be the absolutely reliable value in consideration of the reliability of measurement, the further detailed measurement shall be required for all the furnaces used to thoroughly detect every abnormal point. However, judging from the degree of color change and deformation, the tubes in the lower tiers shall be replaced with new ones of 1/2% Mo.

For furnace wall, all the inner and outer wall bricks shall be replaced with new ones and the support beams in the furnace shall be also replaced. All the baffleplates for the flue gas in the furnace are broken and tube arrangement is disordered and deformed from the zigzag type almost to the square type.

These may have greatly lowered the thermal efficiency of furnace.

Other than the chimneys not surveyed at this time, all the facilities except the steel structure of main frame are in the dissatisfactory conditions so that they require total rehabiliation.

3.3 Heat Exchangers

3.3.1 Heat Exchanger

There are 3 crude oil-residual oil heat exchangers E1A, E1B, and E1C. E1C was replaced with a new one in 1974 due to corroded tube and E1A is not used now. E1B has no maintenance record since 1975 so that it has been used

without maintenance. Therefore, it can be assumed that corrosion of the tube have almost reached the limit. The heat exchanger is a vertical type. While E1C employs the floating head the remaining 2 units employ the fixed tube sheet, therefore, maintenance of shell side is almost impossible. Moreover they have been used for about 60 years, so that E1A and E1B need to be renovated. In this case, for easy maintenance of shell, the new ones shall be of floating head type.

Also, though it is related to the rehabilitation plan for the entire plant, E1C shall be also renovated at the same time with E1A and E1B, and these shall be replaced with 2 new units of the same dimensions or with 1 large-scale unit of horizontal type for easy maintenance.

3.3.2 Condensor and Cooler

3 units of vertical consensor/cooler have been removed and 5 out of existing 21 units are not used yet due to leak of tubes caused by corrosion or blocking caused by the scale which reached the limit. Among existing units these are some ones seemed to be replaced or changed.

In 16 units currently used, 11 units other than 5 good ones (E4A, E5, E7, E14B, and E15A) have the tubes and tube sheets which are severely corroded.

Many units have the leaked tubes with plugs, and even in the units which is in relatively good condition there are some which have many plugs (E5, E7, and E14B). Therefore, if the tube end looks good in condition, there seems to be many tubes which may cause leak.

All of these units have been used for about 60 years and then the cooling water side are extremely corroded as it is apparent from observation of open channel.

The units like E12A and E12B have considerable amount of scale adheres to the cooling water side.

The shell thickness of each unit is 6mm according to the drawing [only that of E4A (old No. 5) is 17.5mm.]. However, the current thickness is unknown since it was not measured at this survey.

In conclusion, here recommend the following 2 renovation proposals concerning to 16 vertical units currently used:

Proposal 1: Replace all the tubes for E4A, E5, E7, E14B, and 15A while use their tube sheets again and replace both upper and lower channels. The other units except above mentioned must be renewed.

Proposal 2: Newly manufacture all the units.

Though the thickness of tube sheet was not measured at this survey, most of the tube sheets have been used for about 60 years so that it is doubtful whether they can be reused and there is no manufacturing drawing available so that partial renovation is hardly possible. Therefore, it is recommended that proposal 2 shall be employed.

In additon, the units not used now shall be removed and all the units shall be re-arranged.

Box cooler E8A has no problem but the extremely corroded coil of E17A needs to be replaced. Other units which could not be checked this time due to time limit would better be checked near future for judgment.

3.4 Pump

All the pumps are new and there is no trouble found in them. Moreover, all of them are compact so that they seem to cause no special problem near future.

However, it is not proper judgment and measure that the new C2 reboiler pump is not used because of the clogging of suction strainer. At first the cause of scale generation must be eliminated and the strainer shall be innovated. This pump shall be immediately prepared for ready use, and the old reciprocating pumps shall be removed.

Fuel pump P500-1A is not currently used because of lack of spare parts for steam turbine. However, this is a very serious problem that there is no stand-by unit for the fuel pump which is very critical for the process. Therefore, this pump shall immediately become available for use.

3.5 Piping

As minor renovations of piping, removal of unnecessary piping, maintenance of steam trap, and stop of gland leak of main steam valve can be considered. It cannot be proper to say that all the piping shall be replaced immediately due to poor arrangement.

But if the tower, vessel, furnace, and heat exchanger are actually renovated according to the proposals, most of main pipings are inevitably replaced. Therefore, it is desirable that all the pipings are replaced with new ones by taking this opportunity.

In this case, care shall be taken for the following points:

(1) While strictly following the piping material specification, use the valves and other parts manufactured by the same manufacturer to make their spare parts compatible.

(2) Minimize using flanges as long as possible and use the welded joints.

(3) Use a minimum required number of valves. That is, the block valve shall not be provided for the heat exchanger, etc. In relation to piping, it is proposed that the hose station for steam, compressed air and water shall be employed in the plant area. Though no hose station is currently provided, it is required for not only maintenance but also safety.

The pipings and valves are partly colored by liquids to avoid misoperation in the case of emergency and for training. In addition to this, the liquid flow direction and liquid name shall be indicated and more thoroughly adopted. This shall apply to all the pipings in the entire refinery.

3.6 Instrumentation

The instrumental facilities currently function well so that it does not require a large-scale improvement. However, the most instruments used now are more than 10 years old except some of them. According to the user's survey report made by Instrument and Process Control Technology Association (IPC) in Japan

in 1978, the expected life of instrument is 10 to 15 years. Also, in consideration of the holding time of 5 years for spare parts of the old model after model changed, it should be said the time to replace the instruments is coming.

On the other hand, pneumatic instruments has been greatly losing their position in use. Therefore, a new refinery employs electrical instruments so that the current pneumatic instruments in the Center are not appropriate to the policy of training in actual plant. In conclusion, the latest electrical instruments shall be introduced at the time of replacement.

3.7 Structure and Insulation

(1) Structure

The fire proof coating of structure is extremely fallen off and deteriorated so that the thermal resistance against the fire is completely lost. Since there was actual fire in the plant so often that it needs to be repaired completely again.

(2) Insulation

In order to enhance the heat insulation characteristic and prevent a person from a burn, the old diatomaceous earth insulation whole of which is extremely fallen off and deteriorated needs to be renovated.

Moreover, the flanges and valves may better be insulated for heat.

As a new heat insulation material, it is reasonable to use the moulded block of calcium silicate as this block is already employed for a part of the plant. For the heat exchanger, rock wool may be used as a heat insulation material. For the exterior covering, the thin aluminum plate with high anti-corrosion characteristic may be used.

Chapter 4 Offsite and Associated Facilities

4.1 Power Plant

The Plan against the future increase of load is properly made. In case a new topping plant is installed, the load is expected to increase a little. However, this can be covered within the range of the current expansion plan.

The overhaul is performed every 4 to 7 years. However, it is recommendable to perform it every 3 years as recommended by the manufacturer because the aging of the equipment will shorten MTBF (Mean Time Between Failures) and each part is expected to be deteriorated in shorter length.

The operation and maintenance management is well performed, and there is nothing special to be pointed out. If anyhting, the inside of operation panel shall be kept clean. The minor trouble such as a leak of oil piping shall not beleft but needs to be repaired.

4.2 Electrical Facilities

(1) Distribution system

The electric distribution system is now in the satisfactory condition. If the current maintenance is periodically performed from now on too, this system is expected to be used for a long future. But as the minor problem, it is desirable to do the maintenance of the items related to the life of equipment such as periodical replacement of silica gel for the breather of transformer.

In addition, the periodical maintenance shall be recorded. By reviewing the past cable troubles, the maintenance technique shall be enhanced while the maintenance management shall be reinforced too. The single-line wiring diagrams showing the distribution system are prepared and kept. But load side indication after the distribution panel is insufficient. That is, they fail to indicate the types and positions of loads in each circuit after distribution panels which supply electricity to motors and/or lighting facilities. Therefore, this shall be implemented so as to ensure safety during the load maintenance and prevent an error in the design and implementation of expansion or modification of electrical facilities.

(2) Motor and operation panel

The life of motor is fairly long if maintenance of bearing is properly performed.

It is important for predicting the motor shut down to measure the insulation resistances of cable and motor winding. It is desirable that the defective points indicated in section 5.3.2 in Part II shall be immediately improved and the equipment shall be kept clean.

In addition, the drawings shall be completed to ensure the safety during maintenance.

(3) Lighting equipment

(4) Grounding and lightening arrester

4.3 Water Treatment Facility

The water contains a high alkalinity and causes scale to adhere to the cooling water system. As the measure against the scale, hydrochloric acid must be added to purge the carbonic acid gas in the water as described in section 5.3.4 in Part II.

The hydrochloric acid may be directly added to the make up water to the cooling water system because the amount of make up water is only 1% of the water processed in the precipitation basin.

It is important for preventing adhesion of scale to manage the quality of cooling circulation water.

4.4 Boiler and Steam System

(1) Boiler

The boiler was installed in 1978 and no corrosion was found after visual inspection of the flue gas side. Also, the boiler thickness is not reduced.

Therefore, the quality of boiler drum water needs to be maintained by blowing boiler water.

(2) Steam Line

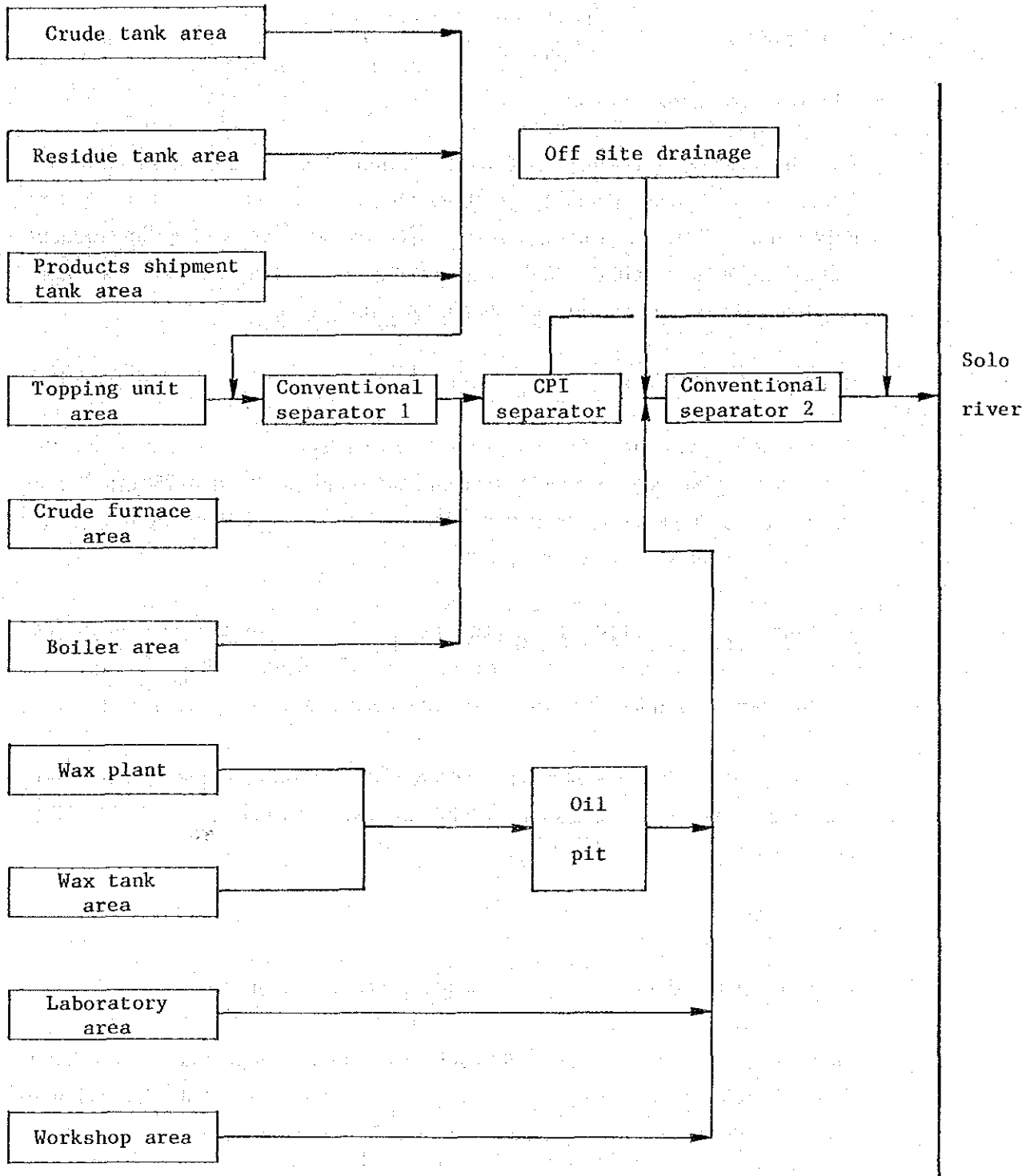
From the viewpoint of energy saving, steam leak and heat insulation need to be repaired.

The steam trap shall be also checked.

4.5 Waste Water Disposal Equipment

In the oily waste water treatment system, the low-performance conventional separator is positioned in the down stream of the high-performance CPI separator. This arrangement might be said reversed in order. Therefore, the water treated by the CPI separator shall bypass conventional separator 2 and is directly disposed to the Solo River, then reduce the burden of conventional separatro 2. On the other hand, the water drained from the oil pit of wax plant and the water drained from the laboratories and workshop area shall be introduced to conventional separator 2 for treatment. This porposal is shown in Fig. III-4-1.

Figure III-4-1 IMPROVEMENT OF WASTE WATER TREATMENT



4.6 Tank Facility

(1) Off site tank

a) Oil leak from rivetted joint

For the stopping of oil leak from rivet joint, there are three methods. Those are additional caulking, seal welding and sealing by sealant such as polyester. But in this case we recommend maintaining of present condition because minute leak will not cause any troubles such as losses of storage oil, soil contamination and catching fire.

b) Roof plate

According to API Standard 650 "Welded Steel Tanks for Oil Storage", the roof plate must have strength bearing the load more than 25 lb/ft^2 and minimum thickness of 3/16 inch nominal. But the tanks which fit to this standard are only T - 101 and 102.

At tanks T - 107, 110, 111, 112, 113, 115 and 116 the roof plate has many open holes caused by corrosion. Roof plates of T - 104 and 114 do not have any holes but the roof thickness shows only 1.5 and 1.7mm.

The work of scaling oil level on the roof of such tanks is very dangerous that the access way to gauge hatch must be installed to avoid aboarding tank's roof.

c) Shell plate

Required plate thickness of bottom plate are shown in Table III-4-1.

This table shows T - 101, 102 and 936 have original thickness thinner than calculated thickness. Also at T - 931 and 933 the original thickness does not satisfy calculated one if corrosion allowance 1.6mm is considered.

Table III-4-1 BOTTOM SHELL PLATE THICKNESS

Tank No.	Thickness of bottom shell (mm)			Judgement
	Original	Calculated	Measured (min.)	
T-101	10.0	10.1	8.1	slightly bad
T-102	8.5	9.3	7.1	slightly bad
T-103	6.5	1.4	5.3	good
T-122	6.8	2.7	6.2	good
T-931	16.5	15.8	15.5	slightly bad
T-933	16.5	15.9	13.8	slightly bad
T-936	7.5	10.5	5.2	bad
T-941	25.4	19.1	23.7	good
T-942	25.4	19.1	23.5	good

About the tanks of which original thickness does not satisfy calculated thickness, the maximum allowable oil level is calculated for reference. Table III-4-2 shows this results.

Table III-4-2 MAXIMUM OIL LEVEL IN TANKS

Tank No.	Oil Level in Tank (m)		
	From size	From calculation	CTC's standard
T-101	9.21-0.3 = 8.91	8.1-10.1x 8.97 = 7.13	8.00
T-102	8.51-0.3 = 8.21	7.1- 9.3x 8.21 = 6.27	7.00
T-931	11.82-0.3 =11.5	15.5-15.8x11.52 =11.30	—
T-933	11.36-0.3 =11.56	13.8-15.9x11.56 =10.30	—
T-936	8.42-0.3 = 8.12	5.2-10.5x 8.12 = 4.02	—

But, since the thickness measured was limited only to one point by each tank, to decide the maximum allowable oil level actually, furthermore measurement of the shell thickness are required.

d) Bottom plate

As Tanks in the Center are installed on the foundations which did not rise above the ground the elevation of each tank bottom is same to or a little lower than the ground level.

By the improvement of the tank yard drainage, the tank bottom must be in the dry circumstance.

(2) Oil dike

a) Structure of oil dike

In Japan a refinery of which oil dikes were made of nonreinforced concrete blocks had large fire damage, because the oil dikes were broken by earthquake and could not stop the spread of leaked oil from broken tanks. The spread oil caught fire and the fire spread to not only tank yards but also plant yards. So oil dikes in the Center have to be modified to earthquake proof structure such as reinforced concrete or embankment of earth. Also opening in the partition dike such as drain channel or hume pipe which harms the aim of dike must be correctly modified.

b) Drainage of tank yards

Drainage valve of A-block yard is equipped rightly. But at the partition dike, because of the opening in the dike where the drain pipe goes through at immediate up-stream of the valve, drainage valve lost its meaning. This opening have to be blocked.

B-block and C-block have no block valve in the drainage which goes through the oil dike, so the valve should be installed.

At C-block, there are no block valves at the every drain openings in the partition dike. This means the dike do not work as oil barrier.

Block valve of F-block drainage is equipped inside of the oil dike. This means operator cannot access to the valve when large amount of oil leakage took place. The valve has to be equipped outside of the oil dike.

4.7 Offsite piping

(1) Corrosion problem

The off site pipings in the Center are installed underground or directly on the ground. This means the pipings are laid in wet circumstances. On the other hand, some portion of crude pipe is assumed to have particular corrosion inside of it, because crude contains much water in it.

It is impossible to do preventive maintenance for the underground pipings, then by increasing patrol frequency the leaks must be discovered and mended as immediately as possible.

New piping have to be installed above the ground.

4.8 Workshop

Most of the machines used in the workshop are very old. They are installed in 1920s or 1930s so that they have very low working efficiency and operability and some of them may cause a danger.

All of these old machine tools can not be used from the viewpoint of the accuracy originally required. Since they are pretty old models the spare parts are not available, so that they cannot be repaired or restored. At present among the old ones the only some machines which are usable are barely operated under bad conditions. Their rate of operation is very low and they will be scrapped near future. Therefore, the necessary machines need to be immediately replaced. Along with replacement of old machines and/or introduction of new type of machines, care shall be taken for the following points to keep the machines in good conditions for a long time:

(1) Train the specialists and let them operate the machines or operate the machines under their supervision.

(2) Perform the maintenance according to the manual and repair any trouble in its early stage.

(3) Fully manage the cutting tools to keep their accuracy. Therefore, be sure to provide the machines (grinder and tool grinder) required for correcting their accuracy.

The number of machine tools installed, the kinds and scale of the entire workshop seems to be too large compared with the production facility size of the center. However, it is understandable that this results from the long history of the center.

The center takes charge of training in practice (in the field) of trainees as a course in the training curriculum, and on the other hand requires the facility for the maintenance of oil wells. By these reasons the environment of the center is so different from a general oil refinery that it is uneasy to make a conclusion. However, only the necessary models shall be selected and renovated while the remaining models shall be scrapped.

In this occasion, it is recommended that the ordinary machine tools shall be introduced rather than introducting the latest models employing numerical control or computer control. Then the specialists shall be trained mastering these machine tools.

4.9 Building

Among the buildings, there are such buildings like a solo-II Pump House which is extremely deteriorated and needs to be rebuilt. But in general, the remaining buildings seem matching to their uses presently and need not to be rebuilt hurriedly.

In another thought, the maintenance of building shall be performed properly to use these buildings for longer time in clean and beautiful state. Then, it is desirable that the renewal of building shall be performed gradually when financial condition could afford it.

However, especially for the building such as training laboratory where inflammable materials are treated and a number of partition walls are installed, it is recommended that the noncombustible material shall be used as the interior material for fire prevention measure.

In addition, the building with a bad working environment such as the wax moulding house shall be immediately improved.

4.10 Oil Well Facility

As shown in [Table II-5-35], the number of production oil wells in the last 6 years is almost constant. As shown in [Table II-5-36], the oil output is also constant. However, if the production of oil depends only on the primary extraction method at the current oil wells, the output will gradually decrease.

The reason for the increase of the Kawengan crude oil output in 1982 is that the number of production oil wells was increased from 18 to 20. Then, the output was decreased in 1983 because the number of production oil wells was decreased from 20 to 18. By this fact, in order to increase the production, the number of production oil wells must increase if the primary extraction were unchanged. That is, a new pumping unit shall be employed for each well which has not been dried up yet.

4.11 Crude Pipeline

The Kawengan crude oil is waxy so that it is sent as the 60% waster mixture from the oil wells to the Menggung crude oil base to prevent wax from adhering to the inner wall of pipe.

On the other hand, the Ledok crude oil is not waxy so that it is sent to the base without mixing water.

However, a transportation trouble caused by adhesion of wax occurs in the pipelines for both crude oils.

In order to remove the wax adhered to the pipe, it can be generally considered that a special pig is thrusted through the pipe for cleaning. However, if a considerable amount of wax is adhered to the pipe like this, the pig cannot be thrusted through the pipe due to the blocking caused by removed wax in the pipe. Also, in this pipe line, the pipe diameter greatly vary in some points. This disables the use of pig.

There is another idea that hot water is charged at the oil wells into the pipeline to melt wax. However, this requires a hot water facility and has several difficulties to be considered. Therefore, careful study shall be required to employ this method. At this time, it's impossible to make a specific proposal. However, stable oil transportation by pipe line is an absolute requirement for stable operation of refinery so that a suitable measure shall be thought out against blocking of pipeline.

Chapter 5 Facilities, Equipment, and General Training Activities of AKAMIGAS and Training Laboratory

5.1 Facilities and Equipment of AKAMIGAS and Training Laboratory

In Chapter 4 of Part II, the current status was analized and the problems were picked up for every corresponding item (division). In this Part, they are summarized as follows and are to be used as the basis (material) to develop the renovation program for the Cepu training center.

5.1.1 Facilities and Training Aids of AKAMIGAS

(1) Lecture room

Now, the number of regular course students is 600 and 30 short courses are held in a year. In this situation, the use rate for the lecture room is considerably high. Therefore, if AKAMIGAS considers to extend the TCDC program and the ASEAN-PACIFIC program as a regional center in the future, the lecture rooms will become insufficient. The management of the center currently shows flexibility to solve the problems such as setting up the lecture room for the short course close to the laboratory. This kind of effort will be required further in the future. Fortunately, the process simulator and pilot plant laboratory, which has a relatively wide space, was newly constructed this year. Therefore, the laboratory space may be partially used as a lecture room.

(2) Library

The Library is well arranged in a small size but the number of reference books seems to be insufficient for the training center of special technology of this kind. Especially, the technical books related to the oil and gas industires and computer need to be complete. The library space seems to be tentatively enough.

(3) Drawing room

As the drawing room for the technical training body of this kind, complete sets of drafting boards are necessary for the effective training of the technical drawing. If one group normally consists of 20 students, 20 to 25 complete sets of the drafting boards will be required including those for the teaching staff. The space of drawing room seems to be insufficient when the above numbers of drafting boards are provided.

The drawing room shall be moved to other large size lecture room, or the old language laboratory currently not used shall be employed as a drawing room.

(4) Training Aids

The audio visual equipment shall be complete and fully used to enhance the learning effect onthe students and reduce the instruction load of lecturer or instructor. Especially, the number of OHPs and the number of slides are not sifficient compared with the number of courses and the number of lecture rooms. It is desirable that the number of OHPs and the number of slides for the regular and short courses shall be increased from 9 to 20 and 2 to 5, respectively. Also, one more unit of the video equipment including the video camera shall be required for the short course in addition to the current unit used for the regular course.

In additon, a special studio will be required for installing these audio visual devices and preparing training mataerials.

(5) Student dormitory

The capacity of the dormitory reaches the limit if it is considered as the sleeping accommodations for 600 regular course students and short course participants. This does not seem to be a serious problem because the dormitory is well operated and managed. However, the room space for living (studying) and sleeping is very small. In consideration of future increase in the number of short courses and increase in the number of foreign students, the current condition needs to be improved. The management of the center seriously accept this fact and decided to construct another dormitory accommodating 200 students near future. Early completion of this dormitory is expected.

(6) Operation and management

The buildings, facilities, and equipment of AKAMIGAS are well operated, maintained, and managed by the established system backed up by the long operation experience. In the AKAMIGAS school building, the rooms and spaces for lecturers, staffs, and clerical employees are well arranged and provided with fire extinguishers. The management of the center is seriously working for the necessary measures and decisions such as planning to construct the additional dormitory.

The mangement also instructs the lecturers and instructors to effectively use the audio visual training materials and equipment. However, they have not used these tools frequently yet because it requires great effort and a considerable amount of time to produce the training film and tape to be used by these tools. In order to increase the use of audio visual units, this barrier needs to be overcome and the effort shall be made to properly produce the training film and tape. For producing the training materials, the instructors and junior staffs like assistants need to participate. As the result, through this activity, also the abilities of these staffs expected to be enhanced.

5.1.2 Facilities and Practical Training Equipment of Training Laboratory

(1) Laboratory

The practical training laboratory is arranged for every regular course so that this laboratory seems to have relatively comfortable environment as an academy or training center of this kind in Indonesia.

Most of the course laboratories are assembled in the training laboratory. This training laboratory was built by the great leadership of Dr. Ibnu Sutowo Stou who was the President of PERTAMINA in 1972. It can be said that the training policy emphasized on the pracatical training has been the motive of constructing additional laboratories as the number of courses has been increased and the technology has been progressed. The use rate of each laboratory is considered to be 80 to 90%. In this sense, the laboratory space is sufficient. However, among these labopratories, the instrumentation & electronic laboratory has high instruction load so that the laboratory space

is insufficient. It currently does not make serious problem because the number of existing equipment for practical training is small. However, the space needs to be expanded if additional equipment for experiment and practical training will be further required in the future.

In July of 1985, the construction of a new laboratory accommodating the process simulator and pilot plant was complete and the process simulator starated being installed there. Since this new laboratory has the space equivalent to that of the training laboratory, the instrument control simulator, the pilot plant called Desalter, and the unit operation system which are installed in the training laboratory can be moved to and integrated in this new laboratory. The space made by movement of these facilities can be used to extend the instrumentation & electronics laboratory and the chemical laboratory. However, movement of these large facilities requires a considerable amount of cost and time. Therefore, the space may be adjusted between the laboratories easy to move.

The laboratory is provided with the supporting facilities for experiment and practical training such as the room for staffs, the warehouse for storing materials and chemicals, and fire extinguishers.

(2) Laboratory equipment

Each laboratory is provided with the equipment for experiment, measurement, test, and practical training. These equipment were new and appropriate for learning the techniques meeting the needs of the era when they were installed. However, most of them are too old now to be used and some of them are technically out of date. Further, as the technology progresses, new equipment are required to learn these new techniques.

However, if the equipment are old but they are operational, they may be used to learn the basic techniques. In this sense, the equipment must be carefully maintained. Though the Cepu training center is nicely operated by the well established management system, some of the equipment of laboratories are broken or disabled for use due to inappropriate maintenance. As the causes, difficulty in obtaining the spare parts and absence of a specialist etc. can be pointed out. However, the biggest cause is

insufficient budget (fund) to keep these equipment at a good condition. Since the AKAMIGAS training system and its activities properly and normally function, it is not too much to say that renovation of AKAMIGAS is mainly required for the hardwares, that is, the laboratory equipment.

The renovation of laboratory equipment can be considered in the following 3 categories:

a) Renovation of the equipment deteriorated and disabled for use

b) Renovation of the equipment technically out of date (including upgrading of measuring instruments and measurement control)

c) Addition of new equipment required to learn modern techniques

These equipment are listed up in Part IV "RENOVATION PLAN." However, the equipment corresponding to categories b) and c) are briefly shown as follows:

- A part of testing instruments and automatic analyzer of Refinery Laboratory

- The instrument analyzer considered to be necessary for Chemical Laboratory or Oil Laboratory

- Inspection and diagnostic equipment required for settling up new courses (such as the inspection course)

- Unit operation Apparatus

(3) Simulator and pilot plant

Installation of these large-scale equipment requires big budget (fund). However, the center has been aggressively working for completion of them step by step. These equipment enable simulated operation of the actual plant and facilities and also they function as a substitute for the field work (OJT). The newly installed process simulator and pilot plants are necessary

for learning the modern process technology so that the effective training is expected by using them.

Instead of the small-scale unit operation equipment made by hand which is currently installed in the oil laboratory, it is desirable to introduce the more large-scale package equipment similar to the same level as the pilot plants.

(4) Operation and management

Laboratory is well operated in the same manner as other divisions in AKAMIGAS. However, the maintenance of equipment is not satisfactory due to insufficient budget and lack of special technique. In the future, the planned distribution of the budget shall be required for the maintenance, and for the newly purchased equipment, the after-sale service shall be imposed on their manufacaturers or the maintenance agreement shall be concluded with them.

5.2 General Training Activities

In AKAMIGAS, the number of participating students has been increased while the number of regular and short courses has been steadily increased since it was started in 1968. AKAMIGAS has been contributing to the development of the oil and gas industries in Indonesia by meeting their needs.

During this period, AKAMIGAS has been seriously working on the improvement and development of the training system such as changing the primary 3-year running system to the current sandwich system and revision and updation of curriculum.

On and after 1980, the financial support fron UNDP has caused the number of opportunities for fellowship to be increased for development and enhancement of the staffs' abilities, and the consulting service has started by the consultant for the software including the curriculum.

Coupled with enhancement of the management and staff abilities, the proper advices from the consultant have been aggressively employed by these management and staff. This greatly has contributed to further improvement and

development of the software such as the AKAMIGAS training system and curriculum.

According to the advices of consultant, the necessary improvements are now being carried out.

Backed up by these achievements, the Indonesian oil and gas industries rate AKAMIGAS high. In addition, the training needs from the overseas has been increased so that AKAMIGAS is expected to become a regional center.

5.2.1 Training System and Method

As described in above, the AKAMIGAS training system was well established and functions well.

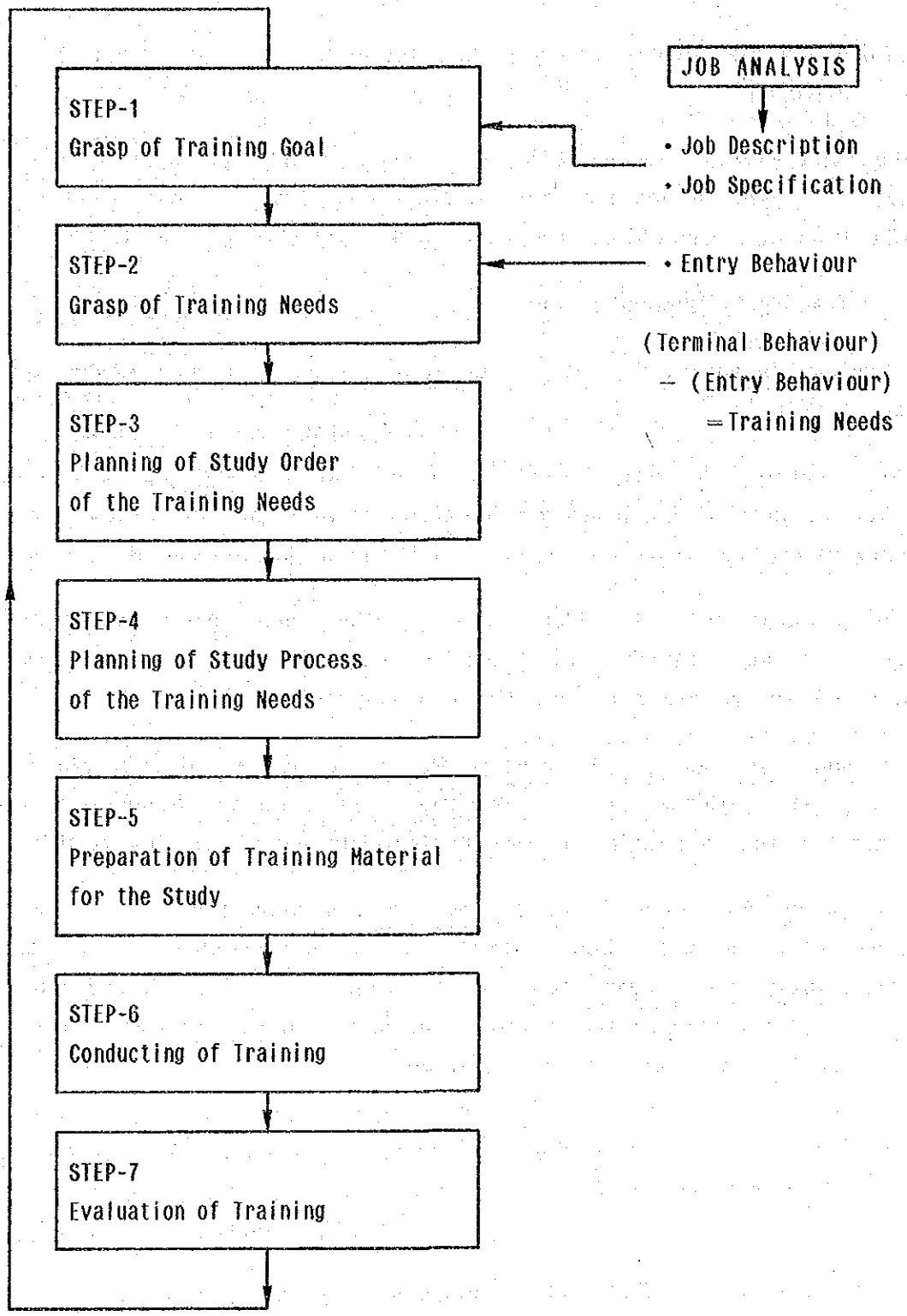
To be concrete, the entry behavior of each student is checked, the terminal behavior required by the industry is obtained from the job analysis to grasp the training needs, and then the curriculum of the study is programmed.

In the training stage, the class room, practice, and field work (OJT) are integrated to consecutively convert the knowledge into the practical skill in the flow of theory-experiment and practice-practical training.

In the middle and end of the training, the test is held for training evaluation. Further, the questionary survey is recently executed for the graduates to check whether the training activity progresses effectively and properly for feedback.

As shown in [Fig. III-5-1], these processes completely match the basic flow (system) of the normal training activity. Even if the contents of each step are different from the standard level or the execution method is successful or unsuccessful, the training target may be accomplished without a large deviation as long as the above basic system is followed.

Figure Ⅲ－5－1 BASIC FLOW CHART OF EDUCATION & TRAINING



It is a great feature and an ideal form for the training system of this Centre that Class room, Laboratory practice, and Field work are executed while linking one another. However, the field work training (OJT) is mainly operating the actual facilities which is naturally dangerous.

Therefore, it is desirable to learn basic operation by using the less-dangerous and medium-sclae equipment prior to OJT. The training performed by using the simulator partially satisfy this purpose. As an example, in the refining course, it is desirable that OJT shall be started after learning the operation principles and opeation by using the unit operation equipment similar size to the pilot plant.

For education and training, the lecturers or instructors are expected to use the audio visual devices as frequently as possible. Use of these equipment enables enhancement of the learning effect of each student. The lecturers or instructors shall recognize that they can enhance their abilities and the training contents by producing the training materials by themselves.

In the class room, it is desirable that questions and answers and roll play shall be effectively employed to make students active. During the laboratory practice, the lecturers or instructors shall employ not only the experiment and practical training to be performed according to the given guidance by the specified device but also the method planned, assembled, and executed by the students themselves. Employment of the latter method enables the students to develop their abilities in application in the future.

5.2.2 Curriculum and Syllabus

For the current curriculum and syllabus used by AKAMIGAS, the UNDP consultants agreed with most of them. Other advices[1/] made by the UNDP consultants are to enhance the effect of the training activities of the Centre aiming at upgrading the practicval knowledge and technique. Among them, the following three advices are considered more important:

Note: 1/ UNDP No. INS-120-0-010-01-X (by John L.R. Kirkaldy), May 1985, and UNDP Report (by David John Allen-Butler), May 1983

a) Be sure to use the "Aims & Objectives" technique to develop the syllabus as an educational material.

b) Develop the curriculum and programme for the practical training in the company which features the sandwich system, that is, "Industrial Training".

c) Develop the curriculum and syllabus of the new subjects such as pollution control, material science, energy management and safety in offshore operation.

If the above 3 advices are implemented, AKAMIGAS could be the educational and training body of educational-industrial complex meeting the potential needs of the industry. However, it will require a long-time and continuous effort to realize this in every course as the proverb says that Rome was not built in a day. Especially, this cannot be developed without cooperation of the industry. Therefore, it is desirable that both the Cepu training center and the industry carry out this steadily according to the long-range plan.

Development of the curriculum and syllabus in the "Aims & Objectives" method has recently started for the short course and turns out effective. For the regular courses, they are to be sequerntially developed by this method. In this connection, it is effective that the consultant or specialist in each field is assigned between AKAMIGAS and the industry to promote and support this development. Further, the same function can be employed for setting up the industrial training program. The specialist must have abundant practical knowledge, technique, and experience in each field. these specialist or consultant can be sent by international institution or by G-G technical cooperation system.

Both regular and short courses have the curriculums and syllabuses conventionally accumulated. On the other hand, as the Indonesian oil and gas industries have been developed and the modern technology have been progressed, the needs for starting the courses concerning new subject and more advanced technology have been increased.

They cannot be carried out as regular courses so that they will be set up as short courses in the future. As examples of these courses, there are Fire

Fighting Course, Inspection & Maintenance Course, and TCDC or ASEAN-PACIFIC program.

The AKAMIGAS short courses have been made a remarkable progress in cooperation with their clients. Therefore, new course can be programmed by themselves. However, in order to start and execute the above Inspection & Maintenance course, the advanced diagnostic technique and know-hows backed up by the years of experience must be required. From this viewpoint, the program appearing in Part IV shall be recommended for the above course. In the beginning stage, the specialist who is specialized in diagnostic equipment and instructs its operation and practical maintenance training will be required. But again, he can be sent by the international body or inter-country technical cooperation.

5.2.3 Staff Training

The PPT MIGAS staffs were conventionally given the training opportunities to enhance and develop their abilities in and out of the country. Especially, the fellowship programmes held out of the country seems to make a great contribution to the improvement of training system and training activity. They are also regarded as labor incentives for the staffs.

The fellowship programs sponsored by the special foreign bodies are expected to continue in the future in order to further complete the education and trianing acativity of AKAMIGAS and transfer new technologies and knowledge.

5.2.4 Development as a Regional Centre

The reputlation of AKAMIGAS is high among the developing countries so that the training needs from these countries have been increased. In this situation, the Indonesian Government expects that the Cepu training center functions as a regional center. However, if the center functions as a regional center, the established theory/policy and completion of facilities must be required. Especially, to gain the effect of training for a short period, it is desirable to aggressively introduce the audio visual learning system. When it is started as a regional center, a little failure and incomplete points at the beginning may be permitted. However, in order to keep its functions at the standard level for continuous operation, the great efforts of the staff and the financial support of the Government will be indispensable.

PART IV

FORMULATION AND ANALYSIS

OF RENOVATION PLANS

Part IV FORMULATION AND ANALYSIS OF RENOVATION PLANS

Chapter 1 Fundamental Conditions and Assumptions for Formulation of Renovation Plans

1.1 Object and Scope of Renovation

In the previous Part III, results of the diagnosis of the existing refinery and related facilities, laboratories and workshop, and various training equipment and aids of AKAMIGAS as well as of the Centre's educational and training activities have been presented with discussions on the countermeasures to be taken. In this Part IV, therefore, based on the inspection and diagnosis/discussions made in the Part II and Part III, concrete ideas and plans for the renovation will be formulated, and each of the renovation plan will be analyzed in detail. It has to be noted that the formulation of the renovation plans is made in accordance with the minutes of meetings on the interim report agreed between the representatives of the Centre and the JICA study team on July 18, 1985 and also, of course, based on the scope of work stated in the Terms of Reference for the proposed study attached as Annex I-1-1, and moreover, in line with the concept that such facilities as those which could be considered rather easily renovated based only on goods and services available in Indonesia, in other words, those capable of being implemented only by the expense of local currency, are to be excluded from the scope and object of the renovation.

Accordingly, the formulation and analysis of the renovation plans has been made centering on the following major items:

(1) Refinery (The renovation is limited to the atmospheric distillation unit, and the wax plant is out of scope).

(2) Workshop machine

(3) Laboratory equipment

(4) Equipment required for inspection and maintenance of facilities/equipment.

(5) AKAMIGAS training facilities/aids, and training activities.

As for the renovation of the existing refinery, three alternative renovation plans which include a case for new installation of refinery (complete/total renewal) will be formulated and analysed.

1.2 Basic Considerations in Formulation of Renovation Plans for Atmospheric Distillation Unit

In the formulation of renovation plans for the atmospheric distillation unit, the following important points should be, and whenever possible, will be taken into consideration so that the Centre's intrinsic functions as training centre could be displayed:

(1) The actual implementation/execution of renovation plans must not constitute an obstacle to accomplishing the Centre's daily training activities and training programme.

(2) The renovation should result in enabling the Centre to have a suitable function to carry out on-the-job training for students who are supposed to work in a modern refinery.

For this purpose, the following points will fully be taken into account, whenever possible.

a) Adoption of modern equipment
b) Introduction of instruments for operating data analysis.
c) Adoption of equipment type which makes repair and maintenance easier.
d) Safety precautions/considerations.

(3) Replacement/renewal of superannuated equipment.

(4) Introduction of equipment required for new training courses to be established and offered by the Centre.

(5) Introduction of equipment for inspection and maintenance of facilities and equipment of the Centre.

(6) Restriction in availability of funds for renovation and their effective utilization.

Chapter 2 Renovation Plans for Refinery (Atmospheric Distillation Unit)

2.1 General

On the basis of the results of the Part II and Part III, the following three alternative plans have been established for the renovation of the existing atmospheric distillation unit of the Centre:

(1) Plan-I:

New Installation (Complete/Renewal) of Atmospheric Distillation Unit. It is determined that the new atmospheric distillation unit shall be designed at a capacity of 2,000 BPSD,[1/] both for Kawengan and Ledok crude oil, on the basis of the projected production of crude oil in cepu and also by taking into account the duration for shutdown and turnaround of the plant especially for the training programme. The new installation of vacuum distillation unit (option) is briefly discussed in Section 2.10 of Chapter 2, PART III.

(2) Plan-IIA:

Partial Renewal of Aomospheric Distillation Unit
The contents of this renovation plan will be indicated later.

(3) Plan-IIB:

Partial Renewal of Atomospheric Distillation Unit
This alternative plan consists of the Plan-IIA plus renewal of some additional major equipment. The contents will be described later.

The contents and results of analysis for each of the three alternative renovation plans for the atmospheric distillation unit of the Centre are presented in the following sections.

Note 1/ Minutes of Meetings on the Interim Report, July 1985.

2.2 Plan-I: New Installation of Atmospheric Distillation Unit

2.2.1 Basic Ideas and Design Concept for Plan-I

A conceptual design for the atmospheric distillation unit has been conducted by bearing in mind the following important points:

(1) The number of tower, vessel and furnace/heater shall be minimized to make the process flow as simple as possible. It has to be mentioned that the existing atmospheric distillation unit has an unnecessarily complicated flow and is therefore unsuitable for those trainees dispatched from modern refineries. From the educational and training point of view, therefore, the flow of the unit should also be simplified. This simplification is possible, because, from the commercial production point of view, the stabilizer is not needed to be installed in the new unit.

(2) A network of heat exchangers shall be arranged so as to save consumption of utilities and, at the same time, to serve as a training medium for energy saving operation in the modern refinery.

(3) The installation of the network of heat exchangers makes it possible to improve heat recovery and, as a result, to allow a compact design of the furnace/crude oil charge heater. This makes requirements for the area and investment for the furnace much less, and achieves a considerably high heat efficiency (approx. 80%) by arranging a steam coil at the convection part of the furnace. An isoflow type furnace having radiation parts with horizontal tubes at convection part shall be adopted.

(4) All heat exchangers, coolers and condensers shall be of horizontal, multitube, floating head type, for the convenience of the training for maintenance in the modern refinery, and their arrangement shall be determined also by taking into account easiness of maintenance.

(5) Valve type trays shall be adopted for the main distillation column and side strippers for the reasons that they are highly efficient, stably operated for a wider range of load, less expensive and more easily maintained than the present bubble-cap trays.

(6) At the time of determining the cut points for the distillation of crude oil, great attention shall be given to the collection/extraction of solvent for the paint industry and wax distillate to be fed into the wax unit of the existing refinery of the Centre.

(7) In order to improve corrosion atmosphere of straight-run gasoline tank, a soda washing/injection unit shall be installed on the way of the gasoline rundown line.

(8) Those instruments required for monitoring the furnace, heat exchangers, towers and vessels, etc. shall be suficiently arranged at the same level as commonly adopted in the modern refinery.

2.2.2 Results of Conceptual Design

On the basis of the fundamental ideas pointed out above, a conceptual design has been conducted for a new 2,000 BPSD atmospheric distillation unit based on both Kawengan and Ledok crude. The following summarizes results of the conceptual design. The design basis is given in Annex IV-2-1.

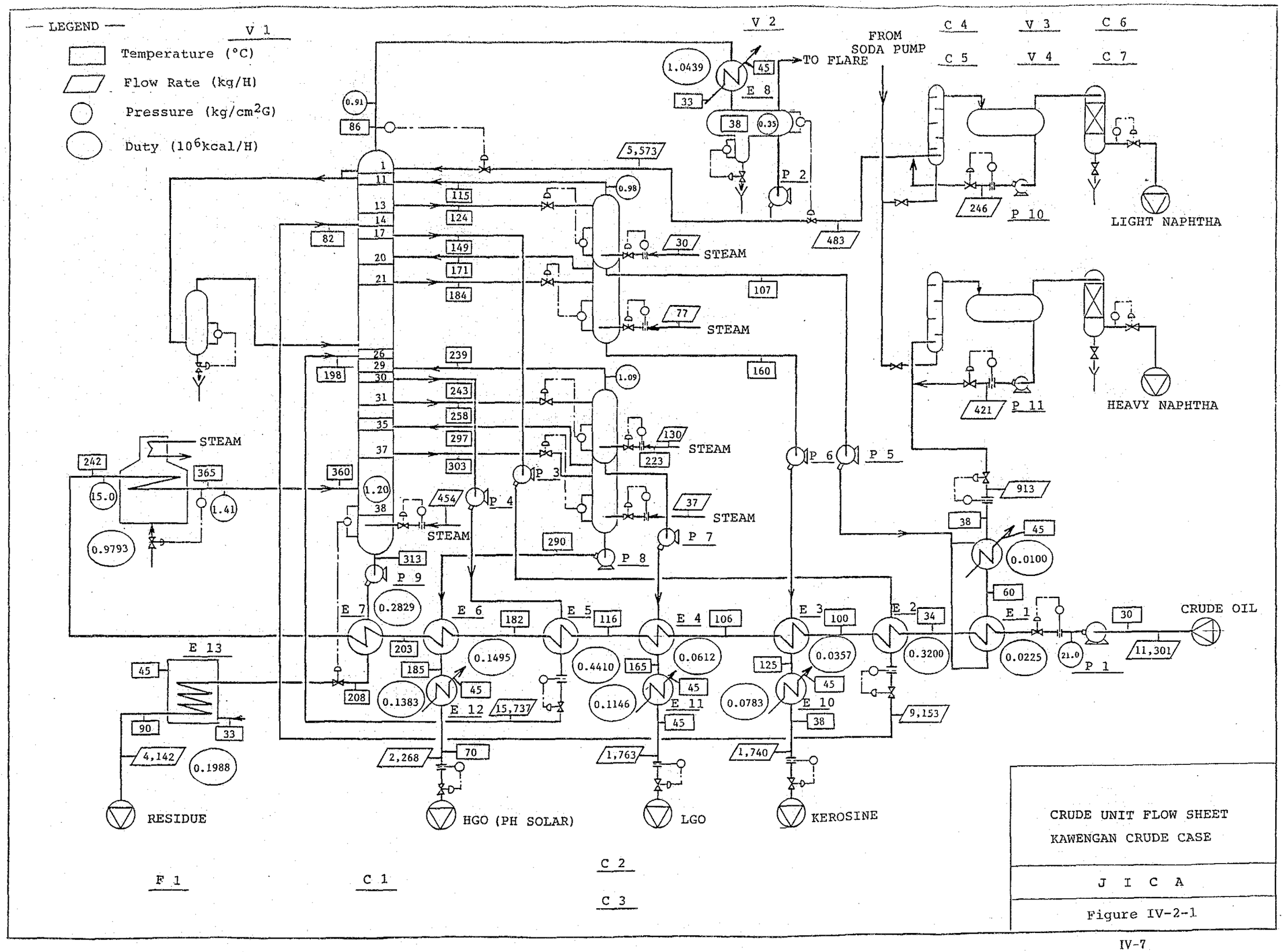
(1) Process flow, and material and utilities balance

Figure IV-2-1 and Figure IV-2-2 illustrate the process flow, and material and utilities balance of the 2,000 BPSD capacity atmospheric distillation unit processing Kawengan crude and Ledok crude, respectively.

(2) Equipment list

A list of equipment for the new atmospheric distillation unit is given in Table IV-2-1.

Short specifications of equipment are presented in Annex IV-2-2. The dimension of the main distillation column is of 1.2m of diameter and 30m of height.



CRUDE UNIT FLOW SHEET
KAWENGAN CRUDE CASE

J I C A

Figure IV-2-1

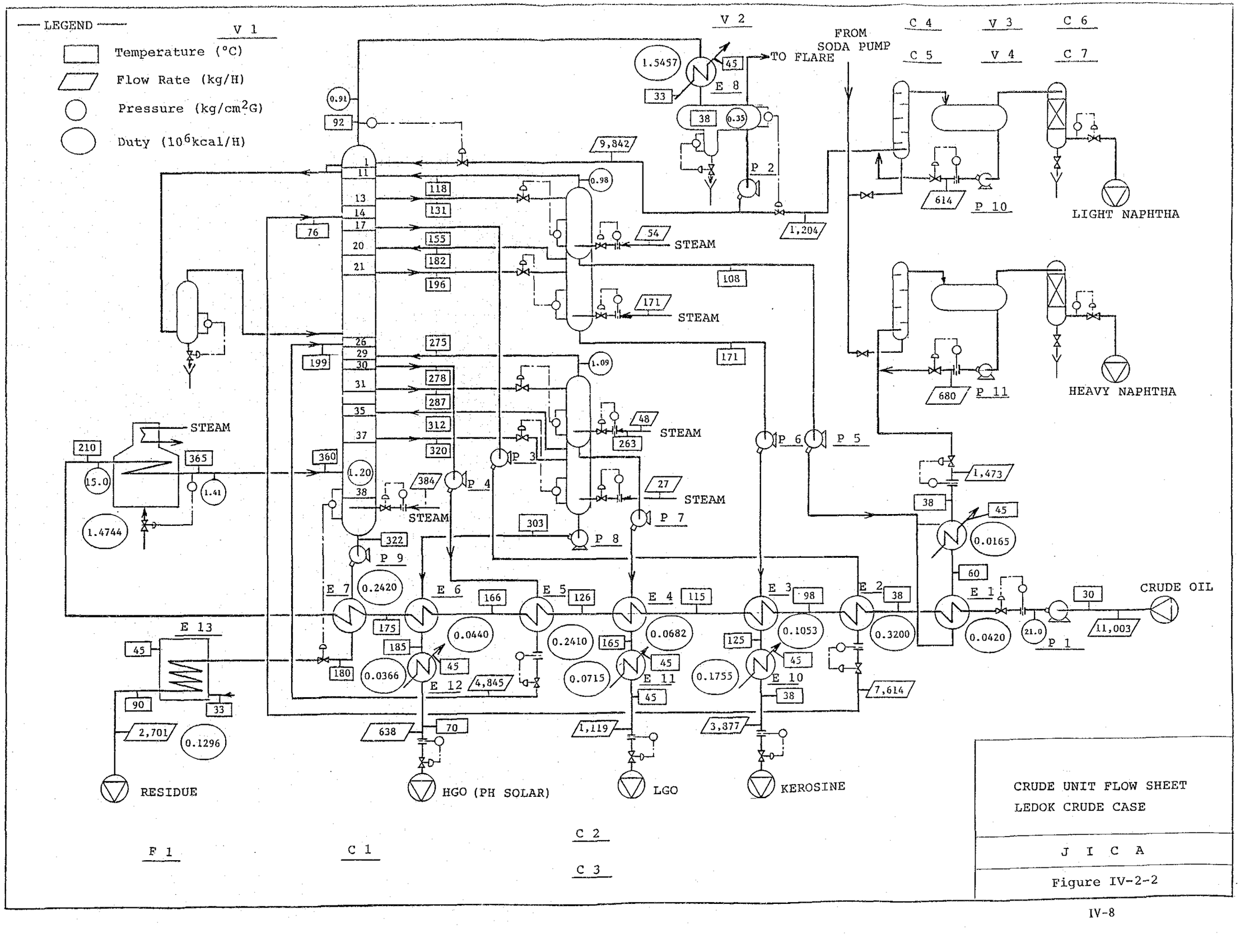

LEGEND
Temperature (°C)
Flow Rate (kg/H)
Pressure (kg/cm2G)
Duty (10^6kcal/H)
V 1
V 2
C 4
V 3
C 6
C 5
V 4
C 7
FROM SODA PUMP
TO FLARE
E 8
P 2
P 10
LIGHT NAPHTHA
P 11
HEAVY NAPHTHA
STEAM
E 13
F 1
C 1
C 2
C 3
P 3
P 4
P 5
P 6
P 7
P 8
P 9
E 7
E 6
E 5
E 4
E 3
E 2
E 1
E 12
E 11
E 10
P 1
CRUDE OIL
RESIDUE
HGO (PH SOLAR)
LGO
KEROSINE
CRUDE UNIT FLOW SHEET
LEDOK CRUDE CASE
J I C A
Figure IV-2-2

Table IV-2-1 LIST OF EQUIPMENT OF ATMOSPHERIC DISTILLATION UNIT

Equipment NO.	Equipment Name	Number of Unit
C 1	Main Column	1
C 2	Stripper No.1/No.2	1
C 3	Stripper No.3/No.4	1
C 4	Soda Mixer No.1	1
C 5	Soda Mixer No.2	1
C 6	Sand Filter No.1	1
C 7	Sand Filter No.2	1
V 1	Water Drain Pot	1
V 2	Over Head Receiver	1
V 3	Soda Settler No.1	1
V 4	Soda Settler No.2	1
F 1	Crude Furnance	1
E 1	Crude/HN Exchanger	1
E 2	Crude/HN Ref. Exchanger	1
E 3	Crude/Kero Exchanger	1
E 4	Crude/LGO Exchanger	1
E 5	Crude/LGO Ref. Exchanger	1
E 6	Crude/HGO Exchanger	1
E 7	Crude/Residue Exchanger	1
E 8	Over Head Condenser	1
E 9	Heavy Naphtha Cooler	1
E 10	Kerosene Cooler	1
E 11	LGO Cooler	1
E 12	HGO Cooler	1
E 13	Residue Cooler	1
P 1	Crude Charge Pump	2
P 2	Over Head Refluxe Pump	1
P 3	Heavy Naphtha Refluxe Pump	2
P 4	LGO Refluxe Pump	2
P 5	Heavy Naphtha Pump	2
P 6	Kerosine Pump	1
P 7	LGO Pump	1
P 8	HGO Pump	1
P 9	Residue Pump	2
P 10	Soda Circulation Pump No.1	2
P 11	Soda Circulation Pump No.2	1

(3) Utilities consumption

In Table IV-2-2 below, the utilities consumption of the new atmospheric distillation unit is compared with that of the existing unit of the Centre. It is clearly noted that a considerable energy saving operation can be possible in the new unit. The basis and assumptions for the calculation of the utilities consumption is summarized in Annex IV-2-3.

Table IV-2-2 COMPARISON OF UTILITIES CONSUMPTION FIGURES BETWEEN THE EXISTING AND NEW ATMOSPHERIC DISTILLATION UNIT

Utilities Consumption	Existing Unit	New Unit
Fuel Oil (1/H)	1,180	200
Steam (kg/H)	2,770 1/	740
Electricity (KWH) 2/	123	157
Cooling Water (m^3/H)	230	150

Note 1/ Including steam consumption of reboiler pump
2/ Including power consumption of both cooling water pumps and fuel oil system pump.

(4) Other design data and information

For further reference, the following relevant data and information are attached as annex of the report.

a) Results of design calculation for the new main distillation column by computer (Annex IV-2-4).

b) Relationship between tray load and column diameter (Annex IV-2-5).

c) Preliminary plot plant (Figure IV-2-3).

d) Drawings of the main column and side strippers (Annex IV-2-6).

e) TBP and ASTM curves of each distillate obtained from Kawengan and Ledok crude (Annex IV-2-7).

2.2.3 Quality/Specification and Yield of Products after the Renovation (Plan-I)

The quality and yield of products obtained by the new atmospheric unit from Kawengan and Ledok crude is shown in Table IV-2-3 and Table IV-2-4, respectively.

For further reference, Table IV-2-5 summarizes the yield of products obtained from the new unit in comparison with that from the existing unit of the Centre.

Table IV-2-5 indicates that the gasoline yield from the new atmospheric distillation unit is rather higher than that from the existing old unit of the Centre. It is however, understood that according to Figure IV-2-4, the TBP point between gasoline and kerosene, that is 150°C, has a considerable allowance as against (as compared with) the minimum flash point of 100°F. For example, as the ASTM initial boiling point (IBP) of kerosene is 155°C for Kawengan crude and 161°C for Ledok crude, respectively, as against the TBP cut point of 150°C, it is judged that the TBP cut point can be reduced upto around 120°C for both crude.

According to the TBP curves for both Kawengan and Ledok crude oil illustrated in Figure IV-2-5, it is understood that the gasoline yield can be decreased by upto approx. 5% in case of Kawengan crude and about 9% in case of Ledok crude, resulting in reaching the actual performance figure of the Centre.

On the other hand, the yield of heavy gas oil (HGO) fraction from Kawengan crude is the maximum one at the furnace outlet temperature of 365°C. If a higher yield of HGO is needed, either an injection/introduction of steam at the entrance of the furnace or a circulation/ recycle of residue can be considered. However, since the present study is to be limited to a level of conceptual design, more detailed discussions shall be developed in the subsequent step of engineering study/service.

Figure IV-2-3 PRELIMINARY PLOT PLAN FOR NEW ATMOSPHERIC DISTILLATION UNIT

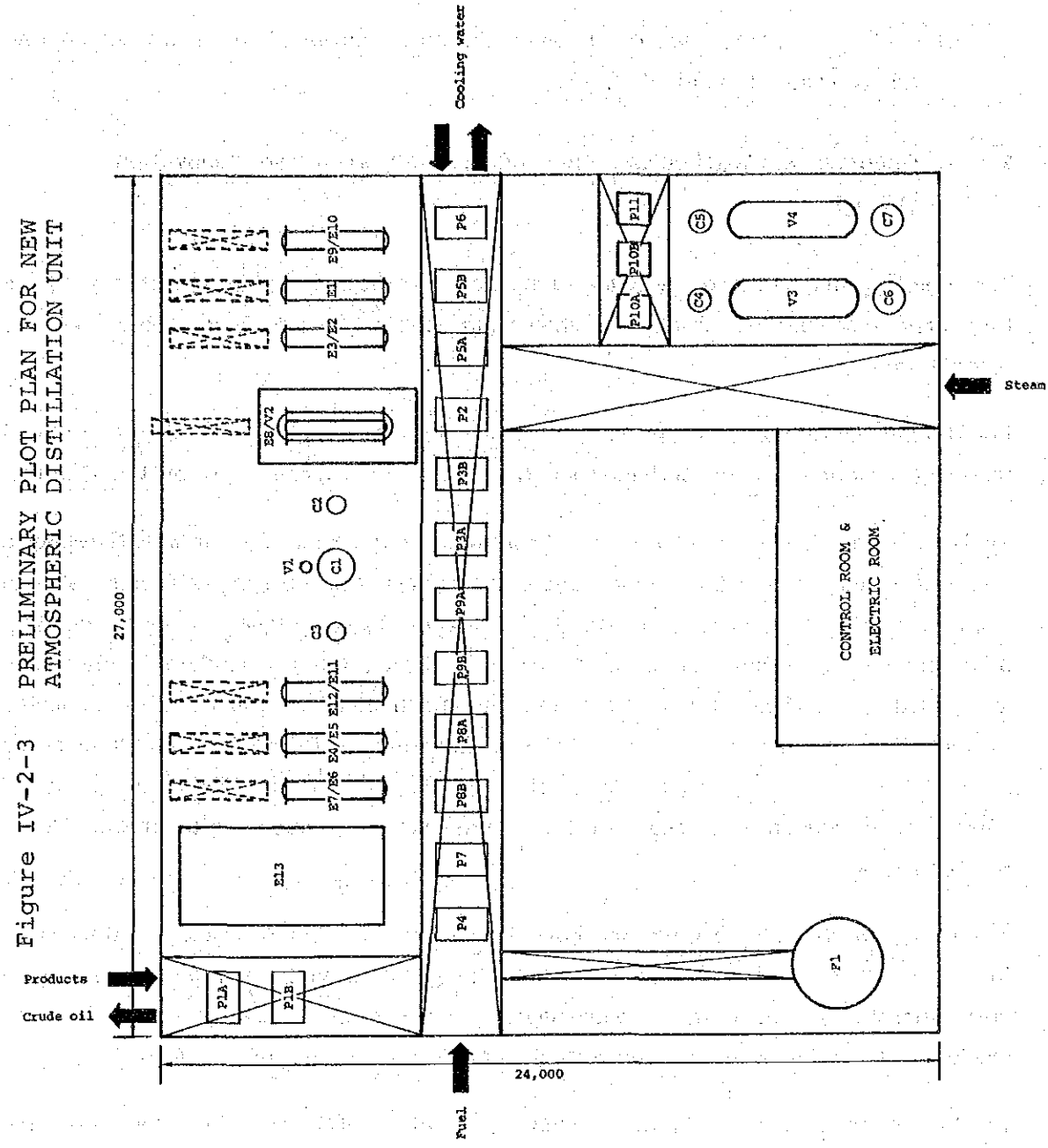


Table IV－2－3 QUALITY AND YIELD OF PRODUCTS OBTAINED FROM KAWENGAN CRUDE

Fraction	TBP Cut Point (℃)	Results of Calculation			
		ASTM Distillation (℃)	Sp. Gr (60°F)	KL /H	%on Crude
Light Gasoline	IBP-110	40-110	0.7132	0.680	5.1
Heavy Gasoline	110-150	102-176	0.7662	1.190	9.0
Kerosine	150-230	155-243	0.8125	2.140	16.2
L G O	230-280	222-312	0.8558	2.060	15.6
H G O	280-360	264-501	0.8695	2.610	19.7
Residue	360-	277-524	0.9121	4.570	34.4
Total			0.8553	13.250	100.0

Table IV－2－4 QUALITY AND YIELD OF PRODUCTS OBTAINED FROM LEDOK CRUDE

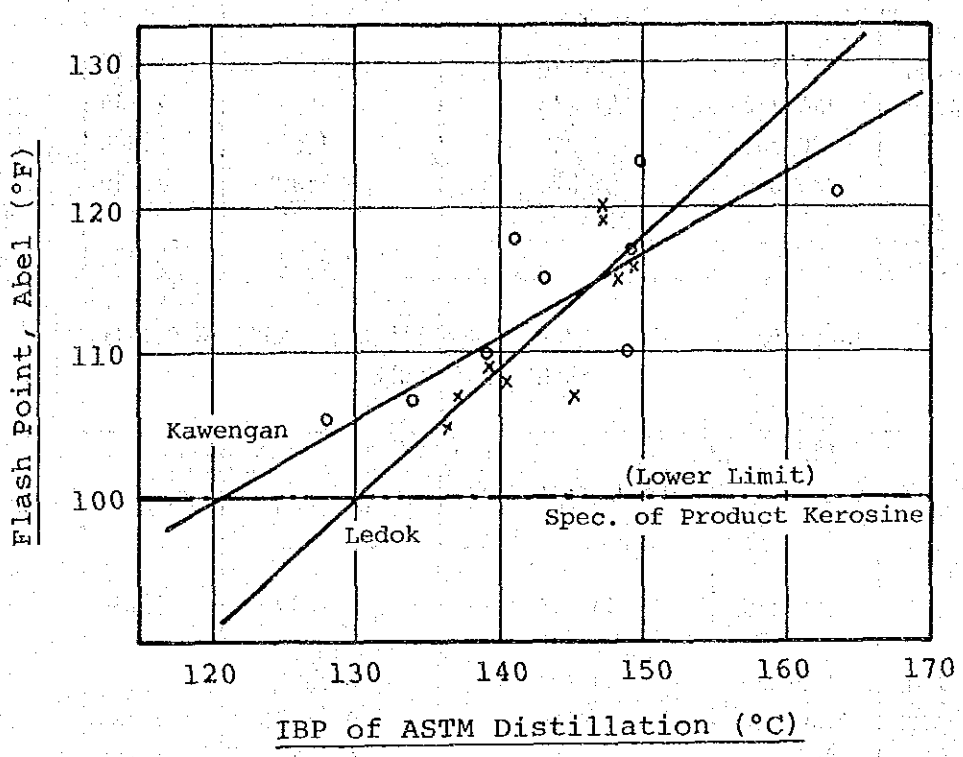
Fraction	TBP Cut Point (℃)	Results of Calculation			
		ASTM Distillation (℃)	Sp. Gr (60°F)	KL /H	%on Crude
Light Gasoline	IBP-110	40-110	0.7005	1.720	13.0
Heavy Gasoline	110-150	103-172	0.7585	1.940	14.6
Kerosine	150-280	161-280	0.8197	4.730	35.7
L G O	280-320	251-351	0.8582	1.300	9.8
H G O	320-350	293-528	0.9019	0.710	5.4
Residue	350-	298-551	0.9423	2.850	21.5
Total			0.8298	13.250	100.0

Table IV－2－5 COMPARISON OF PRODUCTS YIELD BETWEEN THE EXISTING AND NEW ATOMOSPHERIC UNITS

(unit:%)

Fraction	Kawengan Crude			Ledok Crude		
	New Unit	Existing* Unit	Difference	New Unit	Existing* Unit	Difference
Light Gasoline	5.1	8.2	+5.9	13.0	15.6	+12.0
Heavy Gasoline	9.0			14.6		
Kerosine	16.2	18.8	-2.6	35.7	20.8	+14.9
L G O	15.6	21.7	-6.1	9.8	31.8	-16.6
H G O	19.7	20.7	-1.0	5.4		
Residue	34.4	31.1	+3.3	21.5	29.4	-7.9

Note: (*) Based on the actual production performance by the type of crude of the Centre in 1984/85 fiscal year. (Table II-5-11)



Note: Based on data of the Refinery Laboratory in Feb. 1985.

Figure IV-2-4 RELATIONSHIP BETWEEN ASTM IBP AND FLASH POINT OF KEROSENE

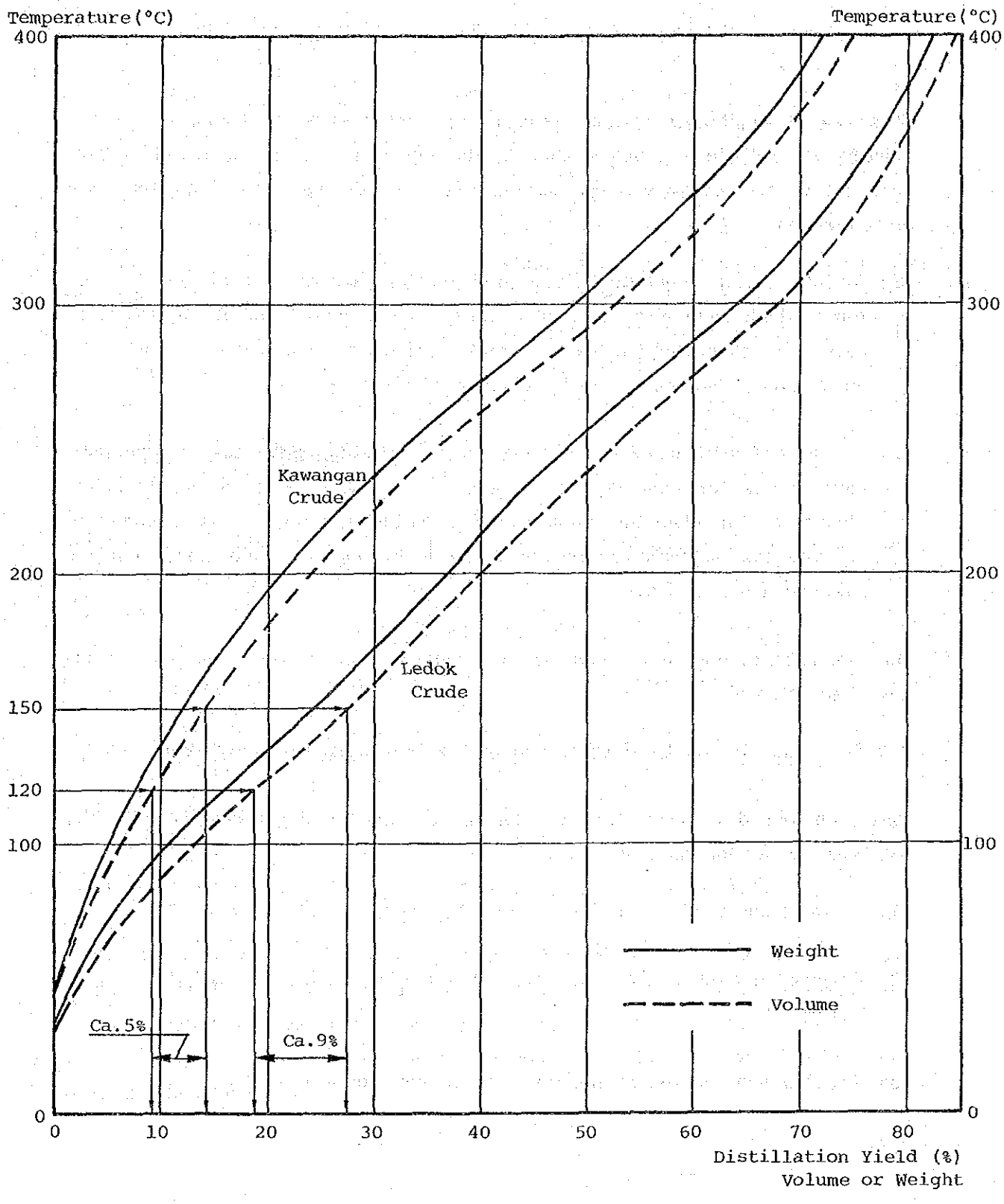


Figure IV-2-5 TRUE BOILING POINT DISTILLATION CURVES OF KAWENGAN AND LEDOK CRUDE OIL

2.3 Plan-II: Partial Renewal of Existing Atmospheric Distillation Unit

With regard to the renovation through a partial renewal of equipment of the existing atmospheric unit of the Centre, the following two alternative plans have been set up and analyzed. Summarized below are the basic ideas for this case of renovation:

(1) Amoung various equipment integrated in the existing unit of the Centre, those which have already been seriously superannuated and those which, in case of emergency/accident, great influence and damage could be anticipated, shall be removed replaced and renewed.

(2) Among presently utilized equipment in the existing unit, due to structural impossibility for opening, those which have not been open-inspected and cleaned so far since the initial construction and therefore are in a condition of very low performance and/or would be damaged by cleaning, shall be removed and renewed.

On the basis of the above criteria, the following alternative renovation plans have been studied.

2.3.1 Plan-II(A): Partial Renewal of the Existing Atmospheric Unit

Based on the discussions and for the reasons presented in the Part III, the following renovation shall be made:

(1) Removal and renewal of the main distillation tower C1B column.

(2) Removal and renewal of the crude furnace F1A, F1B, F1C, and the reboiler heater F2.

(3) Removal and renewal of the following 17 units of heat exchangers.

Item No.	No.	Service
E1 A, B	2	Crude Charge Heat Exchanger
E2 A, B, C	3	Light Gasoline Condenser
E3	1	Light Gasoline Condenser
E4 A	1	Light Gasoline Condenser
E5	1	Heavy Gasoline Cooler
E9	1	Light Gasoline Condenser
E11	1	Heavy Gasoline Cooler
E12 A, B	2	Heavy Gasoline Cooler
E13 A, B	2	Kerosine Cooler
E14 B	1	Gas Oil Cooler
E15 A, B	2	Gas Oil Cooler
Total	17	

(4) Removal of the main distillation tower C1A column that constitutes an obstacle/hindrance to the removal work of the main column C1B as described above.

(5) Cutting and reconnection of related pipings and cables/lines.

(6) Adjustment and appropriateness of pipings.

(7) Dismantling and reassembling of related structures.

(8) Repair work of insulation and fireproof coating and cover.

It has to be noted that according to this renovation plan, the corresponding equipment of the existing atmospheric distillation unit of the Centre is to be renewed based on the same original specification. Therefore, no special difference is expected in the quality and yield of products between before and after the renovation.

2.3.2 Plan-II(B): Partial Renewal of the Existing Atmospheric Unit

This alternative plan is formulated based on the addition of the following two items to the Plan-II(A) mentioned above.

(1) Removal and renewal of the auxiliary distillation tower C2 column, in accordance with the discussions developed in the Part III before.

(2) Renewal of the flasher V1.

It has to be also noted that, in this case again, the corresponding equipment is to be renewed in accordance with the same specification and therefore, no special difference is expected in the quality and yield of products before and after the renovation.

Chapter 3 Renovation Plans for Workshop Machine

As for the renovation of workshop machine of the Centre, the following two alternative plans have been studied.

3.1 Workshop Machine Renovation Plan-I

This alternative renovation plan for the workship machine is based on the selection of machine which is considered necessary at least for the repair and maintenance of the refinery of the Centre among which the existing workshop machines which are properly be utilized are omitted. Table IV-3-1 gives a list of workshop machine with its specification, which shall be newly introduced to the existing workshop of the Centre.

3.2 Workshop Machine Renovation Plan-II

This plan is based on the idea that such machine as noted as "bad condition" and/or "out of use" among the Centre's existing workshop machine used not only for the repair and maintenance of the refinery but also for the oil fields operation and maintenance as well as for the training activities, shall be replaced and renewed. Table IV-3-2 gives a list of new workshop machine with its specification.

Table Ⅳ－3－1　LIST OF NEW WORKSHOP MACHINE AND SPECIFICATIONS
(Workshop Machine Renovation Plan-1)

Type of Machine	Short Specification	Unit	Object No.
Lathe Machine	Center Hight=250㎜ Length=750㎜ Chuck dia.= 45㎜	1	3060
Lathe Machine	Center Hight=175㎜ Length=1,400㎜ Chuck dia.= 35㎜	1	—
Vertical Lathe Machine	Dia. Max=700㎜ Speed Max=730rpm	1	3143
Horizontal Milling Machine	Table:12" ×42"	1	3098
Radial Drilling Machine	Bore Max.=4" Column=11"	1	3124
Shaping Machine	Stroke=32"	1	—
Vertical Milling Machine	Table:335 ×1115㎜	1	3118
Drilling Machine	Bore Max.=25㎜ Stroke= 90㎝	1	3155

Table IV－3－2　LIST OF NEW WORKSHOP MACHINE AND SPECIFICATIONS
(Workshop Machine Renovation Plan-2)(1)

Type of Machine	Short Specification	Unit	Object No.
Lathe Machine	Center Hight=200㎜ Length=1,300㎜ Chuck dia.= 45㎜	1	3057
Lathe Machine	Center Hight=250㎜ Length=750㎜ Chuck dia.= 45㎜	1	3060
Highspeed Lathe Machine	Center Hight=180㎜ Length=1,500㎜ Chuck dia.= 45㎜	1	3063
Lathe Machine	Center Hight=220㎜ Length=1,500㎜ Chuck dia.= 70㎜	1	3065
Lathe Machine	Center Hight=300㎜ Length=2,000㎜ Chuck dia.= 50㎜	1	3068
Lathe Machine	Center Hight=175㎜ Length=1,400㎜ Chuck dia.= 35㎜	1	—
Highspeed Lathe Machine	Center Hight=175㎜ Length=1,400㎜ Chuck dia.= 35㎜	1	3088
Highspeed Lathe Machine	Center Hight=190㎜ Length=1,500㎜ Chuck dia.= 50㎜	1	3078
Lathe Machine	Center Hight=180㎜ Length=1,300㎜ Chuck dia.= 70㎜	1	3075

Table Ⅳ－3－2　LIST OF NEW WORKSHOP MACHINE AND SPECIFICATIONS
(Workshop Machine Renovation Plan-2)(2)

Type of Machine	Short Specification	Unit	Object No.
Highspeed Lathe Machine	Center Hight=325㎜ Length=2,000㎜ Chuck dia.= 66㎜	1	3113
Highspeed Lathe Machine	Center Hight=400㎜ Length=4,000㎜ Chuck dia.= 65㎜	1	3109
Vertical Lathe Machine	Center Hight=700㎜ Speed Max.=730rpm	1	3143
Horizontal Boring Machine	Max. Hight=630㎜ Max. Speed=730rpm	1	3136
Slotting Machine	Stroke=300㎜	1	3140
Horizontal Milling Machine	Table:12" ×42"	1	3098
Planing Machine	Hight=30" Midth=30" Length=8ft	1	3132
Radial Drilling Machine	Bore Max.=4" Column=11"	1	3124
Shaping Machine	Stroke=16"	1	—
Shaping Machine	Stroke=32"		3121
Vertical Milling Machine	Table: 335×1115㎜	1	3118
Vertical Milling Machine	Table: 300×1200㎜	1	—
Horizontal Jack	Stroke=3.2m	1	3150
Drilling Machine	Bore Max.=25㎜ Stroke=900㎜	1	3155
Drilling Machine	Bore Max.= 2～10㎜ Stroke=250㎜	1	3157
Vertical Jack	Stroke=1.3m	1	3149
Jack Pump	Max.= 25㎏／㎠	1	—
Clean Table	Table:0.5 × 1.0m Dia=0.3 m	1	—

Chapter 4 Renovation Plan for Laboratory Equipment

4.1 Refinery Laboratory

As described before in Part III, the renovation shall be made for those facilities and equipment of the refinery laboratory of the Centre under the following basic principles:

(1) Based on experience in the use of various auto-analysers in Japan, such equipment as for automatic distillation testing, automatic flash point testing and automatic residual carbon testing which can be used without a frequent impediment, among various auto-analysers, shall be newly introduced. These auto-analysers will be installed better in the refinery laboratory where on-the-job training is implemented, while in the training laboratory, the renovation shall be centered on the introduction of conventional manual type analysers/ equipment with the purpose for students/trainees to practice there fundamental analytical procedures.

(2) Equipment which can not be considered no longer properly utilized, due to great extent of superannuation and lack of spare parts, shall be replaced/renewed by the corresponding new one.

(3) Equipment which is already more than 15 years old since its initial purchase and therefore whose spareparts is becoming difficult to obtain, shall be replaced by new corresponding one.

(4) Analytical equipment that is judged to be necessary in view of product specification items, shall be newly introduced/ supplemented.

In line with these principles, a list of equipment to be newly introduced under the renovation plan of the refinery laboratory has been prepared and attached as Annex IV-4-1. Assuming that the on-the-job training is to be conducted on a rotation basis, the number of units of equipment required will be one for each equipment except some equipment for water analysis.

4.2 Training Laboratory

The practice of experiment by means of equipment in the training laboratory plays an important role not only for the purpose to prove knowledge and theory learned through classroom lessons and to master them as practical and concrete knowledge and skill, but also as an introducing step to the subsequent on-the-job training.

As described in Section 3.3 of Chapter 3, Part III, the renovation of the training laboratory equipment has been planned based on the following three conceptual categories.

(1) Replacement/renewal of equipment which has become too old to be used more and/or difficult in obtaining spareparts.

(2) Renewal of equipment which has already been technologically behind, by corresponding new one.

(3) Introduction/supplement of necessary equipment for the training/mastery of fundamental and modern sophisticated technologies as well.

Application of the above concept to the formulation of the renovation plan of the training laboratory makes it necessary to introduce/supplement such important instrumental analysers as frequently used for gas analysis and for the identification of materials and chemical elements in chemical laboratory as well as to introduce/renew training facilities for unit operations. A list of equipment to be newly introduced under the renovation plan for the training laboratory is presented as Annex IV-4-2.

Chapter 5 Equipment Needed for Inspection and Maintenance

5.1 Equipment for Inspection

In relation to the training activities of the Centre, discussed in Part II and Part III, it is noted that a great demand is being raised by the clients in a training course for inspection of facilities and equipment, as one of the new courses and diciplines which would be established and offered by the Centre in the near future. In order to implement this course, the following categories of equipment will be required.

(1) Condition monitoring

(2) Static equipment monitoring

(3) Radio examination

(4) Magnetic particle examination

(5) Liquid penetrant examination

(6) Ultrasonic examination

(7) Eddy current examination

(8) Material examination

(9) Other examination

A list of necessary equipment for each of the above categories is given in Annex IV-5-1.

5.2 Equipment for Maintenance

It is essential to maintain facilities and equipment once installed so as to always give full play of their initial performance, and at the same time, to check and confirm upon reassembling of dismantled equipment, whether it is free from leakage and operated safely.

With this objective, it is recommended that an introduction of jet cleaner (which is used for the elimination of scale deposited on heat transmission surface of heat exchangers by means of impact energy caused by injecting high pressure water from small nozzle) be disposed. An disposition of compressors is also recommendable to check leakage in facilities and equipment dismantled and reassembled. Specifications of the jet cleaner and compressors are shown in Annex IV-5-2.

Chapter 6 Training Aids/Facilities of AKAMIGAS

Based on the discussions and also for the reasons described in Part II and Part III, it is recommendable that the following training aids/facilities be disposed to AKAMIGAS. Especially in connection with the adoption/new introduction of the editing/ compilation equipment for the preparation of video-tape teaching materials as one of the audiovisual aids, it is highly recommendable that the Centre install a studio which makes it possible to effectively utilise audiovisual aids including overhead projectors and slides. This is considered possible through the Centre's own efforts.

(1) Audiovisual Aids

a) Overhead Projectors

b) Slide Projectors

c) Video and auxiliary equipment

(2) Drawing/Drafting Board

Details are given in Table IV-6-1.

Table IV-6-1 LIST OF NEW EDUCATIONAL INSTRUMENTS IN AKAMIGAS

No.	Name	Q'ty	Spec.
1.	Overhead Projector		
	(1) Desk Projector	2	High grade overhead projector
	(2) Overhead Projector	9	Popular type and with spare lamp for changing quickly
	(3) Projection Screen	11	150 x 150 cm screen for OHP
	(4) Projection Stand	11	
2.	Slide Projector	3	For 35 mm mounted slide, with horizontal circular tray
3.	Video System		
	(1) Portable Color Video System	1	Portable T.V. camera: 1 set Carrying cart: 1 set Rechangeable battery pack: 1 set Battery charger: 1 set Car battery adaptor: 1 set Video cassette recorder: 1 set Stand for T.V. camera: 1 set Lighting kit: 1 set Monitor T.V.: 1 set Monitor wagon: 1 set Miscellaneous and tool: 1 lot Video cassette recorder: 1 set
	(2) Editing System	1	Video cassette recorder: 2 set Automatic editing control: 1 set Colour T.V. set: 1 set V.T.R. consol: 1 set Miscellaneous and tool: 1 lot
4.	Designing Instruments	10	For A1 (600 x 900 mm) size Consists of: Drafter: 600 x 900 cm Stand: Square pipe type Board: S (2.0 x 3.0) type, 600 x 900 x 30(T) mm Demensions (mm): approx. 900(W) x 600(D) x 800 - 1